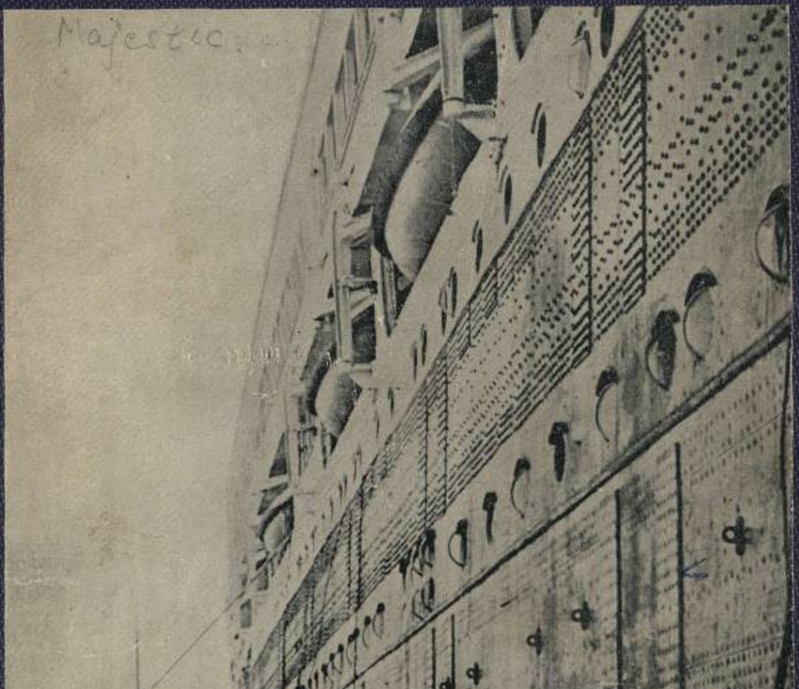
THE LARGEST SHIPS OF THE WORLD



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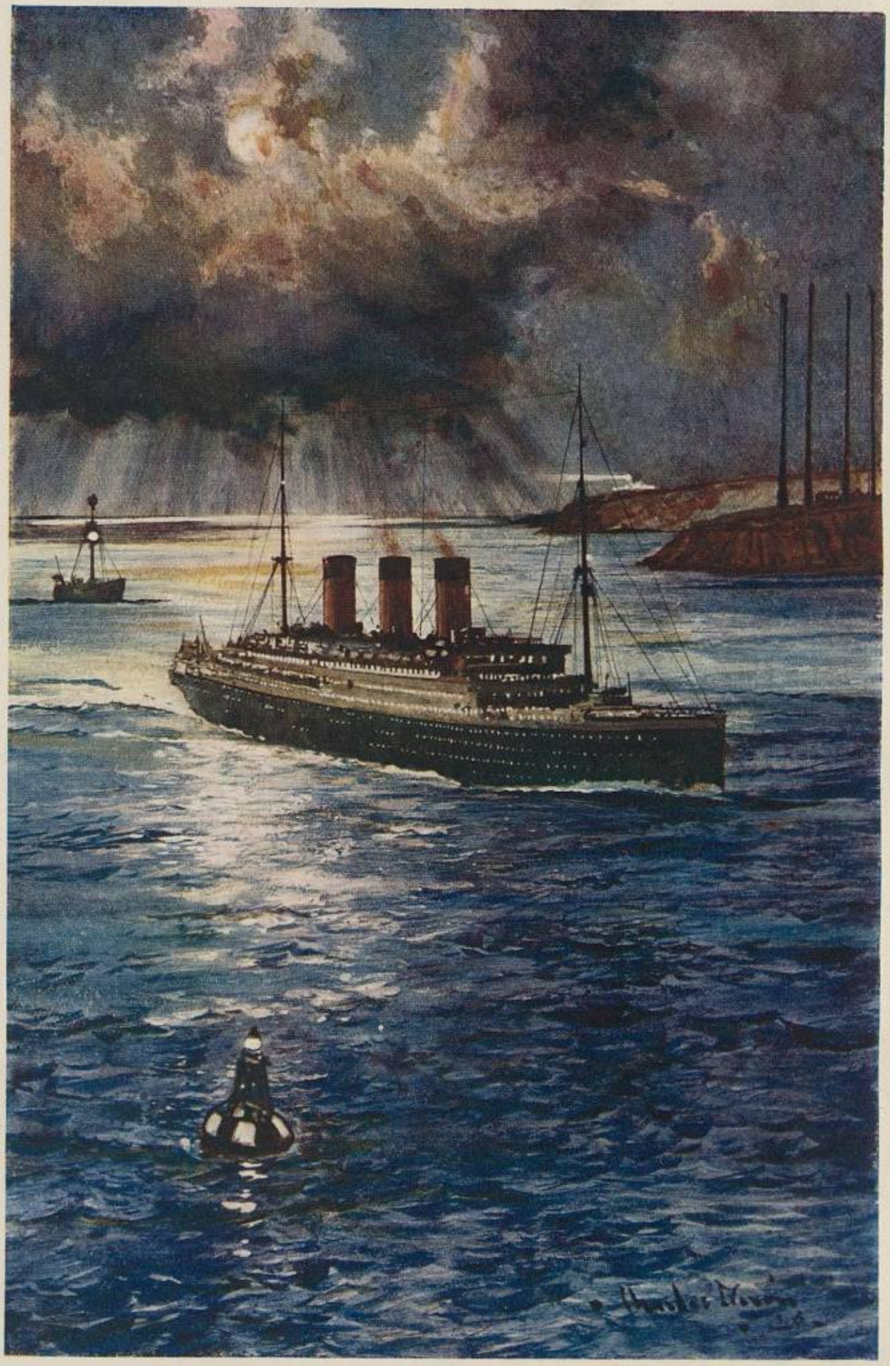

THE "MAJESTIC'S" CONTACT WITH THE OUTSIDE WORLD. 1922 built.

Frontispiece *By Charles Dixon, R.I.*

THE LARGEST SHIPS OF THE WORLD

BY

V. S. FELLOWES WILSON

F.R.G.S.

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PREFACE

THIS book is intended to deal with the wonders of the largest ships of to-day—chiefly passenger vessels plying on the Atlantic. It is written with a view to illustrating the use which man has made in almost every branch of science of inventions that are specially adapted to a "life on the ocean wave".

The work is not a manual of seamanship, and but little attention is given to the early history of the art of shipbuilding or navigation. I have tried to tell something of the eternal struggle between man and Nature, how disaster has been met by science, and of the wonderful and rapid growth of the big liner during the last twenty-five years. Due notice is also taken of water, the ship's environment, and of land, its seat of peril.

The mariner of the past has taken great risks and Nature took toll. On the great ocean steamer tracks we have charts showing not only all dangerous rocks and shoals, but every lighthouse and lightship, with the nature of the flash by which it is known recorded.

If you sailed closely round the British Isles by night, only on six occasions would you be out of sight of some ray of hope, except in fog, and then you may know your position by sounding and by the use of wireless, or listening-in for submarine signals from some lightship marked in the track.

Some traders have demanded specially constructed ships, such as cold-storage meat transport ships, which bring many thousands of carcasses at a time from Australia and New Zealand to England.

Colliers carry on coal trade, and oil-tankers supply oil. There are fruit-trade ships, grain ships and so on. But the ships described here are *passenger ships*, and these are the largest in the world and belong to the fleets of the Cunard, White Star, United States lines, and Compagnie Générale Transatlantique and others.

I am greatly indebted to Lieutenant F. S. Clifford, whose kind assistance in revising a large amount of this work has been invaluable. To the following I wish to tender my thanks for kind permission to use information or illustrations: the Controller of

H.M. Stationery Office ; the Lords Commissioners of the Admiralty ; the Hydrographer of the Navy ; Messrs. Harland & Wolff, Belfast ; Swan, Hunter & Wigham Richardson ; John Brown & Co. ; the White Star Line ; the Cunard Line ; the P. and O. Steam Navigation Co. ; the United States Lines ; Compagnie Générale Transatlantique ; Sir Joseph W. Isherwood, Bt. ; Kelvin, Bottomley & Baird ; the Sperry Gyroscope Co. ; Sir W. G. Armstrong Whitworth & Co. ; British Oxygen Co. ; Bullivant & Co. ; the Editors of the *Daily Mail*, *Shipbuilding and Shipping Record*, *The Shipbuilder* ; Messrs. Marconi Wireless Telegraph Co. ; Submarine Signalling Co. ; the Parsons Marine Steam Turbine Co. ; the Gas Accumulators Co. ; White Patent Oil Burning Co. ; United Flexible Metallic Tubing Co. ; J. Stone & Co. ; Power Plant Co. ; and others duly acknowledged elsewhere.

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A CENTURY ago the ships of Britain were, for the most part, engaged in carrying luxuries for the well-to-do members of society, but to-day it is the masses who benefit. We are clothed and fed by a stream of supplies from all parts of the world, brought mostly in British bottoms.

How is it that these small islands have been leading the world in shipbuilding and commerce and have become the centre of a world-wide Empire? Nature has given this island of Britain a long coast-line, numerous safe harbours and navigable rivers, and placed her on the Atlantic in a position favourable for navigation between the New and Old Worlds. "But for England's geographical position in the Gulf Stream we should have ice on our coasts and land, as in Labrador across the sea in the same latitude.

"We enjoy an equable climate. In winter our soil, rivers, and shore waters do not freeze, and in summer we do not suffer from heat, while we can grow food for our population. We are favoured with high tides that ebb and flow twice a day, keeping the mouths of rivers free from silt, and can at all times carry boats to and from the sea, round curves which sailing vessels find it difficult to pass."[1]

In another place we shall see how the tidal estuaries which

[1] *Geography and World Power*, James Fairgrieve.

can be entered from the open sea are used for shipbuilding and launching. The sea round our coasts has in the past protected us from invasion, and it is the sea which gave us the means of access to other lands, and by her rough and stormy ways moulded the character of our people.

In the reign of Richard II there lived one Master Philpot, a merchant-seaman of the City of London. At his own expense he sought the suppression of the pirate, John Mercer, a Scotchman who had made common cause with our enemies. With fourteen ships and a thousand men he set out in search of the pirate. Master Philpot, then the Lord Mayor of London, could not endure the inaction of the Government, and he himself went to sea.

The pirate had some twenty-one vessels. All but five of these were captured or destroyed, and Master Philpot returned with five hundred prisoners, and Mercer was one of them.

The citizens of London greatly rejoiced, but the Government charged Philpot with making war without the King's permission. Before the Earl of Stafford, Philpot said: "Know, sir, that I did not expose myself, my money, and my men to the dangers of the sea that I might deprive you and your colleagues of your knightly fame, or that I might win any myself, but in pity for the misery of the people of the country, which, from being in a noble realm with dominion over other nations, had through your selfishness become exposed to the ravages of the vilest race. Not one of you would lift a hand for her defence. Therefore it was that I gave of myself and my property for the safety and deliverance of my country."

"To the sailing-ships and to those who went to sea in them our country owes much of its greatness. They laid the foundations of our maritime power, enabled us to develop valuable overseas markets, and provided a training school which produced many famous naval heroes of the past." [1] This can be said of our clippers of the fifties and sixties, of which the *Cutty Sark* is one of the few survivors; she is now a training-ship.

Centuries before the days of these famous clippers, the Cabots, John and Sebastian, received a patent (1496) empowering them to seek unknown lands. Henry VII gave Sebastian Cabot the sum of £10 for discovering Newfoundland; in reality this intrepid navigator saw the American continent before Columbus or Amerigo Vespucci. This is said to be proved by his map, now in France. "He was distinguished for lofty courage and unflagging perseverance in the execution of his designs. Few lives exhibit such incessant activity in the pursuit of an idea." [2]

[1] *Survivors of a Glorious Era*, 1924.

[2] 10th ed. *Encyclopædia Britannica*, vol. iv, p. 662.

After failing to find the North-West Passage (to China and India), English mariners turned towards the possibility of a North-East Passage.

In 1553 three vessels sailed to discover a North-East Passage to Cathay, Sir Hugh Willoughby as captain-general and Richard Chancellor as pilot-major. Willoughby and his crew perished in a harbour on the Lapland coast. Chancellor, however, was more fortunate. He reached the White Sea, performed the journey overland to Moscow, where he was well received, and may be said to have been the founder of the trade between Russia and England. He returned to Archangel and brought his ship back safely to England. On a second voyage in 1556 Chancellor was drowned; and three subsequent voyages, led by Stephen Burrough, Pet and Jackman, effected an examination of the straits which lead into the Sea of Kara. The Company of Merchant Adventurers fitted out two vessels under Arthur Pet and Charles Jackman. Pet, after passing through the strait into the Kara Sea, and having made a persevering effort to push eastward, returned to England in safety. Jackman, after wintering in a Norwegian port, sailed homeward, but was never heard of again.

In 1576 Frobisher sailed with two small vessels of 20 tons, the *Gabriel* and *Michael*. In mid-Atlantic they parted company. Frobisher in the *Gabriel* found new land and returned with specimens of plants and stones. Whereupon the "gold-finders" in London took it into their heads that a glittering piece of mica schist contained gold ore. This aroused intense excitement, and much larger expeditions were fitted out. As many as fifteen vessels set sail on the voyage. One of them, a little "busse" of Bridgwater, called *Emma*, reported having seen land and sailed along it for three days. The phenomenon was never seen again, and may have been only a large ice-field. Small wonder that many of these brave men never returned.[1]

It is a far cry from those days to the giant liners that are the glory of the mercantile marine to-day, but the indomitable spirit that animated the old-time mariners lives on in the modern English seaman.

On May 1, 1922, four of the largest ships in the world were in the port of Southampton. Never before in history had such a wonderful display of big ships been seen in dock together.

The *Majestic*, built for the Hamburg-American Line as *Bismarck*,[2] and now belonging to the White Star Line, 56,551 tons,

[1] 10th ed. *Encyclopædia Britannica*, vol. x, p. 183.

[2] S.Ss. *Berengaria*, *Leviathan* and *Majestic* are the three ships built in Germany in 1913 and 1914 for the Hamburg and America line, and named *Imperator*, *Vaterland* and *Bismarck*.

floated with the *Olympic*, 47,000 tons, of the same company, just astern, and the *Mauretania*, 32,500 tons, on her port side. The Cunarder *Berengaria*, 52,000 tons, formerly known as the *Imperator*, was not afloat. This last ship lay in dry dock close by, as seen in the photograph (Fig. 1).

We are chiefly concerned with vessels of this type, and other ships brought into our story will be described merely by way of contrast. By illustrations and description we shall see how a rudder 78 ft. 8 in. high, which weighs 101¼ tons, is easily moved by one hand, and the direction of its movement is shown on a dial on the captain's bridge and in the engine-room. The boilers of one ship can cover an area of about 5 acres. Funnels rise from the engine-room to a height of 180 ft., 35 ft. higher than Nelson's monument in Trafalgar Square.

Think of ships with nine decks! It is well on half a mile's walk round the deck of such a ship from bow to stern and back. Deck space is equal to no fewer than eight football fields. The top of the hollow steel masts are 225 ft. above the keel! They carry the wires of the "drift of aerial" high above the funnels spread out by Marconi officers to catch wireless signals.

These great vessels need large anchors and cables. The anchors weigh 15½ tons each, and the cables are 1,800 ft. long, made of great steel links.

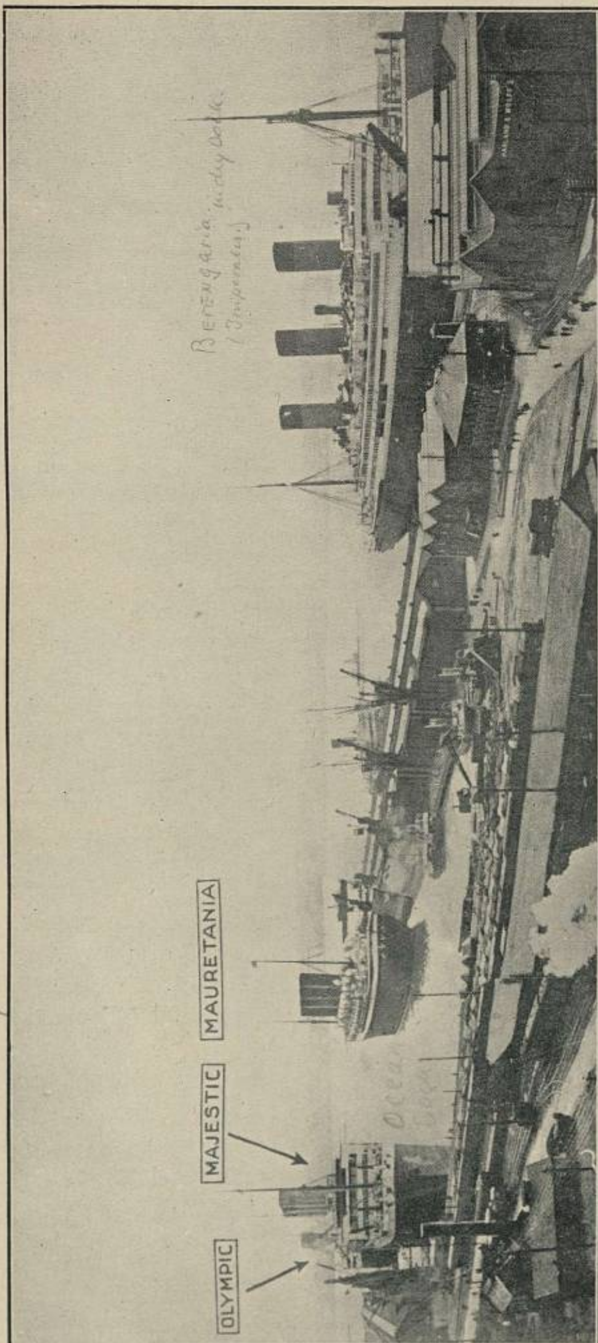
On the foremast there is a crow's-nest "look-out" and a 150,000-candle-power electric searchlight. This is 180 ft. above the sea. The way up to the crow's-nest is by iron steps within the hollow steel mast. The door leading to this is on the fifth, or E, deck below.

Atlantic ships and some vessels of other lines have a swimming-bath, racquet court, gymnasium and Turkish baths.

On these giant ships there are electric lifts for passengers, moving up and down five decks, and some shops, a greenhouse for hothouse plants, and a gardener to look after the plants on board. There is a telephone system and exchange for 900 telephones. World-wide news received by Marconi wireless is printed in the *Daily Mail Atlantic* of Cunard ships, and other lines have their own Press. Printing goes on at night, and passengers have their papers at breakfast-time.

The arrangements for safety at sea are full of interest, and form a separate chapter. We will deal with wireless, the fire brigade, lifeboats, electric lighting and emergency appliances in turn. The Ark, according to information we have in the Bible, must have been a vessel of some 15,000 tons.

Our floating palaces of to-day are 50,000-ton ships, which can carry 4,000 or 5,000 souls in comfort as well as many thousand



By courtesy] *The Daily Mail.*

FIG. 1.—THE FOUR LARGEST SHIPS IN THE WORLD IN SOUTHAMPTON DOCK.

tons of cargo. With engines of some 100,0C0 h.p. they plough their way through the dark blue ocean at a speed of nearly 30 miles an hour, leaving a wash for miles astern.

Now the curtain has been lifted just sufficiently to excite interest, and in another place we will see "how it works". Truly Great Britain is the shipping centre of the world, and has been building ships for all nations.

It is proposed not to go far back into the history of shipbuilding, but for those who wish to do so they will find *Ancient and Modern Ships*, Part I and II, by Sir George C. V. Holmes, K.C.V.O., C.B., and *The Boys' Book of Steamships*, by J. R. Howden, and other books mentioned in the bibliography. Apart from special trade ships, such as the oil tankers, about which a few remarks will be made farther on, the evolution of big ships has with one exception been continuous.

"Great Eastern," 1858, 18,914 tons, 692 ft. long.—Many of us may remember hearing or reading about the *Great Eastern* (Fig. 2), a passenger and cargo steamship launched in 1858. She was built at Millwall, on the Thames, by Scott-Russell from plans by Mr. I. K. Brunel, who was her engineer. This ship had six masts—five of iron, one of wood—and a spread of 7,000 yards of sail, besides having eight engines, divided between her screw and paddles, for she was both a great paddle and screw steamer.

There was no ship to compare with her in point of size; in fact, she was nearly twice the length of the *Persia*,[1] the largest vessel of her time. She proved to be in advance of her age. Launching operations were several times attempted in vain; but at length (after two and a half months) the great vessel was pushed into the water sideways instead of stern first on January 31, 1858. These operations alone cost the company £120,000. "No doubt the chief cause of this expensive failure is attributable to the fact that Mr. Brunel (it was well-known at the time that Mr. Scott-Russell strongly opposed Mr. Brunel's plan of launching) was permitted to try the almost insane experiment of launching the ship on iron instead of wooden ways, as has hitherto invariably been adopted in the launch of all other vessels."[2]

We cannot imagine anyone to-day proposing to build a ship twice the size of our largest vessel afloat, for that is what Mr. Brunel had the courage to do, and no one has a word to say against his big ship construction. That was a triumph. She was intended to trade between England and the East, and built to run to Australia without requiring to coal anywhere on the journey. Ships in those

[1] First iron steamer, 1856.

[2] *History of Merchant Shipping*, vol. iv, pp. 5, 22, by W. S. Lindsay.

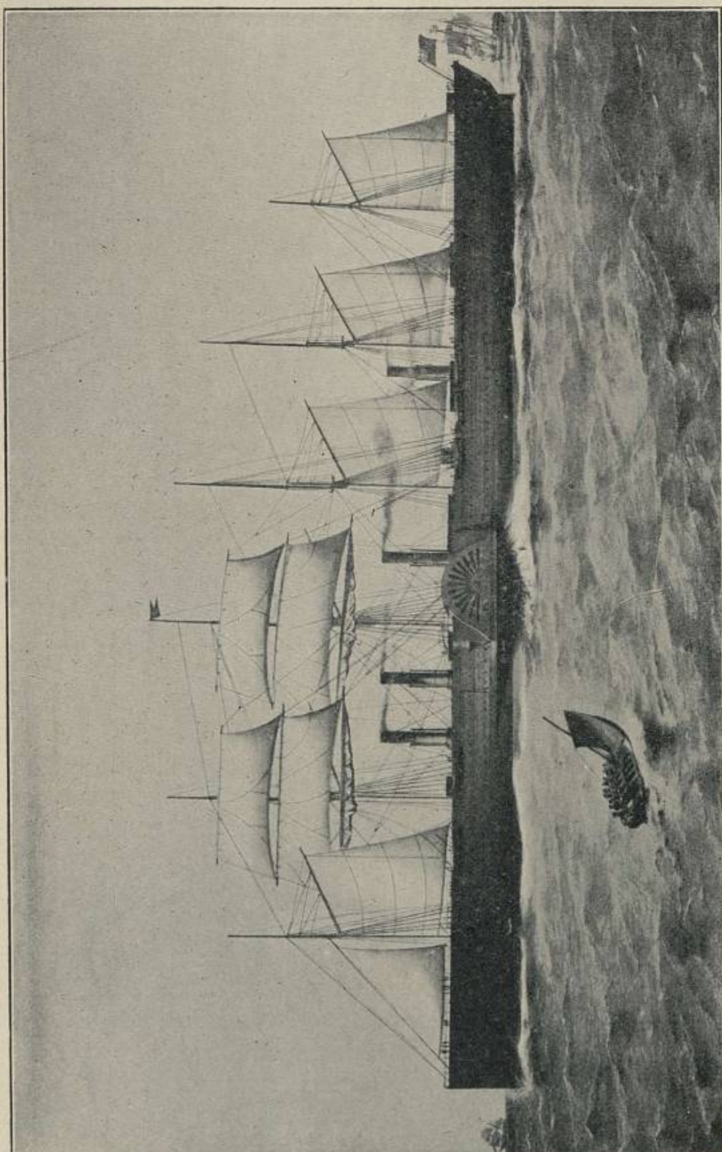


FIG. 2.—THE "GREAT EASTERN". 1858.

Double Skin!
100 ft scheur op 20 ft → geen lek!

days had a radius of 2,000 miles travel. "After the launching much remained to be done to complete the ship ; and her engineer, overworked and worn out with the worry of the launching processes, broke down and did not live to see her sail on her first voyage, for he was attacked with paralysis on board his great ship on September 5, 1859, and died ten days later." [1]

The *Great Eastern* is considered a triumph of iron ship construction, and like all great ships to-day, she had two skins, and was a ship within a ship; and although she ran on to a pointed rock, she was able to continue the voyage without hindrance. It was afterwards found that holes of the combined length of 100 ft. had been torn in her outer bottom. Thanks to her inner watertight skin, no water was admitted. Many reasons can be given for the failure of this big ship. However, she laid the Atlantic cables between this country and America, and we must leave that to her credit.

"Oceanic," 1899.—Forty-one years elapsed before any ship was built which surpassed the *Great Eastern* in length. In 1899 the second *Oceanic* was built by Messrs. Harland & Wolff, of Belfast, for the White Star Company. This ship was then the longest vessel that had ever been built. The *Great Eastern* was 692 ft. over all, whereas the *Oceanic* was 705 ft. long. The illustration of this ship and the *Great Eastern* has been given by the kind permission of H.M. Stationery Office, Westminster, and of Sir George Holmes, K.C.V.O., C.B. "The *Oceanic* (Fig. 3) was considerably narrower than the *Great Eastern*, while her design is also a departure from the older ships. The flat floor and sharp turn of the bilge is almost a rectangle. The bilges had double plating." [2] From that time onward shipbuilders of Atlantic liners forced the pace in big shipbuilding. There was keen competition to earn the distinction of possessing "the largest ship in the world". Big ships are considered best suited to the Atlantic trade. There are many reasons for this. "The large ship can receive without inconvenience a wound which would be fatal to a small one, and the possibilities of obtaining high speed increase with the size." [3]

Length of Ships.—Naval architects and shipping authorities seem to think that the future Transatlantic shipping lies, not with the fastest, but with the largest vessels. The four largest steamships to-day are *Aquitania*, 901½ feet, *Berengaria*, 920–6 ft., *Leviathan*, 950–7 ft., and *Majestic*, 956–7 ft. over-all length.

In less than fourteen years—i.e. *Oceanic*, 1899, to *Imperator*, 1913 (now *Berengaria*)—there was an increase in tonnage of 33,000

[1] *Encyclopædia Britannica.*
[2] *Ancient and Modern Ships.*
[3] *Encyclopædia Britannica*, vol xxi, 1910.

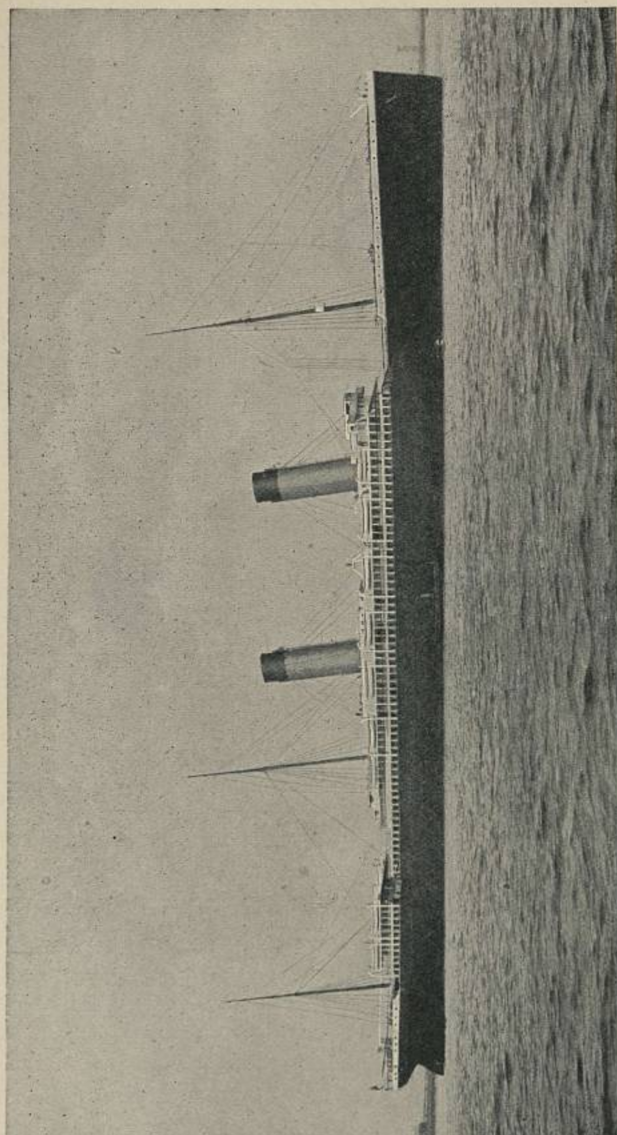


FIG. 3.—"OCEANIC II". 1899.

tons. So rapid was the progress in big shipbuilding that some ports were found too shallow to berth the new vessels conveniently.

Giant Ship Companies.—The three steamship companies which own the largest vessels are not necessarily the largest shipping companies. They do not own the largest number of ships.

The P. & O. Steam Navigation Company has no ship of 30,000 tons and has the largest fleet of ships. The nature of the trade routes of each shipping company places a certain limit on the class and size of ships required.

Suez Canal.—As regards the Atlantic lines, there is no limit to size of vessels plying between Europe and America like there is for vessels going East ; there the Suez Canal is a bar to increase of size. Tonnage must be limited to the conditions on the Suez Canal. The Peninsular and Oriental Steam Navigation Company has vessels built specially for this route, and many other companies trading with the East do likewise.

"At the time when Cook and others were making discoveries, there was no Suez Canal. Ships might sail up the Mediterranean or the Red Sea, and even up the Delta of the Nile and the lakes, but they could not cross the bar of miles of sands ; those few miles were sufficient to block routes that would reduce the distance between Western Europe and India by 4,000 miles." [1]

I remember, when a boy, we arrived from Bombay by P. & O., disembarked at the south end of the Suez Canal works, then under construction, and travelled in palankeens placed on open trucks. We suffered from red-hot cinders falling on us direct from the engine's funnel. Blankets were used as a means of protection. This railway journey ended at Alexandria, where a steamer was ready to take us on to Southampton.

Before the commencement of the Canal, part of the journey was made in coaches ; this was known as the Overland Route. In spite of its name, the Overland Route was mostly a waterway.[2] The Mahmoudieh Canal enabled the P. & O. Company to transport its passengers and goods from Alexandria to the Nile, whence they travelled by steamer to Cairo, and the land portion of the journey was rather less than 100 miles across the desert from Cairo to Suez. Caravans, sometimes numbering more than a thousand camels, were employed to convey a single steamer's loading between Suez and Cairo.

The Suez Canal engineer, Ferdinand de Lesseps, removed this bar in 1869. There is a somewhat similar obstacle at Panama, and a canal piercing the Isthmus there was opened in 1915. Ships for the Pacific by this route will have their limits. The making

[1] *British Shipping*, A. W. Kirkaldy.
[2] *The P. & O. Pocket Book.*

of these two great sea canals has changed the history of sea commerce.

P. & O. Co.—The Peninsular and Oriental Steam Navigation Company trading eastward through the Suez Canal build ships having a maximum draught of 31 ft., and the largest vessels being built for them now are just over 20,000 tons. If naval architects had freedom they would build longer ships, but long ships must be deep in proportion. By dredging channels or by adopting ports of departure and arrival with deep waters something can be done. The *Belgenland* is the largest passenger vessel that has passed through the Suez Canal and Panama.

In the course of her circumnavigation of the globe the great vessel had earned three significant records : she was the largest ship to girdle the globe ; she was the largest to make the transit of the Panama Canal; and she was the largest to pass through the Suez Canal.

Canal Dues.—"There is not only the physical question of draught to consider, but also the equally important one of how far the increased advantages accruing from large ships are financially discounted by the augmented Canal dues. These dues are under special rules, including much that would be excluded under ordinary conditions." [1] Further, it was long ago recognized that for economical working different cargoes should have different classes of vessels ; that cargoes of great density, for instance, which occupy little space in comparison with weight, such as iron ore or machinery and heavy general cargoes, should be carried in strong vessels having great draught and displacement and limited hold space ; and cargoes of less density, such as grain, cotton, wood, and light general cargoes, should be dead-weight capacity. These are known as "three-deck", "spar-deck", and "awning-deck" types.[2]

P. & O. Flag.—The famous P. & O. flag (a square flag quartered diagonally in blue, white, red and yellow) is said to have

FIG. 4.—HOUSE FLAG OF THE P. & O. COMPANY.
By courtesy.

its origin in the colours of the Portuguese and Spanish ensigns, the Peninsular countries to which the P. & O. ships first ran in 1837, plying between Falmouth, Lisbon, Cadiz and Gibraltar. The Peninsular and Oriental Company's flag, as given in Lloyd's book of house flags and funnels, to-day is as illustrated in Fig. 4.

[1] *Syren.* [2] *Ship Construction and Calculation*, Geo. Nicol.

From the Portuguese royal flag we get the blue and white triangular upper quarterings of the house flag, the red and yellow of the flag of Spain furnishing by adoption the colours which fill the lower triangle.

P. & O. Routes.—"At the present time their steamers run to India, Ceylon, China, Japan, the Philippine Islands, Australia and Tasmania. This line is the largest of our shipping companies." [1] The North Atlantic is the best known. It is busiest of the world's seas. It is due to the enormous traffic between the Old and New Worlds that competition has forced the rapid progress in the science of shipbuilding and its great luxuries for passengers.

What would Scott-Russell and Brunel, the builders of the *Great Eastern*, say if they could see a *Leviathan* or *Majestic* of to-day ?

Railway Locomotives' Limits.—Railway locomotives have not been increased much in size, because they are seriously restricted by the size of tunnels and height of platforms at the railway stations. The boilers have increased in height at the expense of the funnel of the locomotive engine. The latter has been reduced to a few inches in height.[2]

We have mentioned the fact that the world's largest vessels come to Southampton ; but why ? Let us learn what a large dock is like.

Southampton Docks.—" Southampton was established by the Romans as the port for their capital city of Winchester nearly nineteen centuries ago. They recognized the great natural advantages of the position at the confluence of the Rivers Test and Itchin, within the perfect shelter of the Isle of Wight, favoured by Nature with high tides four times a day " [3] (the tidal wave being intercepted each way by the Isle of Wight).

" This gives a high-tide level for about two hours twice daily, and a great depth of water in the approach channels even at low-water spring tides." [4]

Docks.—" Since the first docks were opened, the management was in the hands of the Harbour and Docks Board. In 1892 the London and South-Western Railway purchased the Dock Estate from the Harbour Board. To-day it is the only port in the country where the largest vessels in the world can enter and leave at any state of the tide.[5] Both harbour and docks are excellently lighted

[1] *Shipping Construction and Calculation*, Geo. Nicol.

[2] There is also the greater difference between steamships and railways. The sea is a highway open to all, while the land must be bought or hired for railways.—*Steamships*, J. R. Howden.

[3] *The Port of Southampton*, 1921.

[4] Blackie's *Modern Cyclopædia*.

[5] Leviathans, however, may sometimes be delayed in port waiting for slack water to obviate having to manœuvre these large vessels whilst the tide is running.

by electricity, and the largest vessels can be berthed with equal safety by night as by day." At no other port in the world can such vessels be berthed at any hour of day or night.

There are special hydraulic and electric power cranes everywhere, a coal dock for colliers, and special facilities for oil bunkering. The leading oil companies have constructed large installations of oil and motor-spirit. Barges are fitted with a large Weirs' pump,

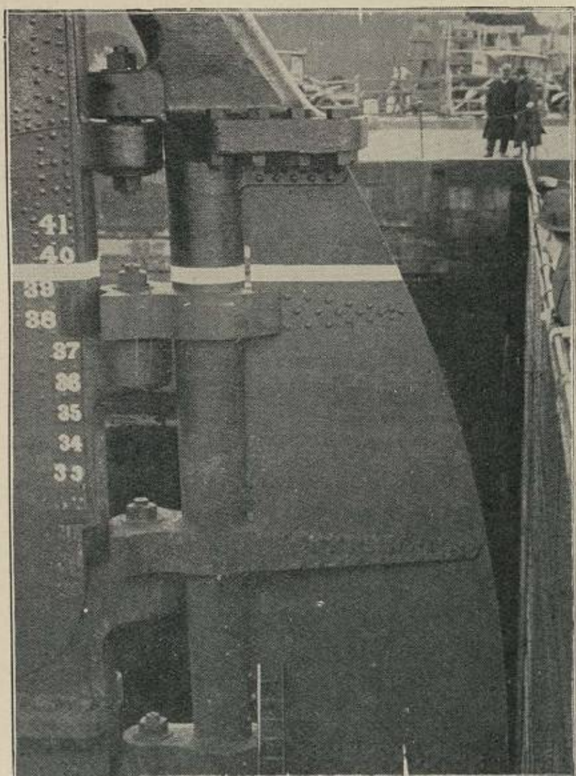


FIG. 5.—"BERENGARIA'S" RUDDER NEARLY TOUCHING CAISSON. ABOUT HALF THE RUDDER IS SEEN. (P. 14.)

and, through an 8-in. pipe-line, are capable of delivering 500 tons per hour from each barge; thus liners like the *Olympic*, *Aquitania*, etc., are fueled in less than seven hours without dirt and with very little labour, such as coal-bunkering requires.

"The railways and railway sidings on the docks extend to upwards of 40 miles, and connect all the quays and warehouses." Docks include cold-storage chambers for 2,000,000 cub. ft., bonded and free warehouses for spirit, tobacco, etc., great grain warehouses for 2,500,000 bushels. There is a great fruit trade and auction at the inner docks. Let us not forget that the secret move of the first seven divisions of the British Army embarked from Southampton, and during the war nearly 8,000,000 men passed through this port.

Dry-Docking the "Berengaria."—One of the finest feats which have been accomplished in recent times, and a repetition of which is very unlikely, was that when the Cunard liner *Berengaria*, of 65,000 tons displacement, was docked in the Trafalgar Dry Dock at Southampton recently. The small clearances at the sides and ends of the vessel can be seen from the interesting photograph shown in Fig. 5. The bows of the vessel are hard up against the fender, and there is a clearance of about 8 in. between the rudder and the caisson. At the sides of the vessel the clearance is very small.

Before docking, the vessel was lightened as much as possible,

FIG. 6.—SOUTHAMPTON DOCKS FROM THE AIR

By courtesy.

and to assist this the lifeboats were put ashore. The operation was performed by Messrs. John I. Thornycroft & Co., Ltd., assisted by the technical staff of the Cunard Line. It will also be appreciated that the feat was not accomplished under normal conditions, as, owing to the shipyard strike, the work was carried out by apprentices and labourers.[1] The large graving dock at Southampton is much in demand now, as vessels require repair and cleaning frequently.

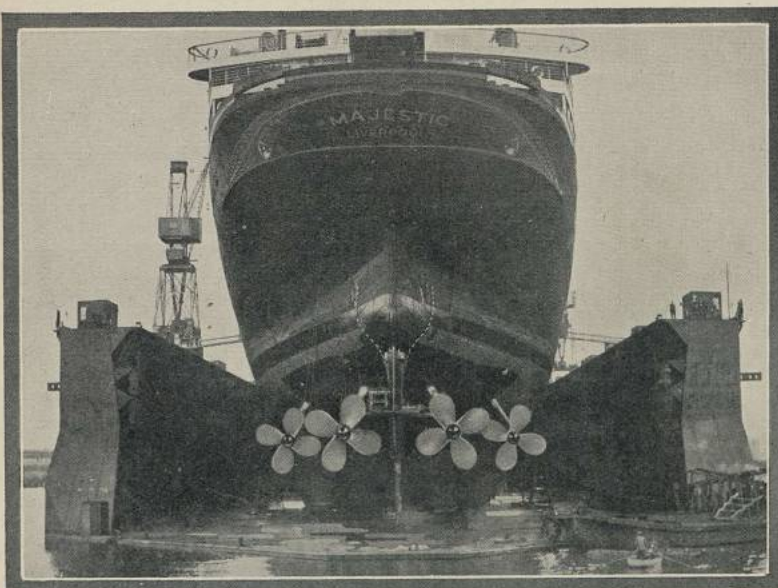
Dock Extension.—"The new extension of the docks, which will include offices, warehouses, a residential quarter, a large area for factories, as well as extensive public parks and recreation grounds, is to be made on partly reclaimed land extending for two miles

[1] *Shipbuilding and Shipping Record.*

north-west of the present docks. The largest ships will then berth a mile nearer the West Station of the Southern Railway." [1]

We have to thank the Dock and Marine Manager for kindly providing the information and illustration, a view of the docks taken from the air (Fig. 6).

Floating Dock.—There is a new floating dock at Southampton. It is by far the largest dock of its kind in the world, and will dry-dock the largest ships. It is 960 ft. long and 134 ft. clear width between fenders. It is capable of lifting and holding vessels of 60,000 tons. Its own weight, with machinery and fittings, is



By courtesy] [*J. Stone & Co.*

FIG. 7.—"MAJESTIC" ON THE WORLD'S LARGEST FLOATING DOCK.

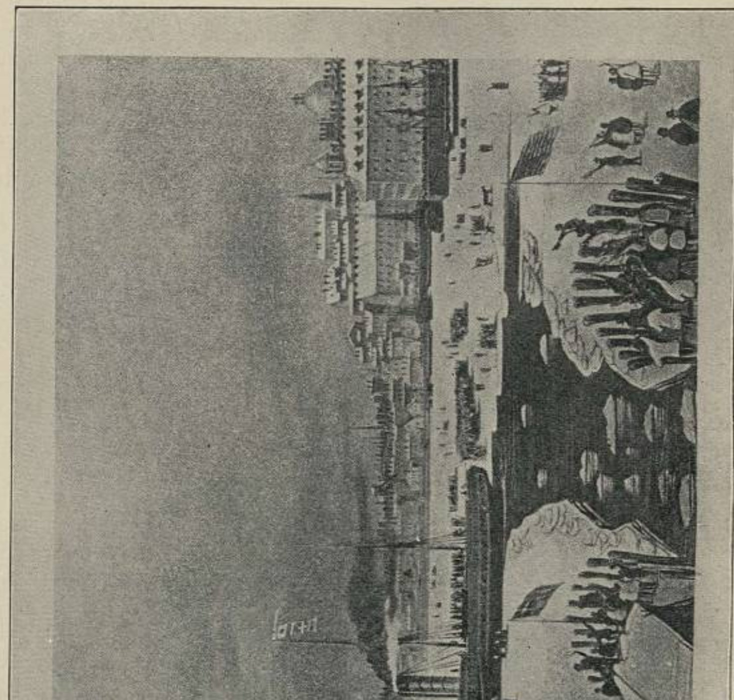
18,800 tons. Here is a photograph of the *Majestic* on the world's largest floating dock (Fig. 7).

The Port of Liverpool, of which we are justly proud, deals with a third of the overseas trade of the United Kingdom, and has a greater export trade than any other British Home port. There are twenty-two graving docks. The "Gladstone" graving dock is the largest in Europe, and is capable of dry-docking the largest vessel afloat.

The oil installation has a storage capacity of 140,000 tons. Coaling can be done at a rate of 300 tons per hour.

The floating landing-stage alongside which ocean liners berth,

[1] *Projected New Docks*, paper from Director and Marine Manager.



By courtesy] [*Cunard Steamship Co.*

FIG. 8.—CUNARD ROYAL MAIL PADDLE STEAMSHIP "BRITANNIA" LEAVING BOSTON HARBOUR.

is 2,534 ft. in length. It is connected with the railway station by covered bridges, by means of which passengers can pass from ship to train in a few minutes. Doubtless the shorter railway journey to London is the cause of Southampton now attracting the big Atlantic liners.

S.S. "Britannia."—It is interesting to know that S.S. *Britannia* was the first passenger vessel to cross the Atlantic entirely under steam.[1] The S.S. *Britannia*, of the Cunard Line, in

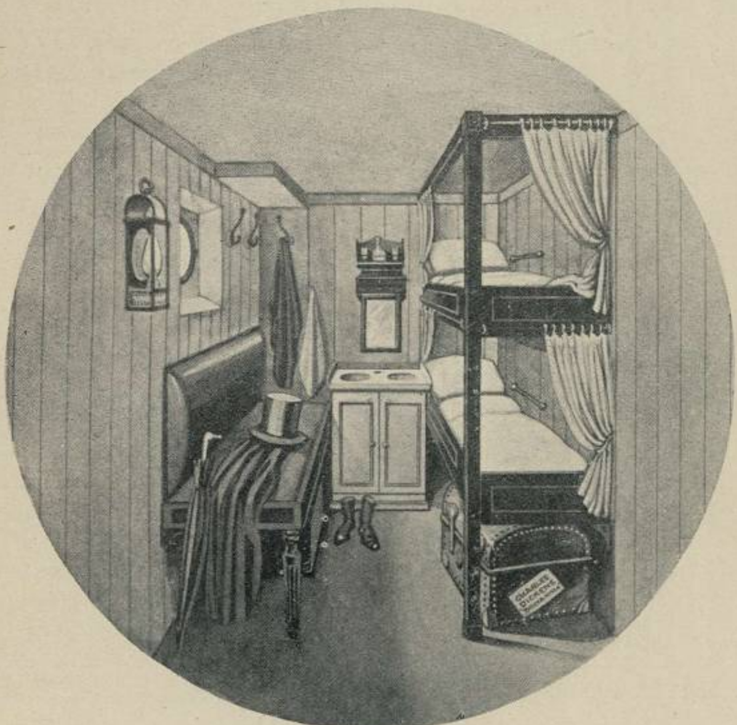


FIG. 9.—CHARLES DICKENS' STATE CABIN ON "BRITANNIA".

1840 (Fig. 8), was a wooden paddle-steamer, 1,154 tons, and only 207 ft. long. Dickens was a passenger in the *Britannia*. This is a description he gives of the state cabin: "Charles Dickens, Esquire, and Lady", the fact being duly attested "by a small manuscript pinned on a very flat quilt, covering a very thin mattress spread like a surgical plaster on a most inaccessible shelf in an utterly impracticable, thoroughly hopeless, and profoundly

[1] The *Sirius*, a much smaller vessel, crossing the Atlantic in 1838 with ninety-four passengers, occupied sixteen and a half days. She did not do so without sails

3

preposterous box." This is cheerful, but comic (Fig. 9). The saloon he described as a " gigantic hearse with windows in the sides ". It was to Boston that the *Britannia* sailed, and one notable illustration is worthy of record as to the way in which the merchants of that now great city expressed their appreciation of the benefits conferred by the establishment of the steamship service to their port. In February 1844 the *Britannia* was ice-bound in their harbour, and the Bostonians at their own expense had a canal 7 miles long and 100 ft. wide cut through the ice, thereby enabling the stoutly built little steamer to reach the open sea and proceed on her voyage. Here you will obtain a realistic idea of the stirring scene when the *Britannia* passed down this ice canal. The ice was no less than 7 ft. thick. We thank the Cunard Steamship Company for this narrative and the picture. The *Britannia* was a wooden ship, the *Great Eastern* was an *iron* ship, the *Oceanic* of 1899 (the first ship to surpass the latter in length) was a steel ship.

Wood, Iron and Steel Ships.—" Although it might seem contrary to the nature of things, a steel ship is actually much lighter in proportion to her displacement than one built of wood.

" A wooden ship of 1,000 tons displacement would carry a cargo of 550 tons, while a steel ship of the same size can take in a cargo representing more than 700 tons. This increase in carrying capacity means larger earning power. The advantages of mild steel over iron are that its strength is 30 per cent. greater than iron at its best, while it is less in weight and more malleable in use." [1]

[1] Howden's *Steamships*.

CHAPTER II

CONSTRUCTION ON A VAST SCALE

Shipbuilding yard, workshops, draughtsmen, model-room—The mould loft —Sea anchors, hydraulic riveter, hand riveting, oxy-acetylene cutter— —Moulding and casting—Engines, propeller shafts, gantry—Piling, blocks, keel—Double bottom—Transverse framing—"Isherwood" longitudinal system—Oil tanker, transverse frames—Side frames—Decks—Steel castings—Brackets, rudder—Division of hull—Water-tight doors—Illuminated indicator—Water-tight compartments—Bulkheads, *Suevic*—Shell plating—Bilge keel, Frahm's anti-rolling tanks system—Gyro-stabilizer.

HERE we are concerned with the building of steel ships. In the days when ships were built of wood, shipbuilding existed at ports where timber was procurable, but now shipyards are on the Clyde, the Tyne, and the Wear, near great coal and iron centres, for steel construction. Ships are built at the mouth of a river where the tides of the sea rise and fall, for the full flood of the tide is to be used to float the hull when launched.

Shipbuilding Yard.—Let us take Belfast, on the Lagan, one of the largest shipbuilding ports, as an example. Sloping down towards the water-edge are several slip-ways ; near these are platers' sheds, smiths' shop, boiler shops, and other buildings too numerous to name. Messrs. Harland and Wolff have kindly supplied illustrations. Fig. 10 is the valve shop and Fig. 11. the erecting shop.

Workshops.—The men in the centre are erecting the great engines in the shop for trial ; on being passed the whole is taken to pieces and removed and taken on board. In shipbuilding about 150 different trades are employed, and as much as £2,000,000 per annum is spent in wages in Messrs Harland & Wolff's works alone.

Draughtsmen.—In three great arch-roofed halls, specially designed for the purpose, there are 300 draughtsmen at work preparing the plans, and there is another separate hall for draughtsmen of the engineering department.

Model-room.—In the model-making shops the hull of every ship is made to scale from plans, and cut in solid pine. Fig. 12 shows the S.S. *Britannic*, the largest ship, and on the left is the

Fig. 10—Valve Shop, Queen's Island, Belfast. (P. 19.)

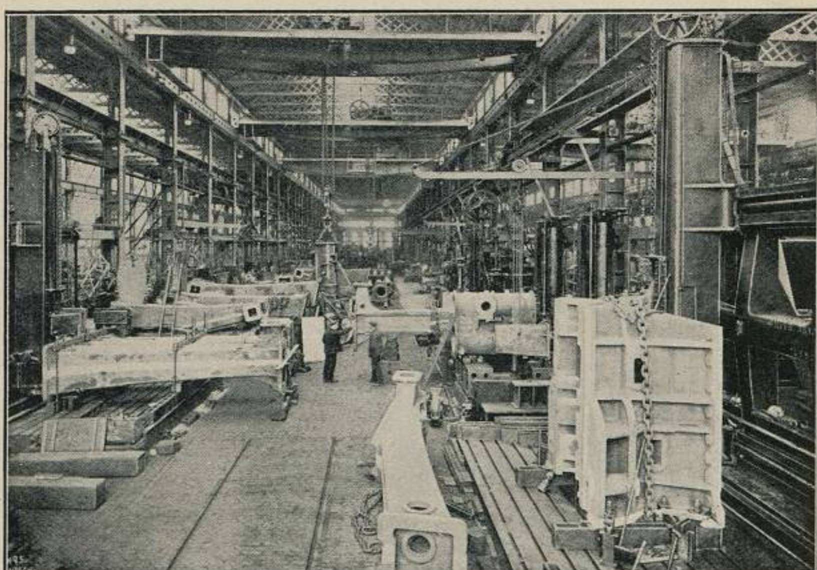


Fig. 11.—The Erecting Shop, Queen's Island, Belfast. (P. 19.)

smallest vessel, the *Kitty of Coleraine*, built by Messrs. Harland & Wolff. The small craft might almost be taken for a lifeboat of the *Britannic*.

The Mould Loft.—The mould loft is a spacious, well-lighted building, with smooth wooden floor, which is blackened—the builders' blackboard. The ship is drawn to full size from plans from the drawing office. Here you see exactly where the frames or ribs of the ship are to be fixed to the keel. Furniture-making and upholstering in every variety for furnishing ships can also be seen.

Sea Anchors.—Ships' lifeboats, together with the entire fittings, occupy other buildings. Here we notice canvas cone-shape sea anchors to keep the lifeboat's head up to the sea when in deep water—one for each boat. "Sea anchors" were specially useful to the lifeboats endeavouring to rescue souls from the burning

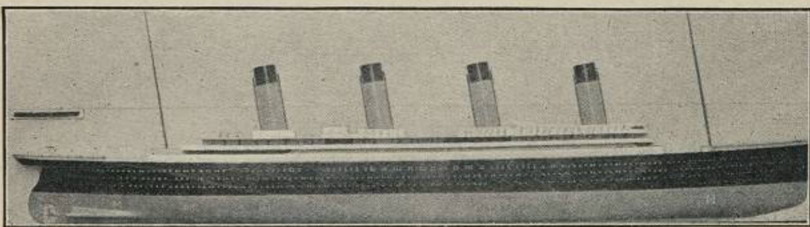


FIG. 12.—MODEL, "KITTY OF COLERAINE" AND "BRITANNIC". (P. 19.)

Volturno, to keep their heads up to the sea, and thus prevent the craft from falling off into the trough of the sea.

Hydraulic Riveter (Fig. 13).—This photograph shows the great riveter at work on the *Britannic*; its great jaws hang down on both sides of the plates to be riveted—one man on each side directs it. Rivets are taken white-hot direct from a portable furnace at hand, placed in position, and the riveter directed over both ends; the jaws close in, a tiny trickle of water falls on the ends—that's all. The great advantage of the hydraulic riveter is that the full pressure can be kept on the rivet until the latter is cold, and therefore no longer liable to stretch. About twice as much riveting is done by the machine as with the hand in a given time. 3,000,000 rivets, weighing 1,200 tons, were used on the *Britannic* hull and decks. Riveting by hydraulic power machines for ships was, of course, a well-established practice long before the day of the second *Oceanic*.[1]

Hand Riveting.—There are certain positions in the skin where

[1] *Ancient and Modern Ships.*

it is very difficult to introduce the hydraulic riveter, and at these the additional security due to the use of the machine is not obtained. Some of the rivets of the *Oceanic* were from 6 to 6½ in. long; a few even up to 7 in. Riveted work is tested by hammering and by flooding for water-tightness. All walls and ballast tanks are so tested. Rivet holes in plates are generally punched in preference to drilling.[1] Although ships are built of steel, they are riveted with iron rivets, not steel, because they are softer and more workable. The hydraulic riveting machines used for the exceptional work mentioned were larger than any up to that

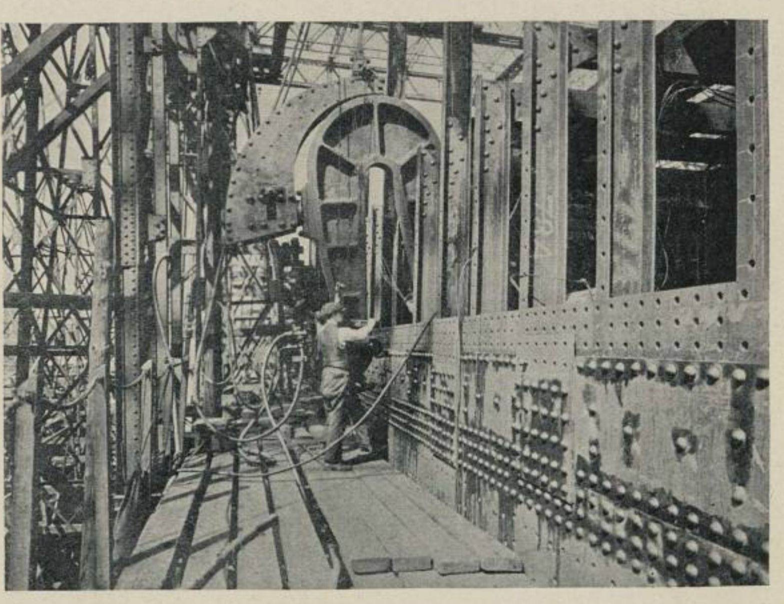


FIG. 13.—HYDRAULIC RIVETER AT WORK ON "BRITANNIC". (P. 21.)

time employed for these positions, some of them having been 7 ft. deep in the gap in order to reach the rivets farthest from the edge of the plates. Such machines were too heavy to handle in the usual way, and therefore a vast travelling gantry was constructed from which the riveting machine could be slung. Two lines of heavy rail were laid on the ground, one on each side of the ship. The uprights of the gantry were mounted on wheels, thus straddling the ship, and it was capable of moving bodily from end to end of the slip-way.

Oxy-acetylene Cutter.—Hydraulic riveting is silent in operation, so too is the oxy-acetylene burner for burning out rivets or

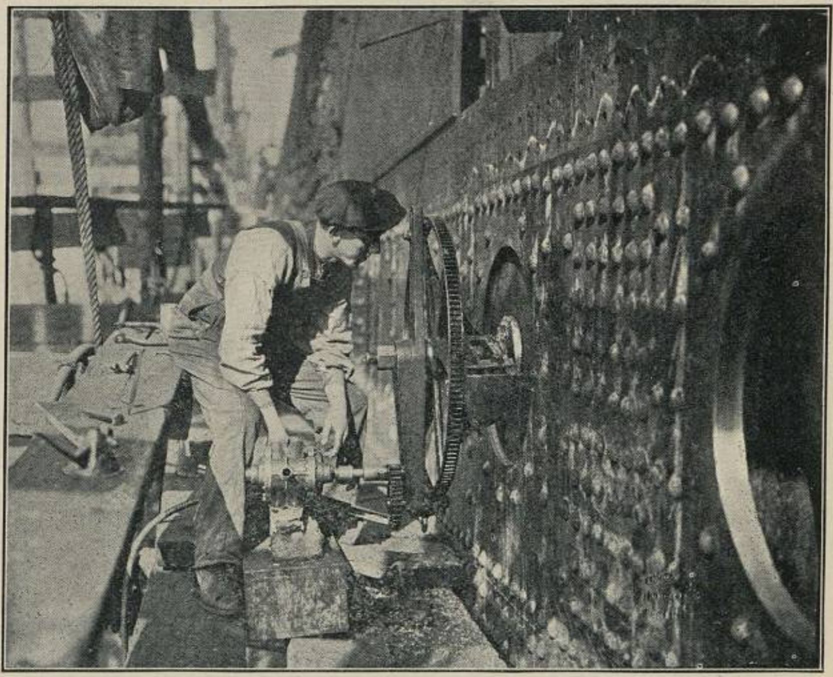
[1] The Furness Shipbuilding Co. drill all rivet-holes, and claim it is cheaper.

By kind permission of] [*British Oxygen Co.*

FIG. 14.—RAY CUTTING STEEL PLATES 14¾ IN. THICK WITH OXYGEN.

37½ cm.

for cutting steel plates. The British Oxygen Company has kindly given us this photograph (Fig. 14), which shows a skilled workman cutting up armour plate 14¾ in. thick with an ordinary type of hand-controlled machine supplied by them. "We are informed that 1,200 tons of armour plate of this thickness were cut in the manner illustrated with liquid air oxygen, of the usual commercial quality, at a speed which varied between 4½ and 5 minutes per foot run, and with a total consumption of oxygen which worked out at 72



[*By courtesy*] [" *The Shipbuilder* ".

FIG. 15.—PNEUMATIC MACHINE CUTTING SIDELIGHTS.

cub. ft. per foot run. Equally good results have been obtained in cutting nickel chrome-plates, varying in thickness from 6 to 12 in." [1]

Moulding and Casting.—In the moulding and casting works a single casting sometimes weighs 150 tons; some moulds take three weeks to build.

Engines.—The writer saw the reciprocating engine of the *Britannic* being erected in the erecting shop; it was 50 ft. high. A beautiful shining length of glass-like steel is slowly revolving in the lathe; it is a part of one of the propeller shafts, 28½ in. diameter, 38 ft. long. Fig. 15 shows how port-holes are cut.

[1] *Industrial Gases*, September 1922.

Bronze castings of large propellers await final cutting into shape, and monster metal bearings near them, turbine casings, change valves, cranks, condensers, uptakes (or flues). Funnels 26 ft. 6 in. by 19 ft. 9 in. diameter all passing through the great evolution which sprang from the naval engineer architect's mind. As you proceed, gradually a change is noticed from steel to brass. Here are port-holes and window-frames of brass. The entire propelling engines, and other machinery and much of the outfit usually supplied by sub-contractors for shipbuilding in other

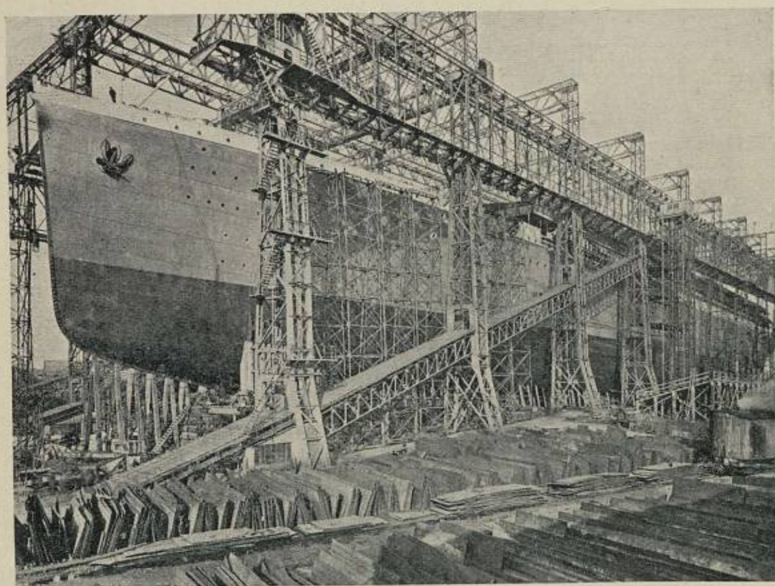


FIG. 16.—"BRITANNIC" IN GANTRY—PLATING COMPLETED.

yards, is manufactured in their own works by Messrs. Harland & Wolff.

Specialities.—There are a few exceptions. Wireless apparatus, for instance, is fitted by workmen of the Marconi International Marine Communication Company.[1] Also submarine signalling apparatus is supplied and put in by men of the Submarine Signal Company, and other specialities are fitted by outside firms.

Gantry (Fig 16).—When the *Titanic* and *Olympic* were built at Belfast a special steel structure called the gantry was erected. It is no less than 228 ft. high, weighs 6,000 tons, built over an area exceeding 840 ft. long by 270 ft. wide, covering the space required for two giant ships. There is a central cantilever revolving crane

[1] There are other wireless firms, like the Radio Communication Co,

mounted on a girder path capable of lifting 3 tons at 135 ft.; also ten walking cranes, each lifting 5 tons, and six travelling frames, each carrying two travelling cranes capable of lifting 10 tons. Access to the upper parts of the structure and ships under construction is provided by four large electric lifts. In the matter

By courtesy of] [*John Brown & Co., Clydebank Works.*

FIG. 17.—VIEW OF BERTH, SHOWING PILING FOR KEEL BLOCKS AT CLYDEBANK WORKS.

of erecting structures over or at the sides of slip-ways, the various shipbuilding yards adopt plans suited to the local conditions.

The shipbuilding yards on the Clyde, Tyne and Wear, where giants have been built, are in many respects similar to the Queen's Island works of Belfast here described, the home of the *Titanic*, *Olympic* and *Britannic*. Messrs. John Brown & Co., of the Clydebank works, built the *Lusitania* and the *Aquitania*. Messrs.

Swan, Hunter & Wigham Richardson built the *Mauretania* at Wallsend shipyard. The Vulcan Co. of Stettin built the *Imperator* (*Berengaria*), and both the *Vaterland* (*Leviathan*) and *Bismarck* (*Majestic*) came from Messrs. Blohm & Voss' works at Hamburg.

Piling.—So far we have noted some of the characteristics of a large shipbuilding yard ; we will now follow some of the work of building. In Fig. 17 is a view of berth, showing piling for keel blocks and standing-ways at Messrs. John Brown & Co.'s Clydebank works, preparing for the *Aquitania*. Note the crane

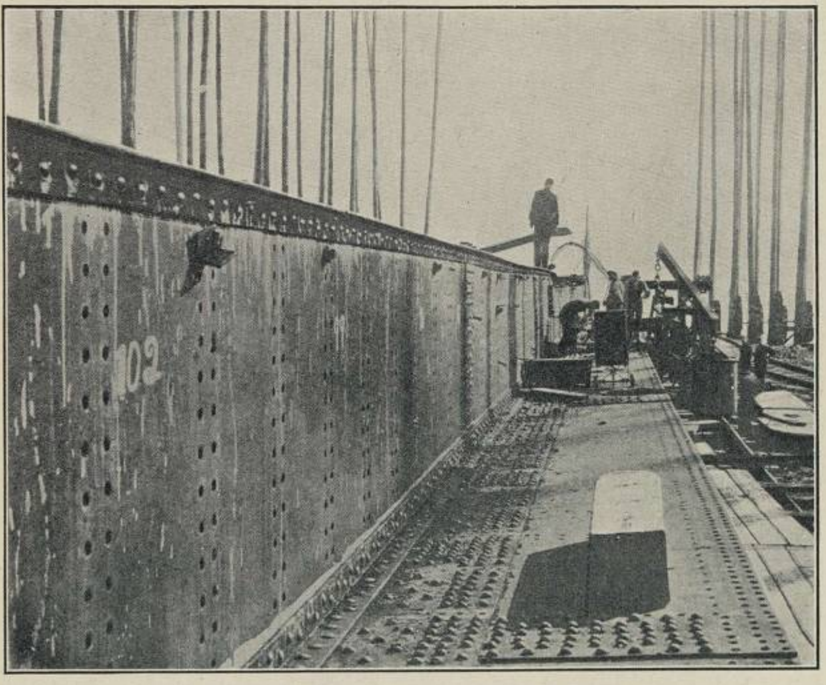


Fig. 18.—Vertical Keel, "Lusitania".

arrangements. There are seven patent derrick cranes along each side of the berth. For large vessels the method of preparing the ground for the hull to be built is practically the same in all yards.

Wood piling 13 in. in diameter, as seen in the picture, was driven into the ground 30 to 35 ft. and then surrounded by concrete. Across the top of this piling 13-in. balks are laid transversely.

Blocks.—Keel blocks are placed in groups of five about 12 in. apart with 3-ft. intervals between the groups, the top blocks being of oak. The keel is laid on a declivity of about ½ in. to the foot, starting 5 ft. 6 in. above ground. At the fore end the hull might be 8 ft. or more above ground.

Keel.—A huge plate girder, in a large ship, about 6 ft. 4 in. depth with a bottom flange, forms the keel. This keel with its keelson is the backbone of the ship ; the first laid longitudinally. Outside this on either side run two other longitudinal framings called bilge-keelsons, placed at the turn of the sides. Above, again, others called stringers, and the lowest is the bilge-stringer.

The vertical keel (Fig. 18) divides the double bottom. The flat keel consists of three thicknesses of plating, having a collective thickness of about 3 in.[1] To this vertical keel or backbone transverse frames and beams are attached, thus making the skeleton of the ship. The vertical keel, together with the transverse frames, divide the double bottom into compartments or tanks, in which water ballast may be carried for steadying the ship and also for carrying oil fuel, feed-water, etc.

Double Bottom.—From bow to stern the double bottom has a depth of 5 ft. 4 in., increased to 6 ft. 4 in. in the turbine-room. The building up of the double bottom consists of longitudinal and transverse girders, to which steel plates are riveted above and below, forming a double skin. Fig. 19 shows *Mauretania* framing completed and double bottom, looking forward.

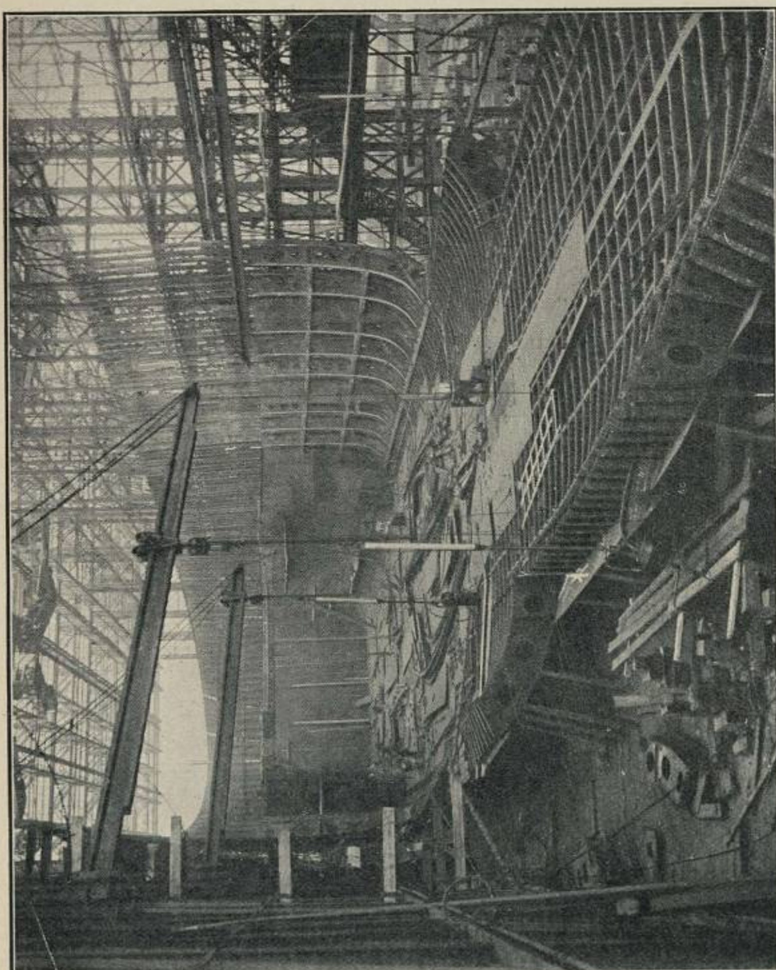
The *Aquitania* has forty-one water-tight compartments in the double bottom, each of which can be pumped out or filled separately. Further, there are six longitudinal intercostal girders. All plating is arranged to overlap, to permit hydraulic riveting extending right out to the ship's sides, with floors on every frame.[2] In this ship the side framing from the margin-plate of the double bottom upwards is formed of steel channels. Stronger web frames are introduced at every third frame.

Transverse Framing.—Frames are 3 ft. apart amidships, reduced to 2 ft. apart fore and aft, and heavy frames fitted on every third frame space in engine-room. All these extend at least to the deck 10 ft. above the load water-line, and some to decks above this level. The shell plating covers these side frames. Many have inspection doors to allow of inspection between the inner and outer skin of the ship.

Returning to the story of the *Great Eastern* and ships of an earlier date, there were no transverse frames even in the double bottom of that big ship, but numerous complete and partial transverse bulkheads—water-tight compartments. Strength was obtained by longitudinal framing. Sir George Holmes, in his

[1] In the *Mauretania*, the flat keel-plate is 5 ft. wide and 3¾ in. thick.

[2] Plate joints are made water-tight by caulking. This process consists in hammering the edge of the uppermost plate with a tool like a blunt chisel, thereby swelling it out and causing it to press tightly against the other plate.



By courtesy of] [*Swan, Hunter and Wigham Richardson, Wallsend Shipyard.*

FIG. 19.—SKELETON OF THE "MAURETANIA"

book, *Ancient and Modern Ships*, says: "As might have been expected, when the earliest iron ships were built the principal features of wooden shipbuilding were largely copied. Hence it arose that the system of transverse framing became almost universally adopted in the building of merchant ships. There was only one notable exception to this rule. It was found in the practice of the late Mr. John Scott Russell, F.R.S., who so far back as the year 1835 built an iron vessel with longitudinal frames."

Thus far we have seen that for big ships builders have clung

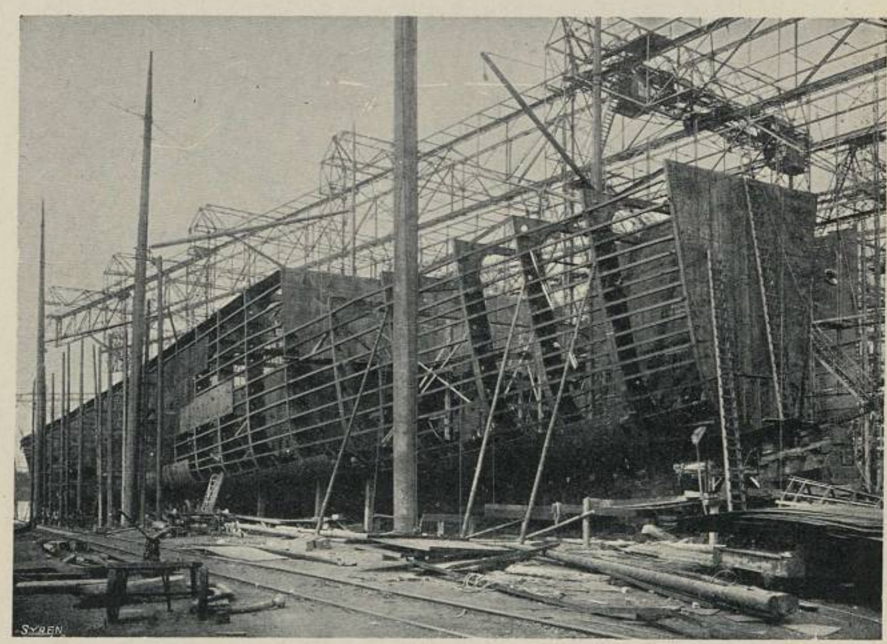


FIG. 20.—"ISHERWOOD" LONGITUDINAL SYSTEM.

to the transverse system. Now there has been some popularity with a longitudinal system of framing ships.

"Isherwood" Longitudinal System (Fig. 20).—This is known as the "Isherwood" system (see interior). Strong transverse girder frames are fitted at intervals of about 12 ft. These are slotted all round their outer edges, in order to admit continuous longitudinal stiffeners being fitted and riveted to plates on both sides as well as bottom and top. These frames do not end at the sides, but continue round the hull and between each deck.

It is claimed that the "Isherwood" system gives the owner a much stronger and lighter and less costly ship than one built on the transverse frame method. They claim also a considerable diminution of vibration, which reduces the cost of maintenance.

Oil Tanker.—Here is Fig. 21, an oil tanker in a big sea. For this class of ship you can add 30 to 40 ft. to the length of a proposed ship, the breadth and depth remaining as before, and still have a stronger one than the shorter vessel built on the ordinary system. Coal consumption would be the same, but she would carry 700 tons more dead-weight. Building is done in record time. From 1907 to 1926, 1,512 vessels have been built, with a total tonnage of over 12,750,000 tons for passengers, cargo and oil tankers.[1]

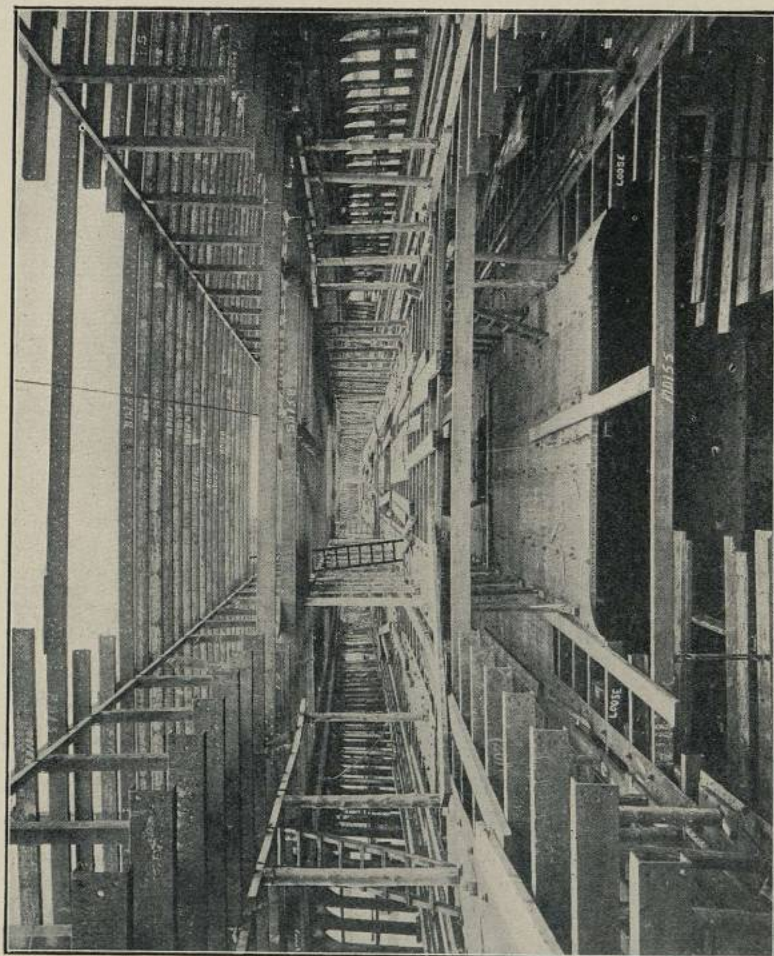
Transverse Frames.—Transverse framing is in favour for

FIG. 21.—OIL TANKER IN A BIG SEA.

big ships. In the view of the *Mauretania* showing the "skeleton," Fig. 19 also illustrates the framing at the fore end completed and the bulkheads partly erected.[2] In the front is clearly shown one of the hydraulic riveters at work on the outer skin, or shell plating. On top of the frames in the centre the inner plates are making the floors or inner skin, forming the double bottom. The distance between the two skins is here 5 ft. Away forward on the right are the frames running up the sides for double plating, well above the water-line.

[1] *Modern Shipbuilding and Economy.*

[2] *Mauretania* has 175 water-tight compartments.—*The Shipbuilders' Souvenir.*



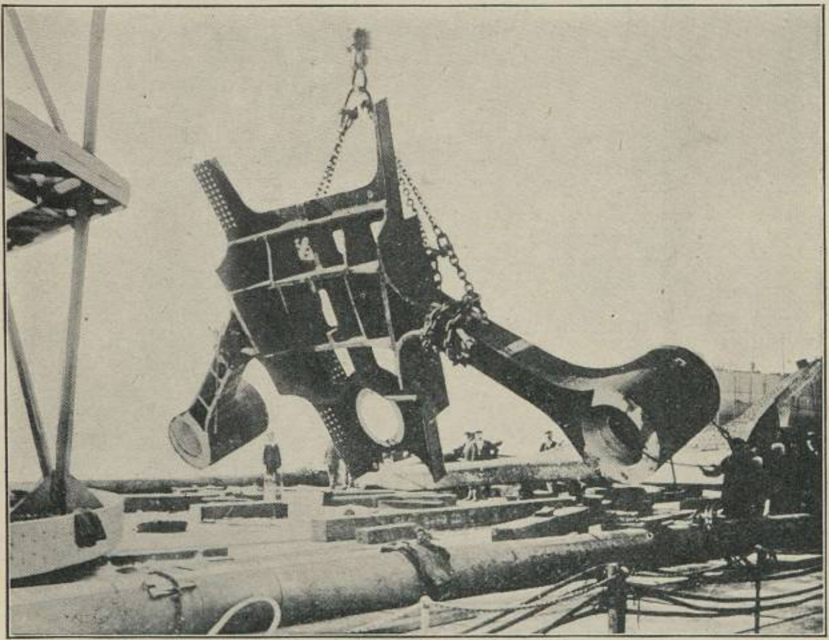
By courtesy of] [*John Brown & Co., Clydebank.*

FIG. 22.—'TWEEN-DECK VIEW, LOOKING FORWARD. FRAMING AND DECK BEAMS.

Side Frames. 'Tween-Deck View, looking Forward. Framing and Deck Beams (Fig. 22).—The 'tween decks are supported on deck beams. The pillaring arrangements in the 'tween decks consist of four rows of tube pillars about 8 ft. apart, with deck girders supporting the intermediate beams, on which steel plates form floors.

Decks. Yellow Pine.—All exposed decks are sheathed with yellow pine or teak. If all the frames and beams put into this hull were placed end to end they would cover a distance of over thirty miles.

Steel Castings.—There are two great steel castings: the



By courtesy of] *"The Shipbuilder."*

FIG. 23.—BRACKET FOR SUPPORTING THE PROPELLER SHAFTS.

stem bar and the stern frame of the hull. The stem bar is forged ingot steel rabbeted to take the shell plating and connected to centre keelson and the keel of the ship.

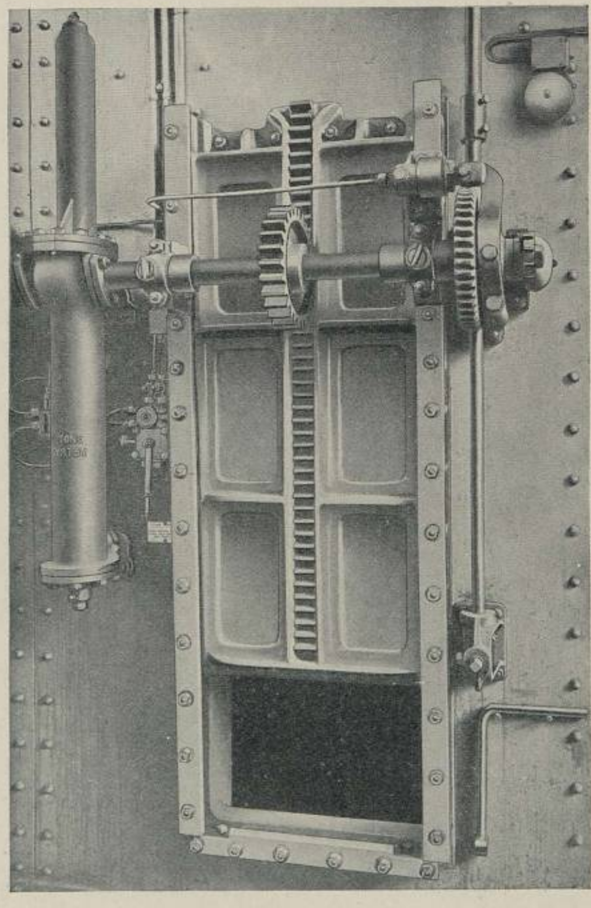
The stern frame is a huge casting weighing from 50 to 75 tons.[1]

Brackets.—There are also castings of brackets for supporting the propeller shafts (Fig. 23). Here is one for the *Olympic* being weighed; it was 73¾ tons.

[1] The stem casting of *Aquitania*, made at Darlington, required a specially constructed railway carriage, and was taken on a Sunday.

Rudder.—The rudder and rudder post are steel castings bolted together. The rudder of the *Olympic* is 78 ft. 8 in. high and 15 ft. 3 in. wide ; it weighs $101\frac{1}{4}$ tons.

Division of Hull.—The *Aquitania* hull is divided into eighty-four compartments in addition to the forty-one in



By courtesy of] *J. Stone & Co. Ltd*

FIG. 24.—SLIDING WATER-TIGHT BULKHEAD DOOR.
(Hydraulic cylinder on left, alarm bell on right.)

the bottom. Sixteen bulkheads extend 19 ft. above the load water-line.

Water-tight Doors (Fig. 24).—All doors below and adjacent to the load-line are of the sliding pattern and are fitted with Stone-Lloyd quick-closing gear. Here is one on S.S. *Paris*. The forty-six doors can be simultaneously closed from the captain's

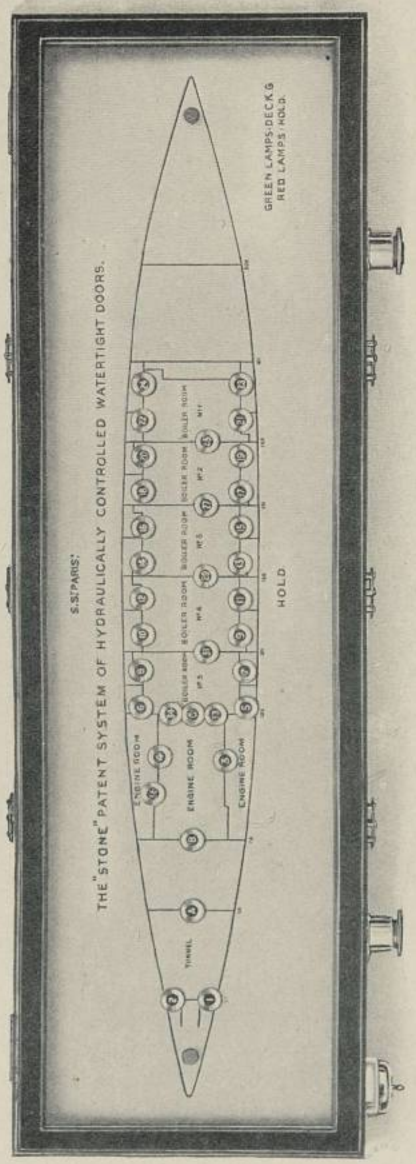
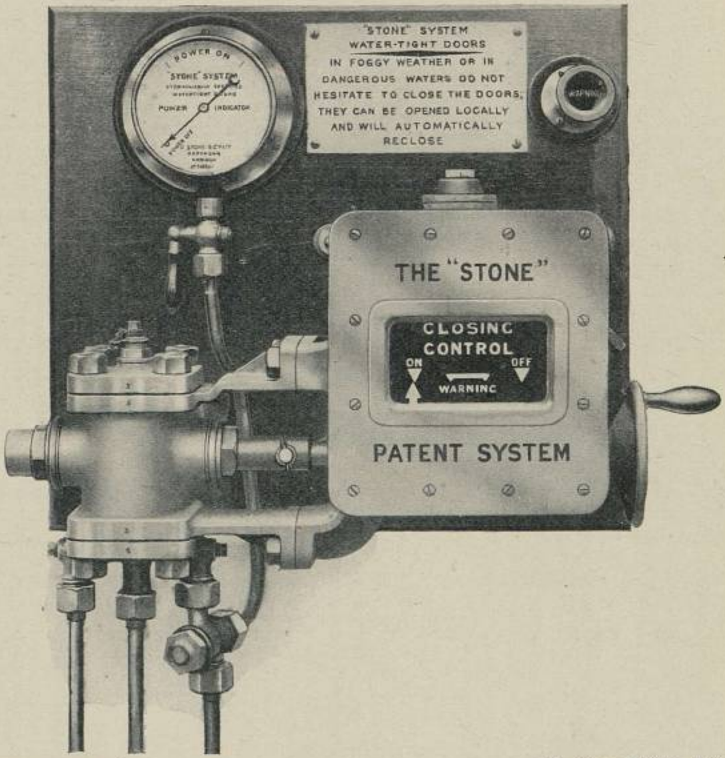


FIG. 25.

(Electrical indicator-discs light up when doors close.) (P. 37.)

bridge by hydraulic power. When the *Titanic* disaster occurred at midnight, far away on the Atlantic, Captain Smith was taking rest in his cabin, until the silence was broken by three sharp strokes on the gong sounding a signal from the crow's-nest more than 100 ft. above him. The engines were stopped by the chief officer, who was on duty. Captain Smith came running out of his room. "What is it?" he asked.

"We have struck ice, sir."



By courtesy of] [*J. Stone & Co., Ltd.*

FIG. 26.—BRIDGE CONTROL-GEAR.

(In closing the arrow moves until doors are closed. Electric bell indicator on right is illuminated while bells are ringing.)

The captain said: "Close the water-tight doors."

"It is already done, sir," was the reply.[1]

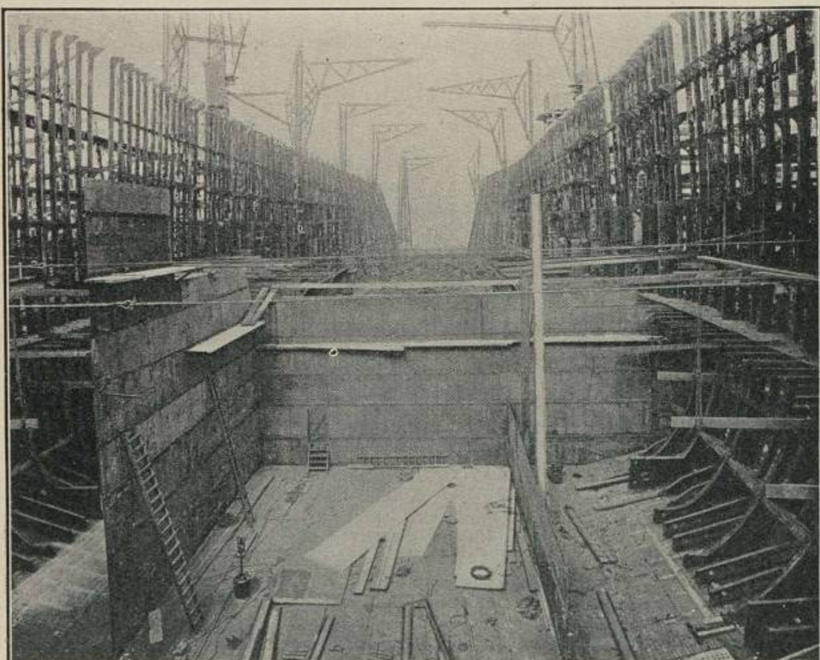
This done, the ship, properly subdivided into several water-tight compartments strong enough to resist pressure, will float.

Illuminated Indicator.—On the bridge there is an illuminated indicator which shows the position of every water-tight door, and

[1] *Titanic*, p. 98.

whether it is open or shut, so that the officer in charge will never be in doubt as to whether one or all are closed. Fig. 25 shows this indicator on S.S. *Paris*. Furthermore, even if the mechanism did go wrong, the whole of the doors close automatically.

There is a float in a small circular vessel which, in the event of water entering a compartment, automatically lifts, and closes the doors opening into that compartment, if not already dropped. Anyone cut off in this way can escape by a ladder in each compartment. A bell rings prior to the closing of each door as a warning,



By courtesy of] [" *The Shipbuilder.*"

FIG. 27.—WATER-TIGHT COMPARTMENTS, " AQUITANIA ".

and a red light on the indicator is extinguished on completion of the closing of the doors. Fig. 26 shows the bridge control-gear of safety doors.

Water-tight Compartments (Fig. 27).—A glance at this illustration shows the water-tight compartment in the *Aquitania*. There are 125 such compartments. The *Mauretania* has 175. The *Titanic* had far less. It has been stated in a description of her [1] that any two main compartments may be flooded without in any way involving the safety of the ship.[2] There are fifteen transverse

[1] *The Shipbuilder*, p. 25. [2] *Olympic* and *Titanic* souvenir.

water-tight bulkheads, extending from the double bottom to the upper deck at the forward end of the ship and to the saloon deck at the after end—in both instances far above the water-line.

Bulkheads.—Bulkheads are those tough steel walls that divide a ship's hull into separate compartments If she rammed any obstruction head-on her bows might crumple up, but the steel walls stretching across her hull would prevent the damage spreading far enough to sink her. If her broadside was rammed by another ship, and one, or even two, of these compartments pierced, even then the rest would be sufficient to hold her up at least for a day or two.

"Suevic."—"When the White Star liner *Suevic* was wrecked a few years ago off the Lizard, it was decided to divide the part of her which was floating from the part which was embedded in the rocks ; and she was cut in two just forward of the main collision bulkhead, and the larger half of her towed into port (Southampton) with no other protection from the sea than this vast steel wall, which, nevertheless, easily kept her afloat." [1] .

We have already seen how necessary doorways or water-tight doors for communication between the different parts of the ship are worked, and there were several ways of closing them ; but once closed they offered a resistance as solid as that of the bulkheads.

We know that the ill-fated *Titanic* on her first voyage had three or four water-tight compartments laid open to the sea by "ice tooth".

Shell Plating.—Look at the *Britannic* (Fig. 16), building at Belfast. No less than 26,000 plates were used on the sides and decks. The largest plate was 48 ft. long and its weight 5 tons, and, as already stated, more than 3,000,000 rivets were used ; these alone weighed 1,200 tons.

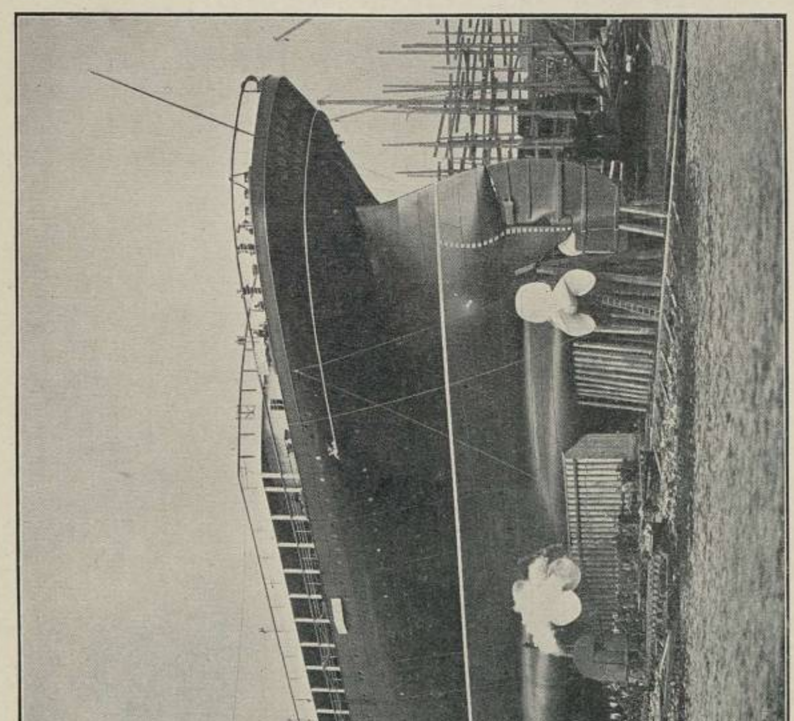
The sharp turn of the sides of the hull at the bilge and the flat door that was noticed in the *Oceanic* of 1899 is the practice of to-day.

Bilge Keel.—Here is a picture of the *Lusitania* on the stocks, showing bilge keel (Fig. 28). In this ship the bilge keel was 36 in. deep and fitted for about 300 ft. of the vessel's length amidships to reduce the rolling of the ship in a seaway.

Frahm's Anti-rolling Tank System.—There is, however, another method of doing this known as Frahm's anti-rolling tank system. The use of water in the bottom of a ship has long been used to steady the ships of the Navy (Fig. 29).

The Frahm anti-rolling tank system is based on the law of synchronism. Provision is made for special water tanks in U form (see section given), the legs of which are as far apart as

[1] *Titanic*, p. 58, Filson Young.

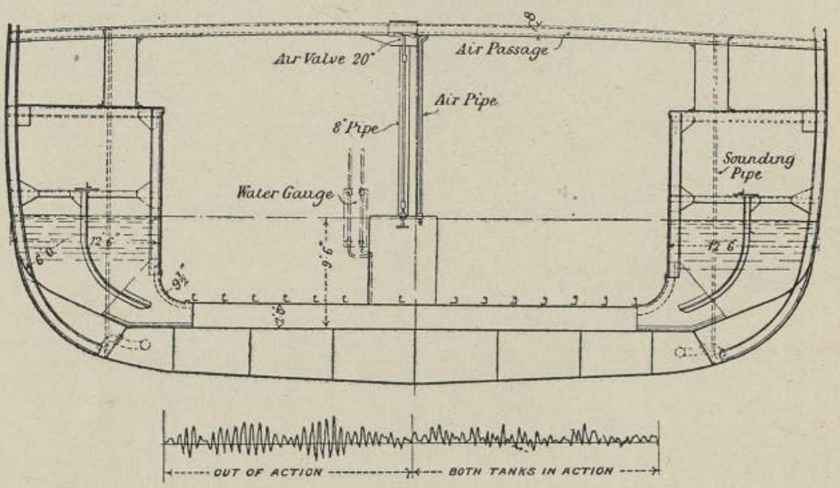


By courtesy of] [*John Brown & Co., Clydebank Works.*

FIG. 28.—BILGE KEEL ON "LUSITANIA". BALANCE TYPE OF RUDDER.

possible from side to side of the ship. Water should entirely fill the horizontal portion and half-fill the two legs. Water being about $1\frac{1}{2}$ per cent. of the tonnage, when a wave comes along the ship lags a quarter phase behind the wave, the water in the tank lags a quarter of a phase behind the ship, and so the water in the tank is always on the side of the vessel about to rise. In this way 60 per cent. of the rolling is stopped.[1]

Recently when on the *Aquitania* I was informed that the Frahm system is not so effective on very large ships. The *Aquitania's* rolling period is very slow, consequently she has had bilge keels fitted on now. Talking of rolling ships, I was



The Graph taken by the Gyroscope Pendulum.

FIG. 29.—FRAHM'S ANTI-ROLLING TANK ON THE CUNARD T.S.S. "LACONIA". (P. 38.)

(Water in tank is 1·08 per cent. of the load displacement. This is the first British passenger ship to be fitted with this patent Tank System.)

told a yarn by an officer of the ex-S.S. *Vaterland* before the war. When crossing the Atlantic a lady told him she was a bad sailor, and she had been round the world and suffered sea-sickness on every voyage, and she was surprised to find the Atlantic so smooth. The officer said: "Well, there is a bit of a gale on now; if you care to come with me I will show you." They both went in the lift, some five decks below, and there to her astonishment she saw the big waves through which the great vessel was riding. "You see," said the officer, "a big sea is not much to look at from the height of a cliff."

Most of us know the discomfort of sea-sickness, and oddly enough we feel rather ashamed to own it.

[1] The *Majestic* has these tanks on H and G decks.

I remember admiring a very humorous young fellow who was a bad sailor ; he often left the breakfast-table on "urgent private affairs", soon returned and "had another go" at breakfast, and was very bright even up to the moment of being again reminded of the disturbing "private affairs". It was all a joke to him ; *mal de mer* never dominated him.

Gyro-stabilizer.—It may interest some of our readers to hear that elimination of roll can be obtained by gyroscopic means. Only recently a vessel of the Royal Navy has been equipped with a gyro-stabilizer built to the patented design of the Sperry Gyroscope Co., of London and New York. Up to the time of writing the largest gyro-stabilizer is to be found in a Japanese cruiser of 10,000 tons.

The apparatus employed is rather difficult of explanation in the space available, but it is worth noting that the wheel forming the gyroscope is 12½ ft. in diameter, weighs about 68 tons, and is driven at a speed of 815 r.p.m.

We know that a ship, great in beam in relation to depth, will roll quickly and jerkily, so ships are built deeper.

CHAPTER III

LAUNCHING A MAMMOTH SHIP

Launching—Ways—Cradles, wedges, lubricants—Make-up of ways—Launching trigger-gear—Hydraulic ram—Hull—Shorings—Hydraulic jack—The launch—Anchors and cable drags.

Mr. Filson Young's description of the building of that ill-fated ship S.S. *Titanic* is true of all these great ships. "The seasons passed; the creatures who wrought and clambered among the iron branches, and sang their endless song of labour there, felt the steel chill beneath the frosts of winter, and burning hot beneath the sun's rays in summer, until at last the skeleton within the scaffolding began to take a shape, at the sight of which men held their breaths. It was the shape of a ship—a ship so monstrous and unthinkable that it towered high over the buildings and dwarfed the very mountains beside the water."[1] It must be very difficult for the mind of a native Indian of some of our Dominions to understand how we come to use the heaviest materials for ships. The vast transverse steel framing suggests cages for elephants rather than a ship to float on the water.

After many months of ceaseless toil the great ship is ready to be released from her wood and iron supports to become fully water-borne and at rest. Great responsibility falls on the foreman who makes all the arrangements in connection with the launching of these mammoth ships. He has the control of a large number of men, who work in "gangs". We shall soon know how primitive is the method of transferring this weight.

The foundation made by driving piles into the ground is on that part to be occupied by the keel and the ways, on both sides of which temporary shorings are erected to support the hull as it is being built.

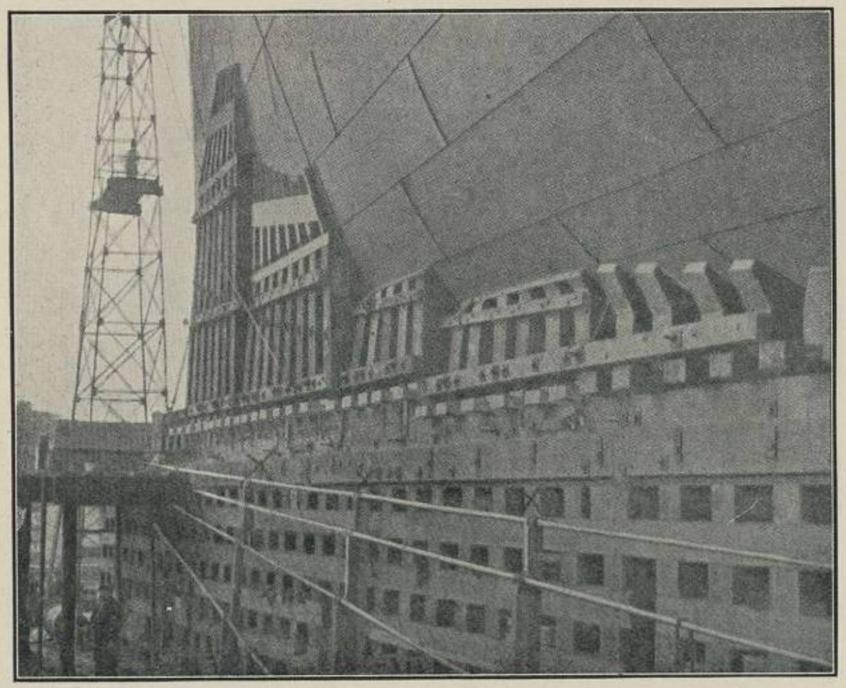
The hull has been built resting on its keel blocks and four rows of shores on each side. There remains the stupendous task of transferring the weight of the ship, thousands of tons, from the keel blocks under it to the cradles resting on the

[1] *Titanic*, p. 14.

ways. These ways are laid after the vessel's structure has been completed.

Launching-ways.—The forward cradle and make-up of the ways are shown in Fig 30. The fixed ways are oak; the sliding-ways are of pitch pine. In the illustration the two thickest timbers meeting each other horizontally are the ways, the *ground-way* being the one slightly outside the *sliding-way* on which the cradle rests, this forming a strong guide 2 in. deep, as shown in Plans 5 to 8, p. 46.

A description of the launching-ways for the *Mauretania* will



By courtesy of] [*"The Shipbuilder."*

FIG. 30.—FORWARD CRADLE AND MAKE-UP OF WAYS.

show what is required. The total length of the ground-ways was 794 ft. and they were laid with a camber of 21 in. in their full length and the declivity of ½ in. per foot. The sliding-way had a bearing of 635 ft. Both the sliding- and the ground-ways were 6 ft. wide on each side, and spaced 25 ft. apart centre to centre. The ways were made up of balks 15 in. thick and 35 ft. long, connected by iron straps and bolts.

Cradles.—The *forward cradle* was formed by vertical timbers with fore and aft ties on sides. The poppet timbers were held in

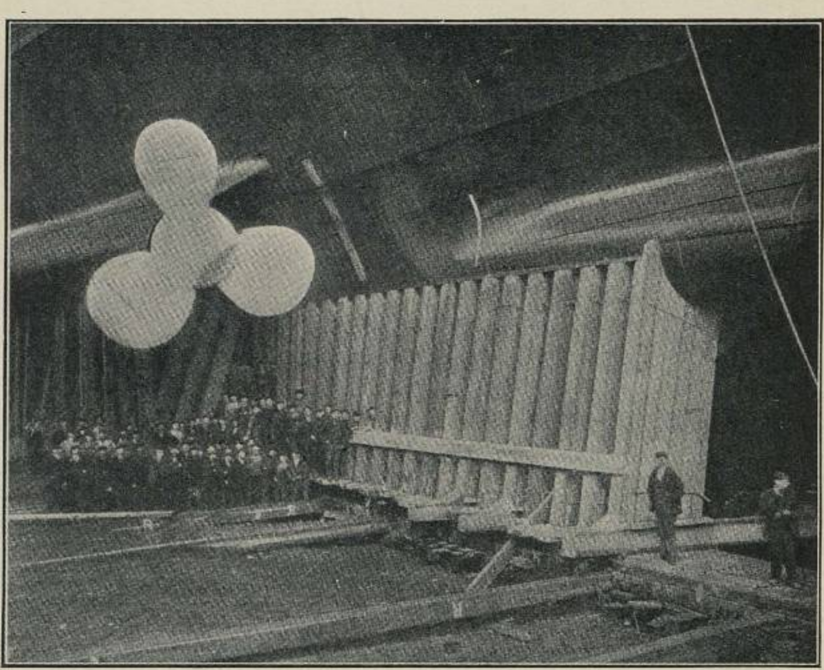


Fig. 31.—After Cradle.

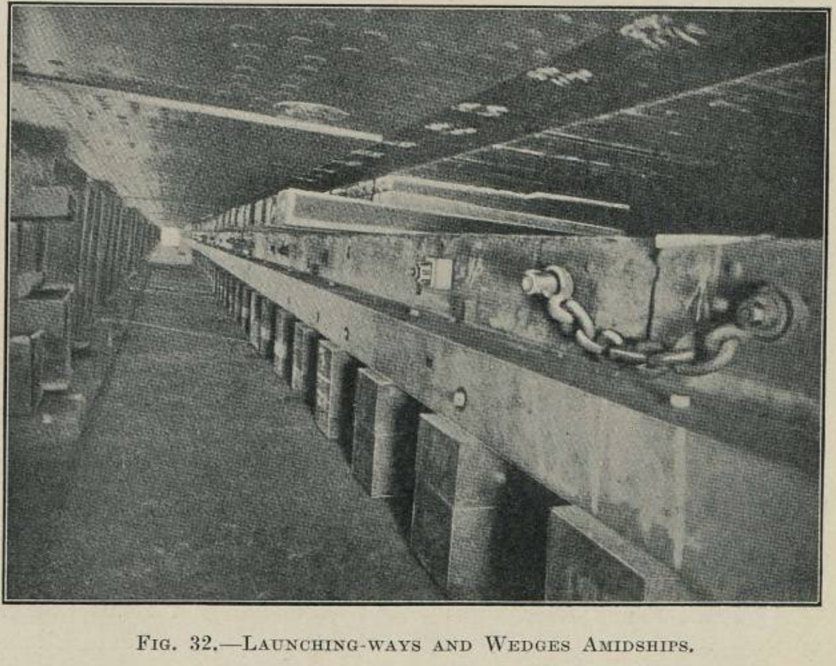


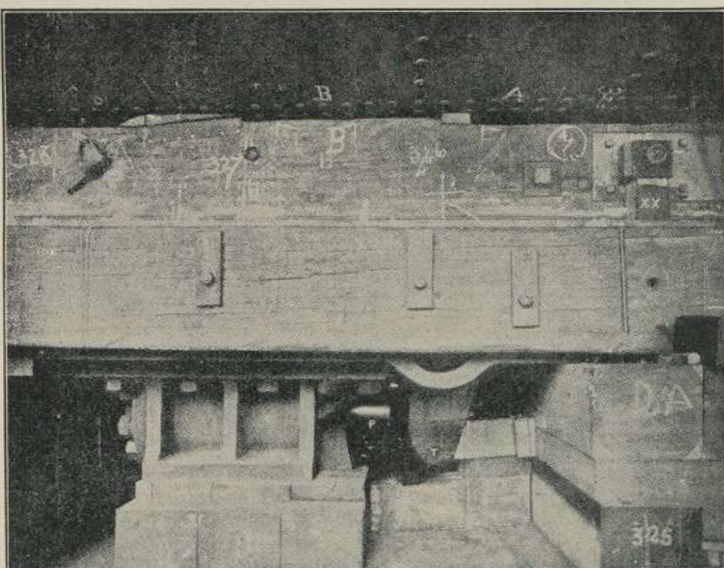
Fig. 32.—Launching-ways and Wedges Amidships.

position with angle bars fitting closely against the shell seams. This forward cradle had for a moment to take a thrust equal to 3,700 tons when the vessel dropped off the ways.

The *after cradle* (Fig 31), is made to fit under the shaft shell plating, and inclined inwards with straps to prevent them spreading outwards.

Wedges.—Amidships only *single wedges*, 11 in. by 4 in., were used (Fig. 32). Ramming up to take the weight of the ship from the keel blocks on to the launching cradle was commenced the day before the launch.

Lubricants.—The lubricants applied from end to end of the

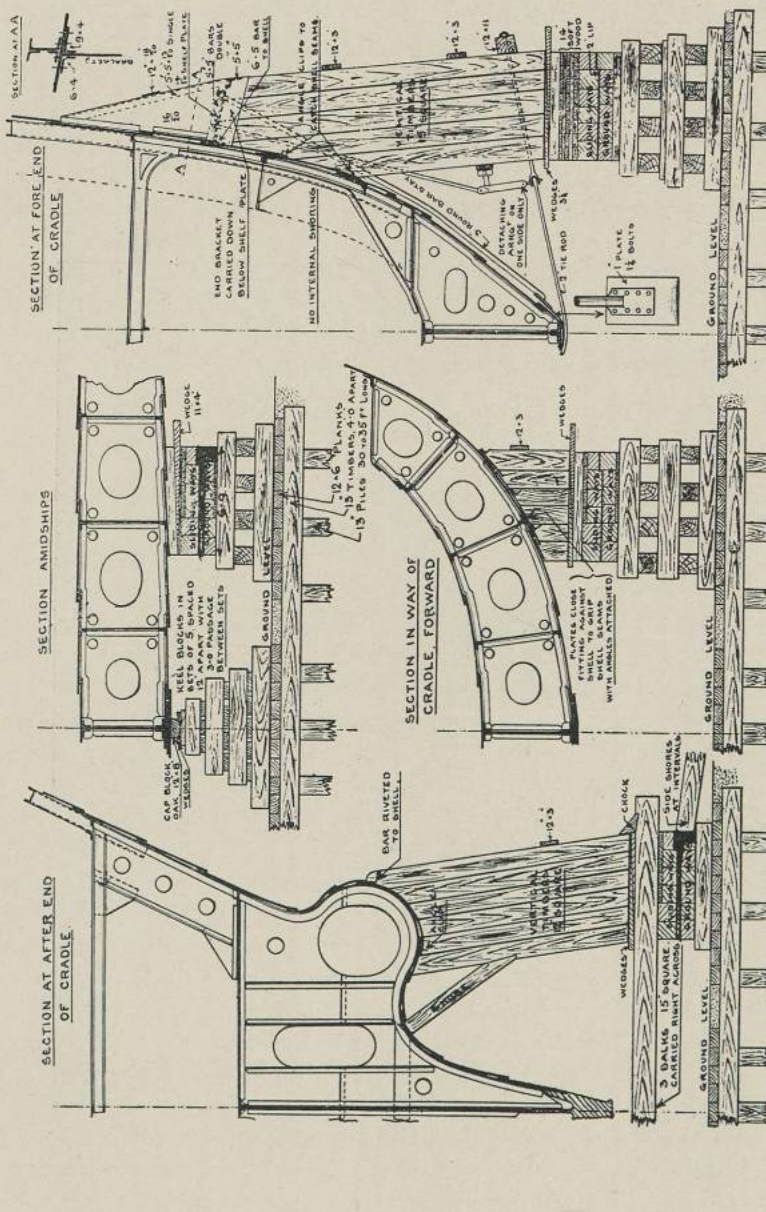


By courtesy of] [*" The Shipbuilder."*

FIG. 33.—HYDRAULIC TRIGGER-GEAR. (P. 47.)

ways consisted of tallow, train oil, and soft soap, the total amounting to about 23 tons. The ship being lifted by the primitive wedging process, the keel blocks were knocked out in about twenty-five minutes, the vessel being prevented from moving by the triggers held in position by hydraulic power. When released, the vessel moves on its slide, at first imperceptibly ; then, gathering impetus, she dashes down at a speed of about 12 knots an hour. This picture gives a good view of the making up of the ways.

Make-up of the Ways.—Imagine the problem of making a building, foundation as well as a suitable pathway, for liberating a mass of steel weighing about 27,000 tons, lowering it a distance



By courtesy of] [*Swan, Hunter and Wigham Richardson, Wallsend Shipyard.* "*The Shipbuilder.*"

FIG. 34.—SECTIONS THROUGH LAUNCHING CRADLES.

of about 35 ft. during an inclined longitudinal travel of perhaps 800 ft., and then checking the impetus of the mass afloat in about the same distance from the end of the ways. This is launching, and from the moment of the release of the hull to the moment the vessel becomes fully waterborne about sixty seconds has elapsed. The launching weight of the *Olympic*, for instance, was 24,600 tons.

Trigger-gear.—Now to hold this weight on the slide while building the hull is a *trigger-gear* hydraulically operated. It is incorporated with the standing ways (Fig. 33). About 300 ft. from the bow the usual timbers supporting the standing ways gave place to two solid steel castings, each weighing about 15 tons, in the body of which was fitted a cast-iron trigger (marked "T" on picture), disposed vertically with its upper part projecting above the standing ways into a recess, a cast-iron shoe in the bottom of the sliding-way.

The trigger pivoted freely on an axis in the centre of the casting, and when in position, with its upper point engaging the steel shoe of the sliding-ways, it was held there by a hydraulic ram pressing against the under part.

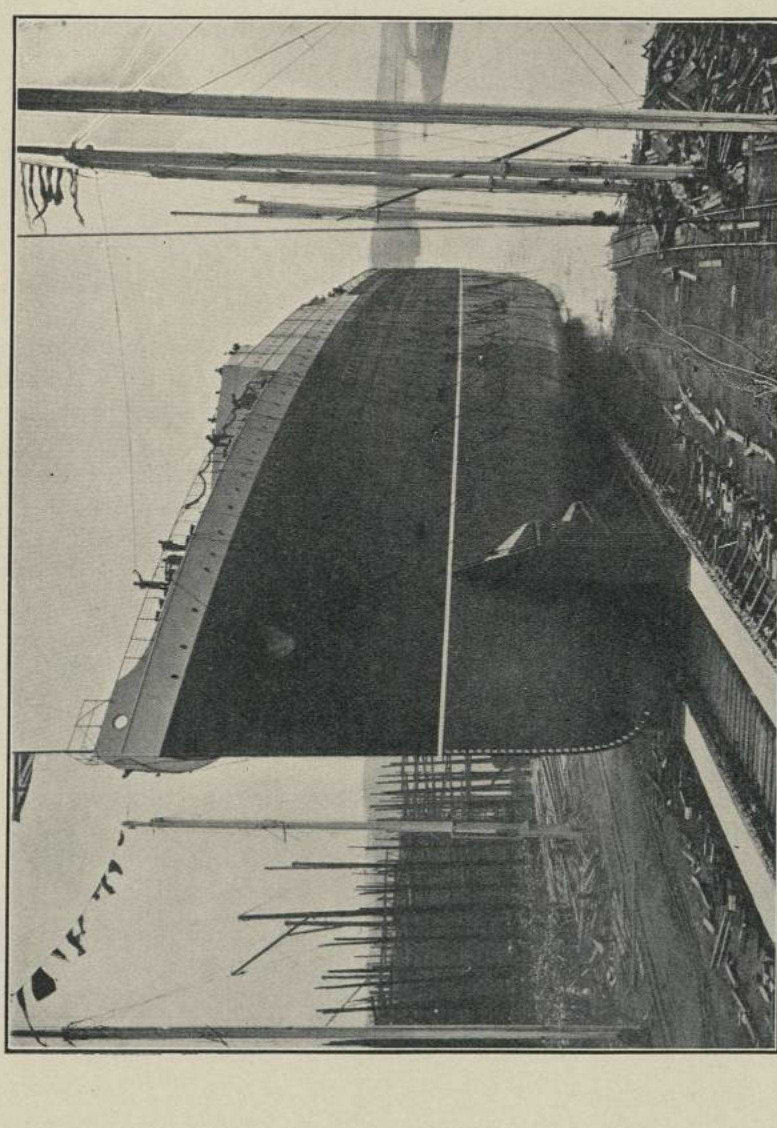
Hydraulic Ram.—The ram marked "P" worked in a cylinder of 15 in. diameter. This arrangement holds the hull on the slide. For the purpose of launching, the hull is temporarily strengthened inside with timber stays.

Wedges.—Wedges made of red pine about 9 ft. long and 4 in. thick are driven in below the forward and after cradles—double, i.e. one on top of another from opposite directions (Fig. 34). Amidships only single wedges, about 2 ft. 4 in., are used. Ramming up now allows for removal of the wedges and oak blocks under the keel. Lubricants previously applied on the ways as stated, the action of the triggers alone keeps the hull from moving.

Shorings.—Shorings which have helped to support the hull are removed on the morning of the launch, three or four gangs of men each side of the keel commencing at after end and working forward. Provision is made for starting the vessel on her downward journey.

Hydraulic.—A set of four 100-ton hydraulic jacks was fitted on each standing way for the purpose, but it was not required.

Now it must be remembered that the hull is supported on the ways by fore and aft cradles, and amidships by the arrangement of wedges seen in Fig. 32. From the moment of the release of the hydraulic pressure on the triggers the *Olympic* became fully waterborne in sixty-two seconds. She was brought to rest, her bow 500 ft. away from the end of the way. How different to the launching of the *Great Eastern*, which took two and a half months to accomplish! As already stated, the very critical part of



By courtesy of] [*John Brown & Co., Clydebank Works*

FIG. 35.—LAUNCH OF "LUSITANIA". ON THE WAYS.

launching operations is when the vessel exerts a downward thrust of her fore part on the ways at the moment of leaving it. The special arrangements for checking the way on the ship when waterborne are as follows:

Three heavy anchors are fixed in the bed of the river on each side of the ship's course, and connected by wire ropes to eye-plates riveted to the hull of the vessel along her top sides. In addition to this two or more piles of cable drags, each weighing over 80 tons, are connected in a similar manner with an 8-in. steel-wire hawser.

Anchors and Cable Drags.—The anchors and drags act simultaneously in bringing the ship to a standstill. The ship's own bow anchors are also kept ready for letting go. In the picture showing the under part of the amidships, the wedges are seen, and chain links connecting the sliding-way timbers, the latter for the purpose of collecting from the water after the launch, for they have to be used for the next vessel built. Fig. 35 shows the launch of the *Lusitania*—on the ways—and the hawsers are seen attached to the eyelets on the hull, the other ends being fastened to anchors and cable drags. Now several tugs are on the scene to take charge of the hull and bring her alongside the quay, where she remains while all the engines are put into her.

CHAPTER IV

ENGINES AND AUXILIARIES

Floating crane, auxiliary engines, non-flammable substance—Funnels, whistles—Anchors, cables, steel hawsers, rudder, balanced rudder—Armed cruiser's fight—Derricks and steam winches, cranes—Mails and post office—Baggage hoists—Signals, Blue Peter—Taking a liner out of dock—Passenger luggage—Officers' duties—Trim of the ship—The captain, chief constructor—Doldrums.

Floating Crane.—Look at Fig. 36. That is a 200-ton floating crane specially built by Sir William Arrol & Co., Ltd. This mammoth appliance is lifting a boiler into the *Olympic*. This is one of the largest floating cranes in existence.

Auxiliary Engines.—All the boilers, main engines, the refrigerating and electric generating engines, and other auxiliary engines, of which there are no less than seventy, have now to be placed on board. The rudder gear engines alone are 750 b.h.p. The work of closing up the decks over the beams and pillars, etc., which had to be left loose while the machinery was being installed, is now completed.

Non-Flammable Substance.—The insulation of provision and cargo chambers throughout the ship with special non-flam. substances (a precaution against fire about which we will see more in another chapter) is now attended to. The laying and caulking of the upper decks are proceeded with. The fitting up of state-rooms on all decks and of side framing and ceiling panelling of saloons are also items of work now being entered upon.

Special electric plant has been arranged for temporary lighting purposes, as many as 4,000 16-c.p. lamps being required to enable the work to be carried on.

Funnels.—On page 51 (Fig. 37) we see the last funnel of the *Britannic* leaving the shops. She has four such funnels ; they are elliptical cross-section, and measure 24 ft. 9 in. by 19 ft., and their height from level of the furnace bars to the top is 150 ft. There is ample space for a tram-car to pass through its casing.[1]

[1] Casings for funnels are, like the ship's bottom, double skin, as seen in this illustration.

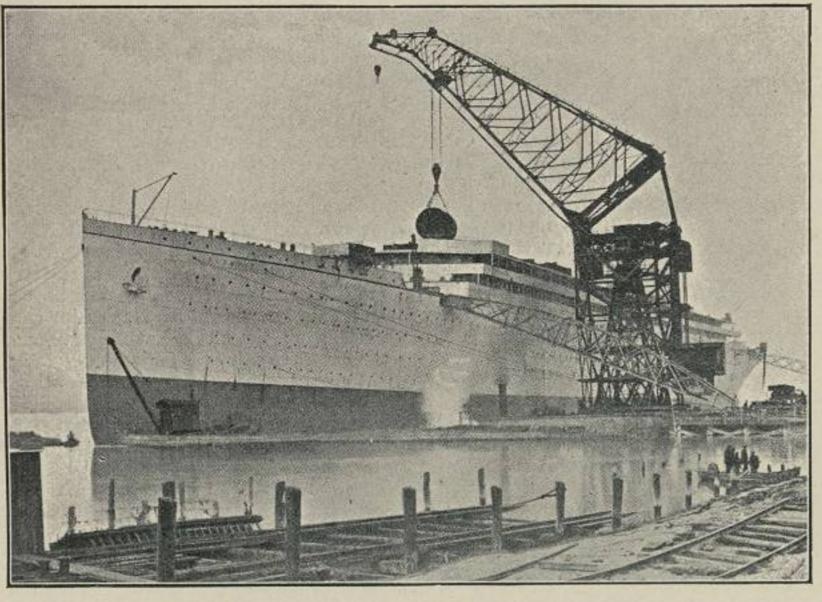


FIG. 36.—FLOATING CRANE LIFTING A BOILER ON BOARD "OLYMPIC".

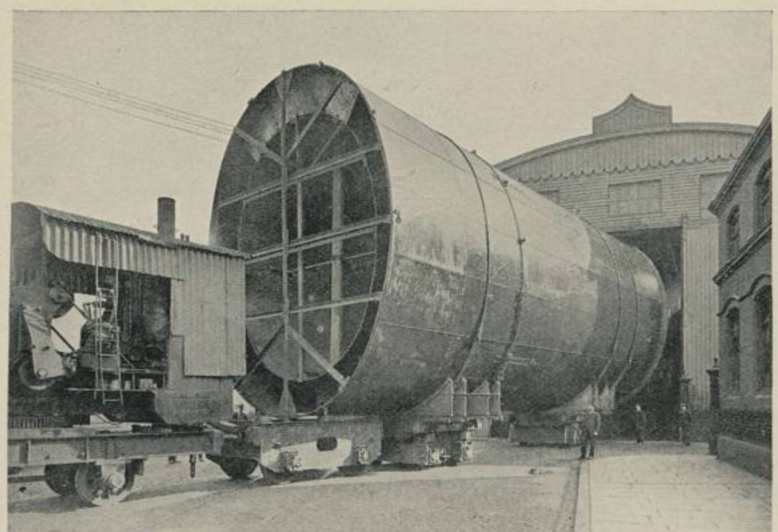


FIG. 37.—FUNNEL OF "BRITANNIC" LEAVING THE SHOPS.

Not all funnels are smoke-stacks ; some are entirely for ventilating purposes, drawing off foul air from the ship as well as fumes from the kitchens. The size of the funnels is most impressive. I shall never forget my first visit to the *Olympic*. After passing through various saloons and visiting a state apartment, the racquet court, and lastly the gymnasium on the boat deck, stepping across to the rails and turning round I saw the enormous funnels. The height of the Nelson Column in Trafalgar

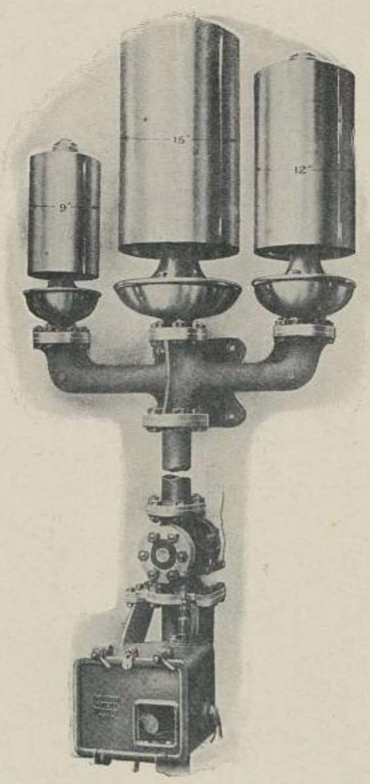
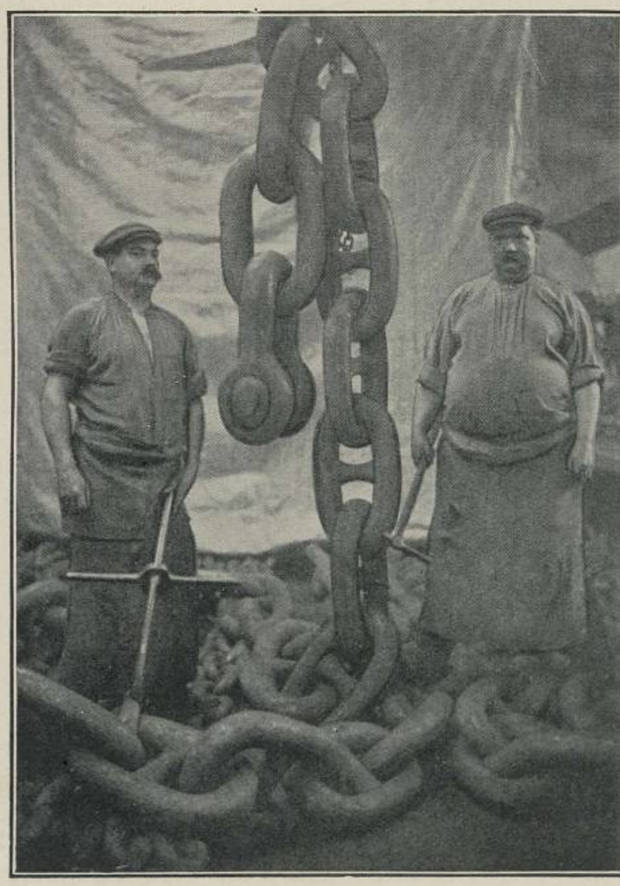


FIG. 38.—THE WHISTLES OF THE "AQUITANIA".

Square is 144 ft. The top of the *Olympic's* funnels stand 150 ft. above the furnace bars, while the funnels of the *Majestic* are 30 ft. higher than those of the *Olympic*. Funnels from furnaces run through all the decks, but there are two exceptions. (See Chapter IX.)

Whistles.—The whistles usually attached to a funnel might be mentioned here. In Fig. 38 one set of whistles is shown.

The three domes are 9 in., 15 in. and 12 in. diameter. The total height from the base of the branch piece to the top of the centre dome is 3 ft. 6 in. The total weight of the three domes and branches is $6\frac{3}{4}$ cwt. The *Olympic's* whistles are electrically operated, the officer on the bridge having merely to close the switch to give the blast. There is also an electric time control, whereby the whistles are automatically blown for eight to ten



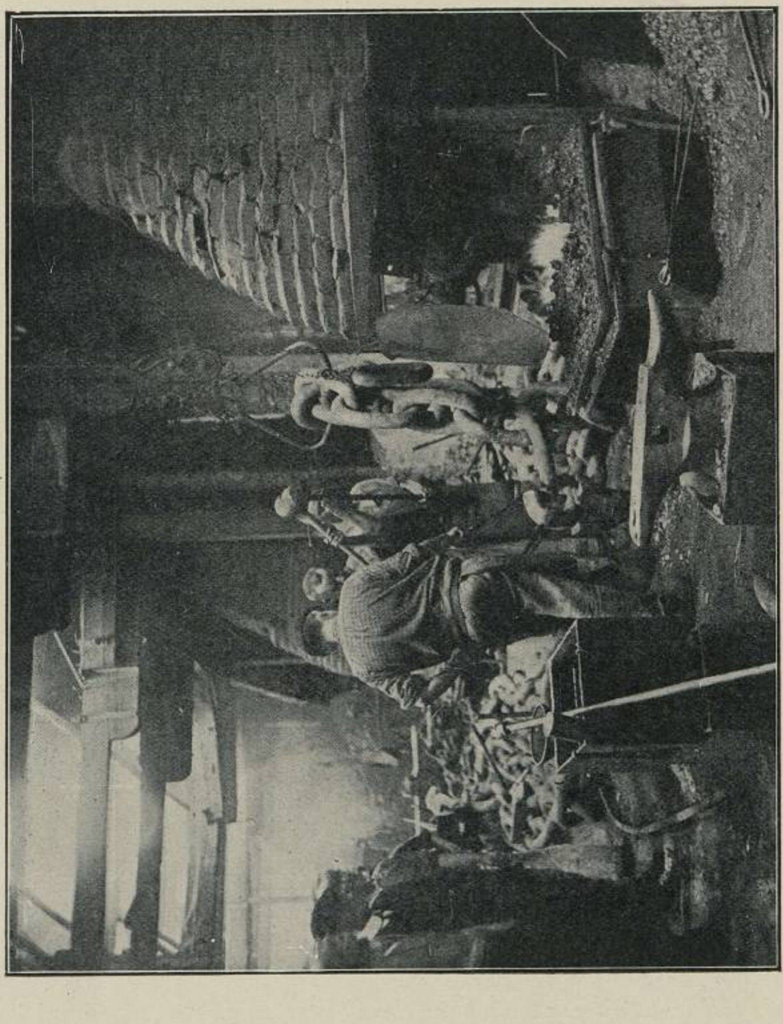
By courtesy of] [*Brown, Lenox & Co.*

FIG. 39.—CABLES OF "MAURETANIA".

seconds every minute during thick weather. The dismal sound is repeated throughout the period of a fog at sea.[1]

Anchors.—There are usually three to four anchors on a large liner; the largest weighs $15\frac{1}{2}$ tons. Messrs. Samuel Taylor & Sons, of Staffordshire, have made 20-ton anchors. These are known as "Dreadnought" Stockless Anchors.

[1] By kind permission of Messrs. T. Downie & Co., of Liverpool.



By courtesy of] FIG. 40.—MESSRS. BROWN, LENOX' WORKS—CHAINMAKING. [*Brown, Lenox & Co.*

Cables.—Cables and moorings for the *Mauretania* (Fig. 39). Each link is $4\frac{1}{4}$ in. diameter, the end link $5\frac{3}{8}$ in., weighing $2\frac{1}{2}$ cwt. each. Total weight is 200 tons. Some cables are 2,000 ft. long. They are tested on a strain of 370 tons successfully. Fig. 40 shows the firm of Messrs. Brown, Lenox & Co.'s works, Pontypridd.

Messrs. Brown, Lenox & Co., Ltd., of Pontypridd, have made chains since 1808. The first chain-testing machine ever made was installed at their works, and is in daily use to this day.

The famous engineer, Mr. I. K. Brunel, who designed the *Great*

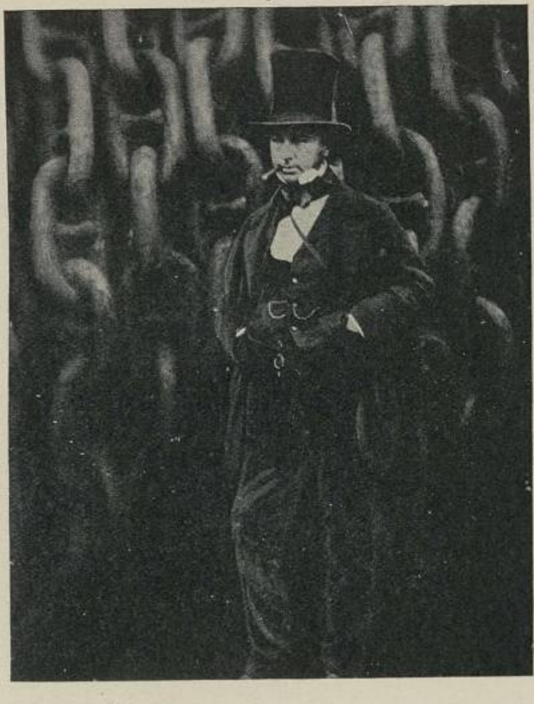


Fig. 41.—Mr. I. K. Brunel and Chains of "Great Eastern".

Eastern, commissioned the firm to make the cables required for the great ship in 1856. An interesting reproduction from an original photograph in the company's possession by their kind permission appears in Fig. 41. It is generally acknowledged that this is the best photograph extant of this great engineer.

A note on the original photograph by Mr. Brunel says: "I wanted Mr. Lenox to stand with me, but he would not, so I alone am hung in chains." These cables were $2\frac{7}{8}$ in. The cables of the *Mauretania*, $3\frac{3}{4}$ in., have in turn been exceeded by cables of $3\frac{7}{8}$ in. for the *Aquitania*. Messrs. Brown, Lenox & Co., Ltd., also supplied these, each of the links weighing 2 cwt. The weights of these links are exceeded by mooring chains, which are the permanent moorings in harbours to which these leviathans are moored. The links of some of these exceed 5 in. in diameter, each of them weighing 3 cwt., and these in turn are shackled to large Admiralty pattern rings measuring about $8\frac{1}{2}$ in. diameter in the solid iron, and weighing about 16 cwt.

Steel Hawser.—Steel-wire hawsers $13\frac{1}{2}$ in. circumference were

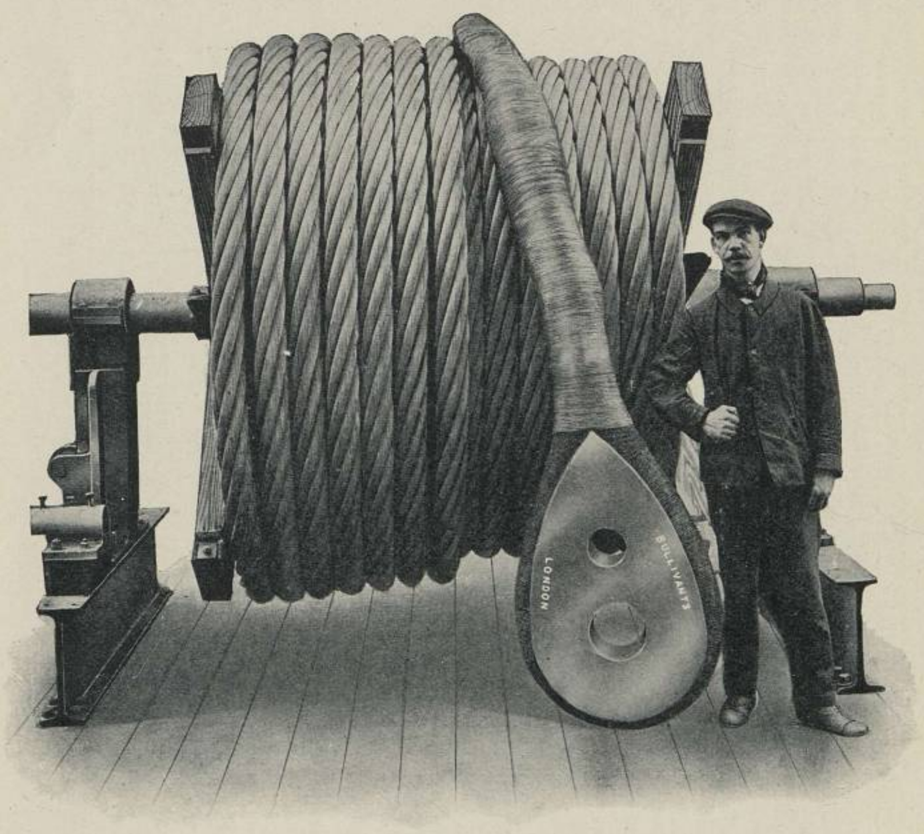
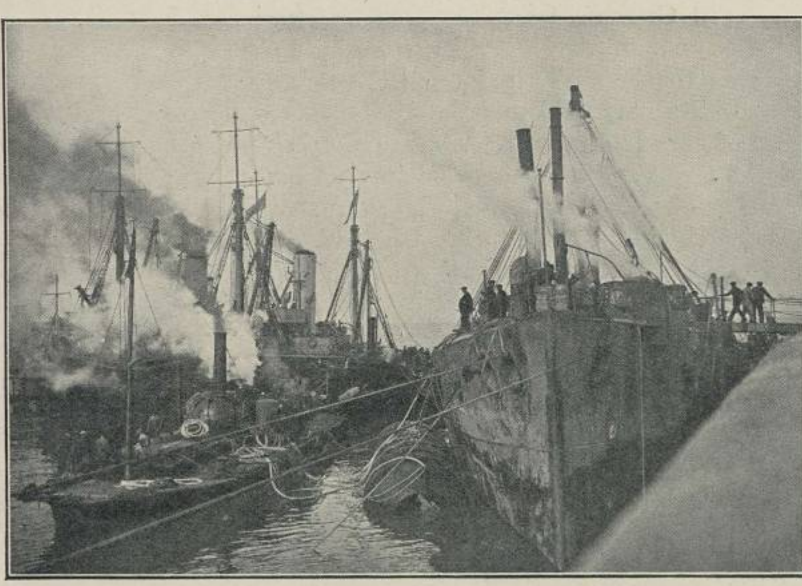


FIG. 42.—STEEL-WIRE ROPE.

made by Messrs. Bullivant & Co., Ltd., of Millwall, who kindly supplied information as well as the illustration (Fig. 42). The steel-wire ropes used for launching the *Lusitania* were 7 in. circumference.

This firm supplies steel ropes for salvage of ships, and recently these were used on the salvage of H.M.S. *Vindictive*, of Zeebrugge fame (Fig. 43A); that silent sea passage under cover of smoke-screen ending at midnight in a brilliant defiance of hundreds of coast defence guns—a daring exploit for which the men had volunteered. Flexible steel ropes for riggings, cranes, lifts, hoists, derricks, etc., are sent all over the world by this firm. The largest steel ropes are guaranteed to take a breaking stress of no less than 1,200 tons on the single part.

Rudder.—The rudder is in its place with construction of the hull, and the rudder of the *Olympic* was mentioned there. These are not always alike. There is a *frame* rudder and a *plate* rudder. The former is forged. The framework is plated on each side, and the space between the plates is filled in with



By courtesy of] [*Bullivant & Co.*

FIG. 43A.—SALVAGE OF H.M.S. "VINDICTIVE"

(Steel ropes being used.)

wood. The upper rudder stock is a separate forging or casting to which it is bolted. The plate rudder-main post is coupled to the stock. A very thick plate, the required shape of the rudder, is notched into the main rudder post. The three ships, *Berengaria*, *Leviathan* and *Majestic*, have rudders similar to the *Olympic*. Fig. 5 shows that of the *Berengaria*, solid cast steel, built in sections and coupled together with bolts some $3\frac{1}{2}$ in. diameter.

The *Mauretania* and *Aquitania* have the balance type of rudder. The last-named ship's rudder weighs 70 tons. It was built in three sections, and the extreme width of the blade is 28 ft. The stock has a diameter of 25 in. and is forged steel.

Balance Rudder.—Balance type of rudder is intended for vessels to be used as auxiliary cruisers, as in the Navy. For a protection against hostile projections the rudder is wholly submerged. Many liners and other merchant ships are now built with a cruiser stern. The Admiralty also require gun decks—specially strengthened positions for gun platforms—reminders of the liability to be called on to fight. We have every reason to be proud of the splendid work done in the Great War, and will remember how on September 14, 1914, the Cunarder *Carmania* met the German armed cruiser *Cap Trafalgar*, a slightly larger and quite new vessel, off the island of Trinidad.

Armed Cruiser's Great Fight.—Captain Noel Grant, of the *Carmania*, manœuvred his ship so that the enemy seldom saw her broadside to shoot at, and the *Carmania's* stem and stern were hard to hit; nevertheless, great havoc was done to the bridge and centre of her upper works. The excellent shooting by our gunners sent the *Cap Trafalgar* to the bottom. This was the first occasion in history of a single ship fight between armed cruiser liners. The *Carmania* is now following her peaceful vocation on the Atlantic run to New York as before. We have yet another story to tell about this ship later on, for she became famous the year before the war.

Derricks and Steam Winches.—Cargo is taken on board by means of ships' derricks and steam or electric winches. The steam winches of a cargo steamer are so noisy that accidents occur through orders being misunderstood or not heard. In large vessels there is a great improvement in this respect; there is no noise and no smell to offend. For the purpose of description we will take the deck working arrangements of the *Aquitania*.[1]

The Mail room is situated aft, and the luggage room forward on the lower orlop deck, while the two cargo holds are both forward. Six silent-running type of cargo and warping winches work these apartments.

Cranes.—On the bridge deck aft there are two cranes for handling the mails, luggage, and other goods. They can lift 30 cwt. at a speed of 120 ft. per minute.

A conical steel casing carries the column, and in it is fitted the whole of the machinery and electrical appliances. Large hinged water-tight doors are provided for inspection and repairs of the machinery.

Mails and Post Office.—One of the functions of these great steamers is to carry the mails. All parcels and letters pass across from one continent to the other by them. On an average 3,800 bags are placed on board just before leaving port, and to do this

[1] *The Shipbuilder*, "*Aquitania*", p. 95.

high speed is required. In December 1923 as many as 9,100 bags were conveyed to America by one ship.

Baggage Hoists.—The baggage hoist, which is electric and silent, is mounted close by the hatchway. The motor is entirely enclosed, and all parts are self-lubricating.

Signals.—First of deck signals " the flag " is the oldest plan, and is still in use. During the war a squadron of warships used visual signalling in the South Atlantic. " Admiral Sir Doveton Sturdee, with *Invincible* and *Inflexible*, met *Canarvon*, *Kent*, *Cornwall*, *Glasgow* and S.S. *Orama* at Abrothos Rocks in S. Atlantic, and sweeping south the seven ships spread out to extreme visual signalling distance in fan-shape 200 miles wide in order to avoid using his wireless," for fear of disturbing Admiral Von Spee and his squadron.[1] Speed and silence were his best weapons.

By flags we spell our messages according to an agreed international code. Nelson's famous flag signal when sailing into battle will never be forgotten. " England expects every man to do his duty " was hoisted on his flagship, H.M.S. *Victory*. Visibility must, of course, be good. Next comes sound signals—gun signals fired at intervals. Then there is the steam whistle or syren used as warnings in fog, at fixed periods. Whistle signals in narrow waters as follows :

One short blast : " I am directing my course to starboard."
Two short blasts : " I am directing my course to port."
Three short blasts : " I am going full speed ahead."

Generally speaking, all steamers keep out of the way of sailing ships. A vessel meeting another end-on must keep to the right. The most critical moment is when steamers are crossing one another's track. The one which has the other on its right hand, or starboard, must keep out of the way. The Morse flash lamp is much used by passing ships at night ; rockets and flares in cases of distress or call for a pilot. There are cone, canvas drums and ball signals as well as the semaphore on the bridge to be found in most ships. The most modern and far-reaching signals are by wireless ; in this case the ship's name or call letter and her position at sea is announced first. Later on we will see how wireless is used by ships in distress.

Blue Peter.—The flag known as " The Blue Peter "[2]—a blue flag having a white square in the centre—used to signify that the ship on which it is hoisted is about to sail. It is the letter P of the International Code hoisted at the foremast-head of a ship in port—a warning alike to all persons, whether crew, passenger or visitors on board.

[1] *A Naval History of the War*, 1914–1918, by Henry Newbolt.
[2] Periodical, *The Blue Peter.*

Taking a Liner out of Dock.—The engineers, when taking a liner out of dock, have a bad time. Orders passed by telegraph from the captain's bridge to the engine-rooms are rapid, and so sometimes appear to be rather contradictory. Every few seconds the gong goes and the great dial-hand swings round. (See Fig. 43B, "Tugs at a Monster".) The largest liners do not use their engines when in close quarters with other ships; they are handled by at least four powerful steam tugs, which have specially padded noses to use when pushing is required, and there is a tug ahead

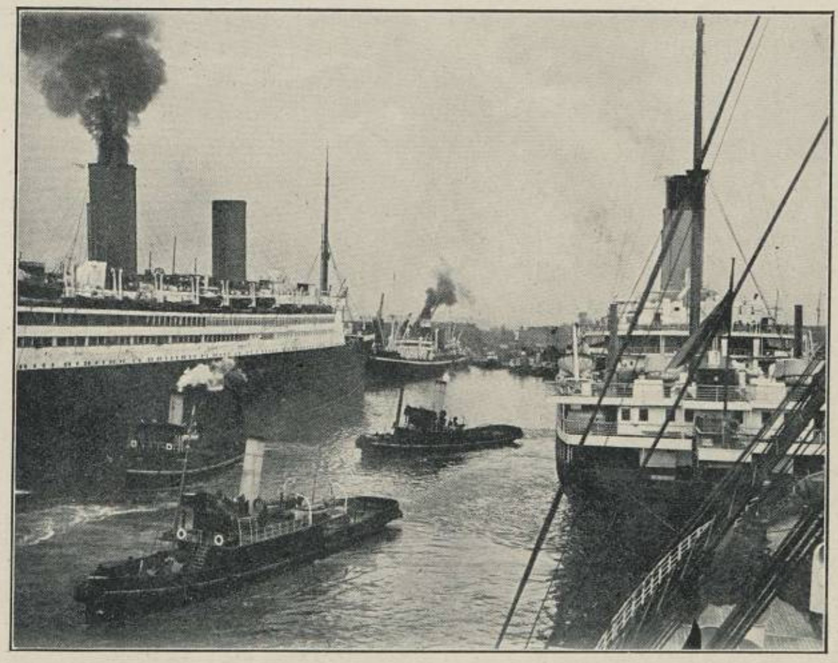


FIG. 43B.—MONSTER HANDLED BY STEAM TUGS—WITH SOFT NOSES THEY PUSH

(This is Southampton, the Home of the Giants. The *Berengaria*, on the left, had just arrived.)

and another astern to steer the monster—a job which engages all the ship's officers: the captain and pilot with one officer on the bridge, and the chief officer is forward, while another officer is on the observation bridge aft. On some of the liners this bridge extends beyond the ship's sides, so that a clear view can be got from stem to stern of the ship's free board.

Passenger Luggage. Officers' Duties.—In a big steamship junior officers stand watch with the senior officers for the purpose of learning their duties. The control of passengers' baggage falls to them; and on the voyage, weather permitting, the ship's hold is opened and the baggage is hoisted on to the decks, where passengers may open boxes and obtain changes of garment. Sometimes thin and light clothing suitable to the changes of climate are needed as the good ship enters other zones. In all cases the baggage must have the label "wanted on voyage" pasted on before the voyage begins, for only boxes so marked are stowed where they can be easily found when required.

Trim of the Ship.—The chief officer is responsible for the crew and the safety and trim of the ship, and the second officer has the care of navigation and all instruments connected with it.

Before the war the two largest Hamburg-American ships had a commodore (his ship was the *Vaterland*, now the U.S. liner *Leviathan*) in supreme charge; under him there was one acting and three reserve captains, one whose special duty was navigation, and another captain had the care of the passengers—by no means a soft job.

The Captain.—To-day a staff-captain is carried, and his duties are to see to requirements of passengers and crew as well as to relieve executive officers of a certain amount of their duties.

"Chief Constructor."—There is yet another officer of high rank found on the U.S. line's ship *Leviathan*, i.e. the "Chief Constructor". He controls all departments of the ship for construction, repair and supply, and he has at his finger-ends the name and address of the makers of everything on the ship. If any fitting is wanted in the engine-rooms, he is appealed to, and the exact article is soon forthcoming; likewise, when a steward reports that a screw or clamp of a glass light or port-hole has broken a new one is immediately produced. This is the man whose brain has knowledge of the concerns of all departments, with one exception, wireless, because that is the affair of the Marconi Officer. He is responsible to the Marconi Company, who supply everything on the ship which works wireless apparatus.

There are certain customs, unwritten laws, of the mercantile ship as there are in the Royal Navy; for instance, you may be asked into an officer's "room"—do not call it a "cabin". The shelter canvas on the bridge is known as "canvas dodgers". In the good old days, when a "B. and S." stood for a brandy and soda on a P. & O. ship, a humorous way of inviting a friend to have a split was to use the company's motto, "Quis separabit," for "let's have a split".

Doldrums.—In the still heat of the Red Sea or in the "Doldrums," a belt of calms, where everyone is in the dumps, this was a particularly cheery invitation.

CHAPTER V

HOW IT WORKS WITHIN

The Pilot—Boiler-room telegraph—Stoking indicator and interrupter—Telegraph—Tachometer—Charts—Rudder steam steering-gear—Quadrant—Electric helm indicator—Hand steering—Starting platform—Speed indicators—Starting levers—Engine-rooms—Coal fuel—Conversion: coal to oil—Oil fuel—Pneumercator gauge—Trim of ship—Boilers—Stokeholds—Forced draught—Ash ejectors—Loud-speaking Navy 'phones—Ordinary telephone system—Upper bridge—Docking bridge aft—Compound and triple expansion—Engines—Reciprocating engines—Railway locomotive—Turbines in series—Turbines in parallel—Blades fixed and moving—Sectors of blades—Thrust block—Condenser—Air pump—Feed-heater—Main circulating pumps—*Turbinia*—Geared turbine—H.M.S. *Badger*—Oil separator—Comparative trials, triple expansion *v.* geared turbines—Water separators—Motor-driven gear of turbines—Shafts—Propellers—Rope guard—Wooden screw.

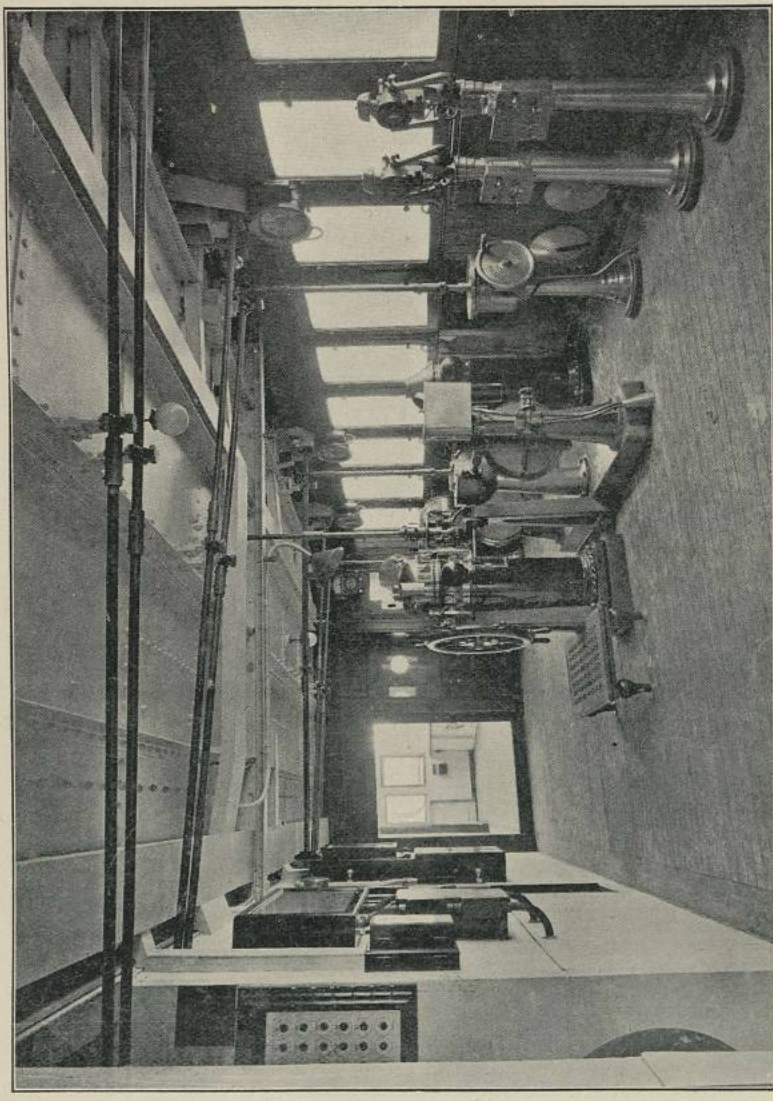
The Pilot (Fig. 44).—Our ship is moving. The pilot, acting under the watchful eye of the captain, has taken the great liner down the river to the pilotage station. "Half-speed ahead" is repeated, and the officer on the bridge turns the handwheel and the hands on the dial of the telegraph hurry round. A gong sounds in the engine-room some 70 ft. below, where a similar dial shows the hands pointing to the order "half-speed ahead".

Boiler-room Telegraph.—The chief engineer at the starting platform (Fig. 45), by pressing a button, rings a single-stroke gong on the bridge, acknowledges the order, and passes it on to the boiler-rooms by the electrically worked Evershed "Boiler-room Orders Telegraph" by pressing the switch "half" on the transmitter instrument.

This illuminates the order "half" and sounds a gong at each of the indicators which are more than 100 yards from the starting platform. On the right side of the transmitter are pedal switches for the orders "Stop", "Slow", "Half" and "Full".[1] (Fig. 46.)

Stoking Indicators (Fig. 47).—This is not all. There are Kilroy's stoking indicators, which automatically notify the number

[1] There are other patents which serve the same purpose.



By courtesy of] FIG. 44.—BRIDGE AND NAVIGATING INSTRUMENTS, "AQUITANIA". [*Cunard Steamship Co.*

of each of the 168 furnaces of the ship (*Aquitania*), signalling these numbers in rotation at regular intervals, ringing a loud gong to call attention at each change of signal. By an electro-magnetic timing device, the rate of firing desired by the engineer is set, so that the minimum number of furnace doors will be open at one time and no opposite doors in a double-ended boiler open together, to prevent loss of heat.

Regulator Timing Apparatus.—In vessels using oil fuel this

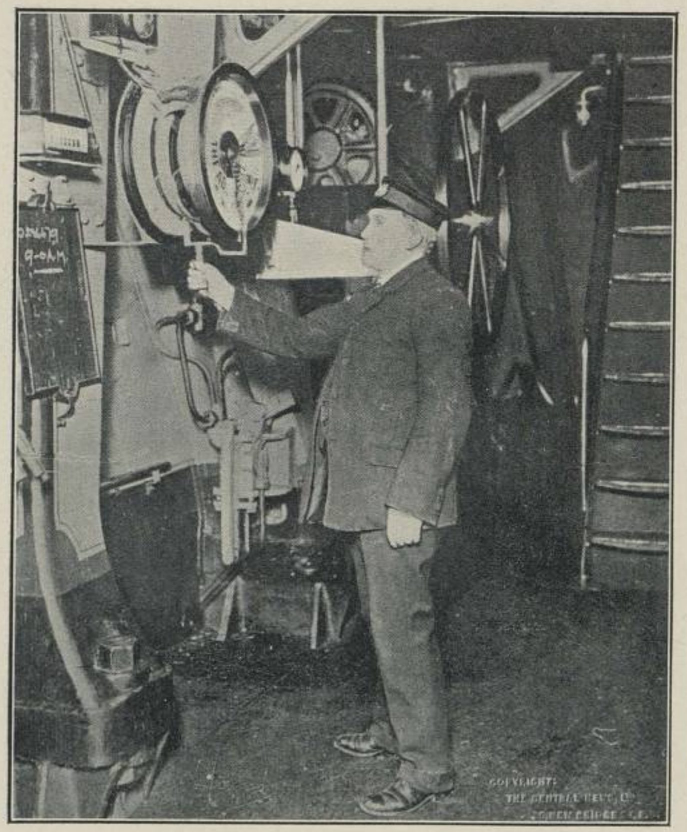
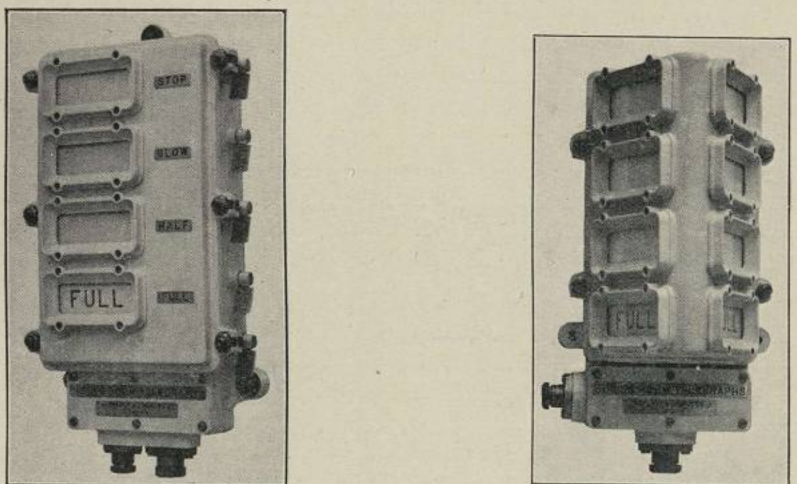


FIG. 45.—TELEGRAPH IN THE ENGINE-ROOM.

control is not required, but in the case of coal, stokers will proceed to put on eight shovel fulls, as found by experience. Say the rate of firing is once in every fourteen minutes, then a complete rotation of numbers will be effected in the fourteen minutes firing interval. The regulator, or timing apparatus, is operated entirely electrically.

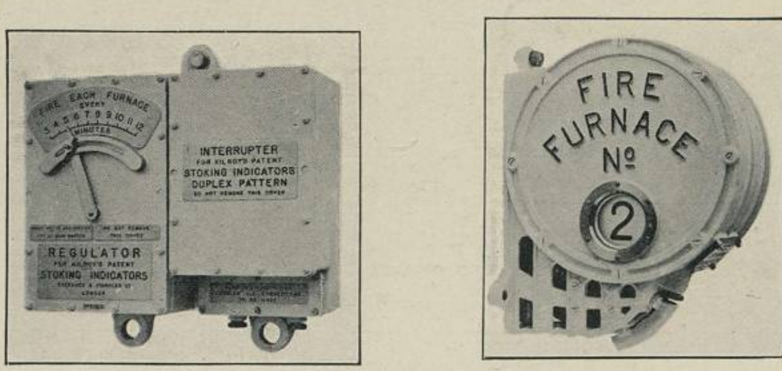
Here are interesting pictures (Figs. 48A and 48B) showing the stokehold of the *Aquitania* stoking coal and in the same vessel's stokehold when oil-burners are in use; the latter is cleaner, cheaper, and easier to work.

The pilot has taken the great liner out. Starting in smooth



Transmitter. Receiver.

FIG. 46.—BOILER-ROOM TELEGRAPH



Regulator. Indicator.

FIG. 47.—KILROY'S STOKING INDICATOR.

water he often ends in a rough sea. He is now preparing to disembark. Those who are leaving Great Britain for the far-off posts of Empire watch the pilot with keen interest and a silent thought that he, at all events, is returning home; and only after seeing him "go over the side" do they feel that the voyage has really begun.

Telegraphs.—Soon the telegraph instruments on the bridge are passing the order "full speed ahead". The captain gives his order with one hand—one revolution of the hand-wheel moves the pointers on both the bridge and engine-room instruments to the centre of the next order and locks them in this position. There is no possibility of mistaken orders. The pointers can only take up the mid-position of each order.

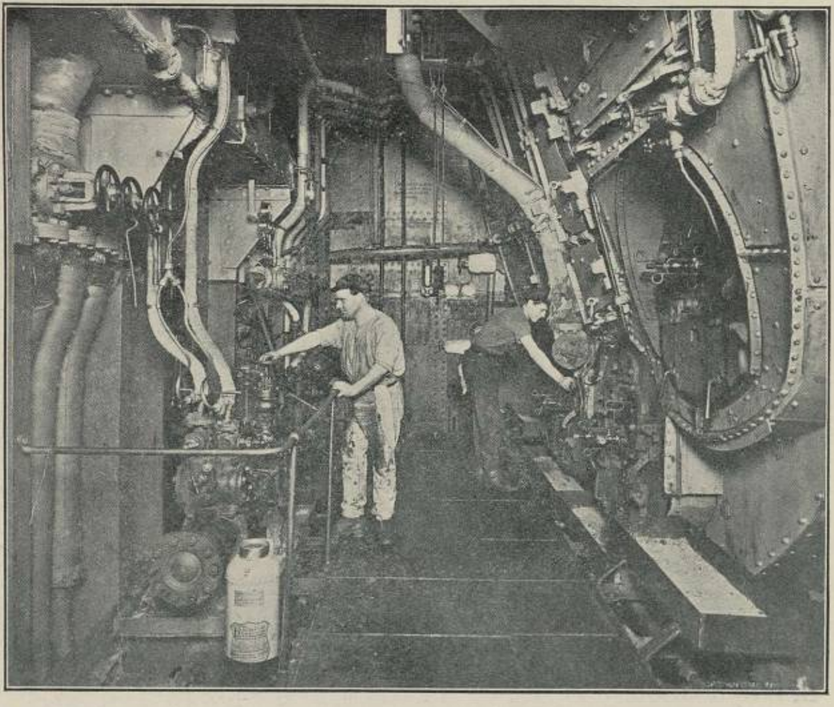
The vessel is now passing the outer lightship. The time is taken accurately, for it is from this point that the trans-oceanic

By courtesy of] [*"Central News."*

FIG. 48A.—STOKEHOLD OF THE "AQUITANIA" UNDER COAL.

passage begins and average speeds and fuel consumption are reckoned. Orders are given, and the bo'sun "pipes down" stations, by which is meant the chief officer and the port watch leave the forecastle-head and the first officer and the starboard watch leave aft. Similarly in the engine-room the double watch employed in pilotage waters come to an end, and on "top" and "down below" the regular watch-keepers settle down to the ordinary sea routine; the captain has set the course, written up his night order book, and, the visibility being good, goes to his quarters.

Tachometer Tell-tale.—Not only does the captain get an instant reply to every order from his bridge telegraph with leads over 600 ft. long, but he has on the bridge a combined tachometer and tell-tale with two pointers, one showing the direction of rotation of the union shaft and the other the speed of rotation. The dial is graduated in revolutions per minute, and the tachometer pointer indicates the speed, and there is a counter which shows the total number of rotations run. A similar set of instruments is also in the engine-room, so that the engineer can see the result of his



By courtesy of] [*Cunard Company.*

FIG. 48B.—ENGINE-ROOM OIL-BURNERS, "AQUITANIA"

manipulations. There is a complete set working on each shaft with four propellers; there are four dials and four counters. These are found in the illustration on page 68.

On the Charts.—The course of the voyage has been plotted and set down even before any passenger arrived on board, but the actual course taken by the ship will be marked off at regular intervals, so that the ship's position is known at any time.

Rudder Steam Steering-gear.—The quartermaster, whose duty it is to steer the ship, stands at the wheel watching the movements of the great compass in front of him. The huge rudders of large vessels require powerful steam steering-gear. By moving a small steering-wheel by hand he causes the engine to turn the tiller the required distance and direction.

The steering-gear in the White Star liners built by Messrs. Harland & Wolff consists of a spring quadrant and tiller on the rudder-head (in the *Olympic*) worked through wheel-and-pinion and bevel gearing by either of two sets of steam engines. Either engine suffices for the working of the gear, the other being a stand-by.

The Quadrant.—The quadrant is connected to the arms of the

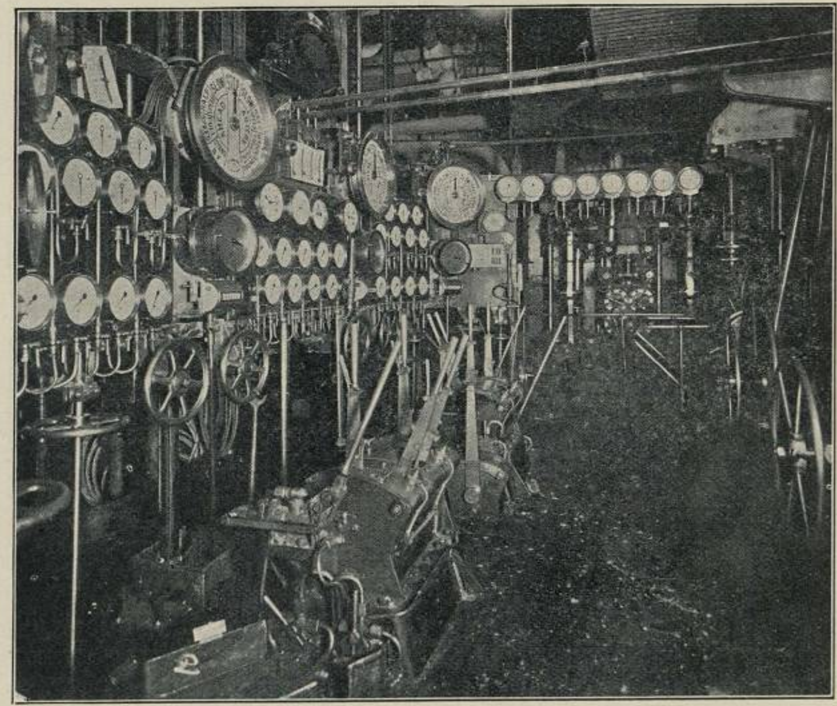


FIG. 49.—STARTING PLATFORM, "AQUITANIA"

working tiller by means of heavy spring links, which prevent undue shocks coming upon the gear of the engines. The tiller can be also worked by the warping capstans should the whole gear be disabled.

The Electric Helm Indicator.—Shows the precise position of the rudder at any moment. It is placed on the navigating bridge. (See Fig. 44, page 63.) The instrument is placed high up in the back of this picture. Dials of all such instruments are illuminated at night. There is a helm indicator in every navigating station and in the engine-rooms.

Hand Steering.—Hand steering in the old days was usually done by two or four men on either side of a large steering-wheel, or couple of wheels, and sometimes in a heavy sea the rudder would take charge of the men or send them flying.

Starting Platform.—The starting platform of the *Aquitania* amidships (Fig. 49). There are 120 indicators, gauges and many other interesting instruments, all of which do not appear in the illustration. These are the tell-tales, which the engineer requires. There is a barometer indicating atmospheric pressure—the state of the weather; a clinometer showing the trim of the ship; a steering repeater of the gyro-compass; clocks which are electrically controlled; and the illuminated indicator showing the position of all the ship's water-tight safety doors, and whether open or closed. The whole shows the engineer in charge, not only what is going on in the engine-rooms, but also in the most distant parts of the ship.

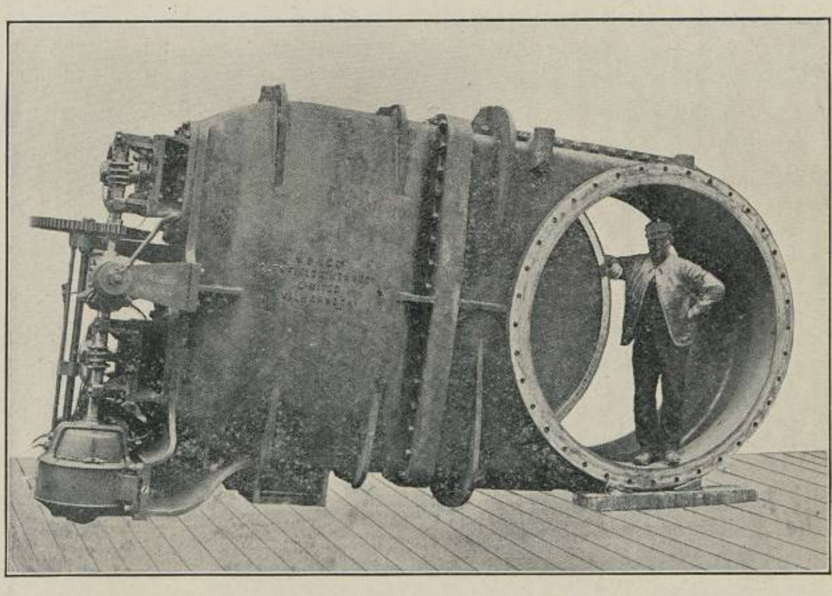
Speed Indicator.—There are indicators for recording the speed of each turbine, together with instruments which show the direction of rotation at any moment, thus enabling the engineer officer to be certain that each turbine is responding to the controlling levers operated by him. (Four dials of the four turbines are in the illustration.) There is a device for warning the engineer in case a turbine should revolve in a direction contrary to that ordered. A bell rings, and a red light gives warning.

What happened when the first gong in the engine-room drew attention to the captain's order to "go ahead"?

Starting Levers.—Starting levers on the platform—similar to those on a locomotive—are pulled over. These control combined steam and hydraulic engines which operate the huge valves (see illustration, Fig. 50, of a valve on the *Mauretania*). The steam is admitted. From the intermediate pressure ahead turbine the steam exhausts through a pipe 7 ft. 6 in. in diameter. The shut-off valve can be opened or closed in four seconds by the action of a twin-cylinder steam engine placed directly underneath. In case of emergency, the valve can be operated by hydraulic power.

Engine-rooms.—Engine-rooms and the arrangements in them are not the same in every ship. The turbine-rooms in the *Aquitania* occupy 84 ft. of the length of the ship immediately abaft No. 4 boiler-room, the space within this length being divided into three compartments transversely by two longitudinal water-tight bulkheads. The turbines being encased and having no moving parts visible perhaps look a bit dull, but the engine-rooms also contain some sixty or seventy auxiliary engines, pumps, filters, separators, refrigerating engines and so on.

Coal Fuel.—Coal fuel has been used in steamers for over a hundred years. In the past British ships have clung to routes where coal has been placed for their use at convenient distances. Most of the supplies came from the British Isles, consequently the price per ton increased with the distance from the base. To-day in the British Empire, so far as Australia and Far-Eastern trades are concerned, the prices are lower, as coal is found in South Africa and Australia—in fact, Eastern coals begin to compete in Colombo, where good Indian coal is obtained. The United States supplies coal quite cheaply to American ports. Nevertheless, American coal



By courtesy of] [*"The Shipbuilder."*

FIG. 50.—SLUICE VALVE, "MAURETANIA".

for steaming purposes is as 95 to 100 when compared with South Welsh. British coal has so far been free from competition along the Suez route. Healthy competition is good for both capital and labour.

Conversion—Coal to Oil.—Apart from this, we see a great revolution taking place. All the world's largest ships have become oil-consumers, and so great has been the rush for the conversion of ships from coal to oil fuel that some great shipping firms have considered it necessary to warn shipowners that oil may be difficult for all of them to obtain. Not all routes have oil depots, but any oil-tanker on the high seas may be an oil depot.

The Royal Navy is almost completely oil-driven. Here is a picture of H.M.S. *Victorious*[1] bunkering (oil fuel) at sea (Fig. 51).

The method is clean, economical and requiring little or no trouble when compared with coaling. Flexible metallic tubing is suspended on a line from ship to ship. Everyone who has been through Port Said, where in the old days the coaling was the fastest and perhaps the dirtiest in the world, will remember how coal-dust penetrated into the cabins in spite of the ship being closed up.

In the Royal Navy everyone, including officers, and indeed

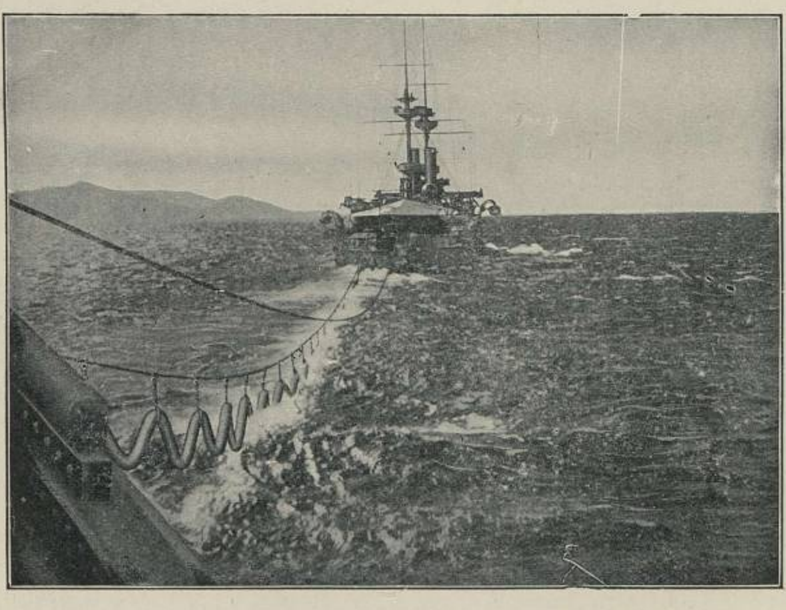


Fig. 51.—H.M.S. "Victorious" Bunkering Oil at Sea.

even His Majesty King George V, has taken a hand at coaling. Coal-rig means donning any old garment you can find.

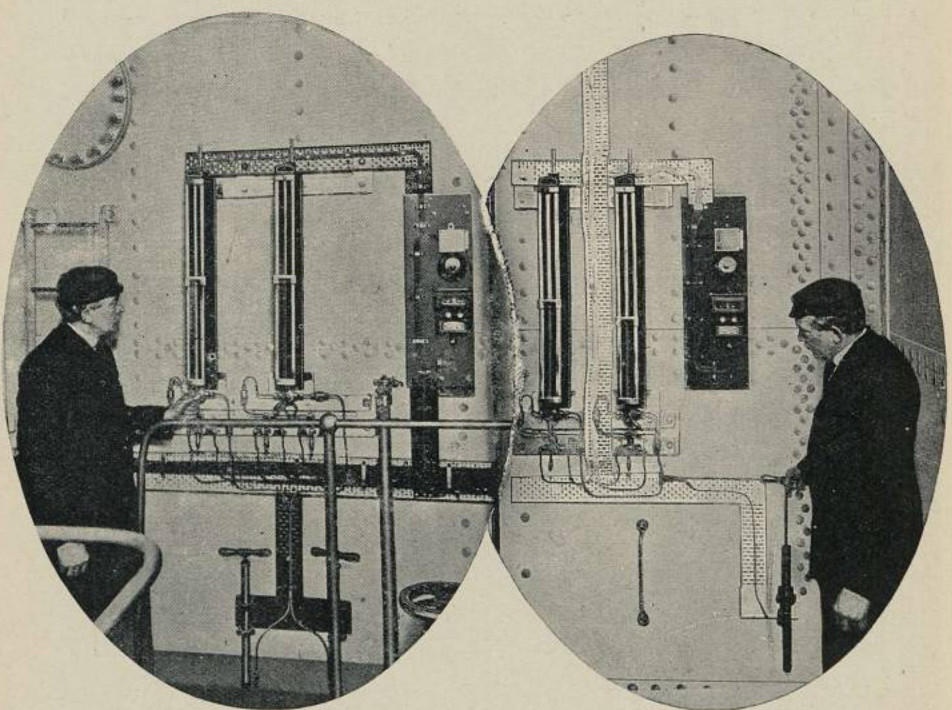
Oil, as has been shown, does away with much toil, grime and expense, for ships require few hands to attend to oil fuel. No wonder all shipowners rush to obtain these great advantages.

Oil Fuel.—The "White" low-pressure mechanical system seems to be most in favour, and is the system in the *Aquitania*. Of course, there are many different systems. Each boiler-room is provided with two 8-in. filling pipes on each side of the ship. There are four connections for bunkering purposes. If connections

[1] This picture was obtained through the kindness of the United Flexible Metallic Tubing Co., Ltd.

on only one side of the ship are in use at one time, the vessel could be completely bunkered in six hours.[1]

Pneumercator Gauge (Fig. 52).—Each storage tank is supplied with a pneumercator gauge.[2] This gauge tells the depth of oil, and the quantity of oil in the tanks can be noted at any time. Electric alarms are fitted, so that when a tank has reached its 95 per cent. capacity level a bell rings. These alarms are also fitted to the *settling tanks* already described.



Operating control valve. Pumping air into chamber before taking reading.

FIG. 52.—PNEUMERCATOR TANK GAUGE.

Trim of Ship.—The pneumercator is also an instrument which is ever ready to tell the officer on the bridge the trim of the ship. This draught indicator is an instrument of precision which, located in the captain's office in a ship, indicates fore and aft draught, and registers the mean draught and corresponding tons displacement. It shows the trim of a vessel under all conditions, and is also used to weigh cargoes, the contents of bunkers, etc.

[1] The *Leviathan* to run her engines must carry 9,500 tons of fuel oil.

[2] Messrs. Kelvin, Bottomley & Baird, of Glasgow, to whom we are indebted for kindly supplying the illustration and information.

Boilers.—Some ships have fire-tube (Scotch) boilers, and others (the *Majestic*, for example), water-tube boilers (Fig. 53) shows one of twenty-nine boilers of the *Britannic*; this weighs 105 tons. The boiler capacity in mammoth ships is much the same; they differ, however, in the number and kind—some are single- and some double-ended. The *Aquitania* has twenty-one double-ended, the *Britannic* had twenty-nine double-ended, while the *Berengaria, Leviathan* and *Majestic* all have forty-six single-

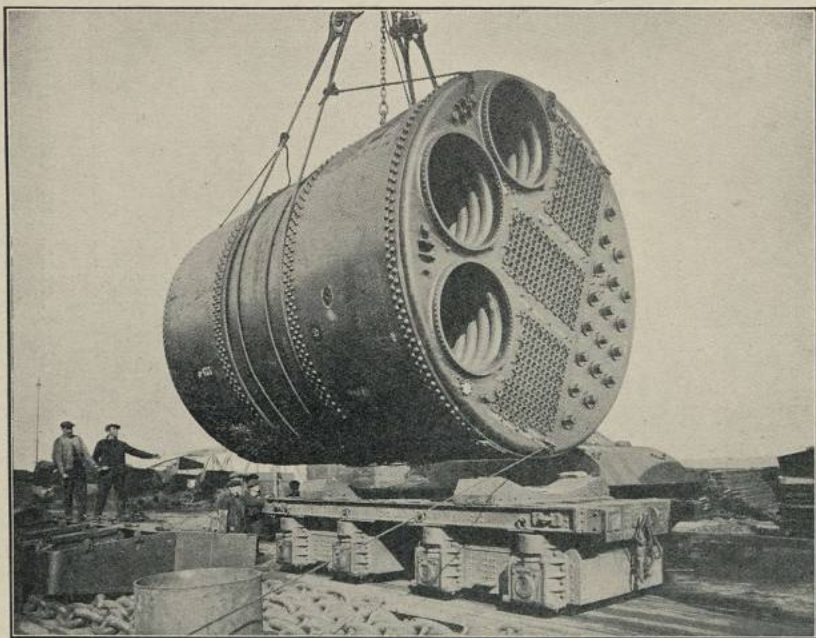


Fig. 53.—One of the Twenty-nine Boilers Weighing 105 Tons, "Britannic".

ended boilers. Fifty-four miles of tubing are in the boilers of the *Aquitania*.

Stokeholds.—These are placed in four or six stokeholds, which are divided by water-tight transverse bulkheads.

Forced Draught.—The combustion air required for Howden's *forced draught* is collected and supplied to furnaces by rotary blasts in the engine-rooms and stokeholds. Each blast is fitted with a rotary wheel 13 ft. 9 in. in diameter, and presses the air under the grates of furnaces through large pipes. The Howden fans draw their air from the top deck down huge ventilators. The air cools and ventilates the stokeholds, and is finally drawn in by the forced draught fans of the furnaces. These fans require four 50-h.p.

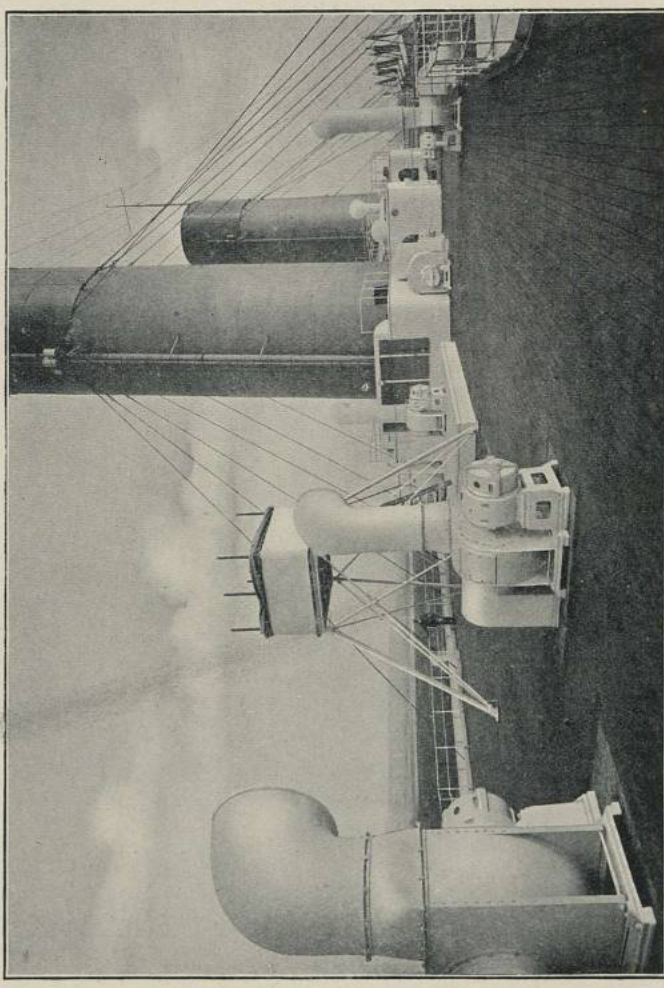


Fig. 54.—"Sirocco" Fans and High Compass on "Olympic".

motor engines. The *Olympic* has Sirocco [1] fans for ventilation; these are seen in Fig. 54.

Ash Ejectors.—A photograph of one of Messrs. J. Stone's hydraulic underline ash-expellers is given in Fig. 55. There is a hopper, the top of which is furnished with a grid lying flush with the stokehold floor. A horizontal pipe leads to a chamber through which a stream of water is directed by a hydraulic ram. This stream carries away the ashes and is discharged through the bottom of the ship. In another ash ejector there are powerful pumps which force the ashes through large pipes carrying a force of water to eject it

By courtesy of] [*J. Stone & Co., Ltd.*

FIG. 55.—HYDRAULIC UNDERLINE ASH-EXPELLER.

out of the ship above water-level. Yet another means is by ash hoists along the engine-rooms; these are silent in working. When the *Aquitania* was using coal for fuel, about 120 tons of ashes had to be removed every day.

Loud-speaking Navy 'Phones.—In the illustration of the navigating bridge (Fig. 44) two 'phones will be seen, the nearest on the right suggesting a musical trumpet. These are the universal type loud-speaking Navy 'phones. They are on all war vessels and more than 3,000 ocean liners. On the latter, loud-speaking 'phones are fitted in the wheel-house on the bridge for communicating with forecastle, crow's-nest, engine-room, and after docking bridge.

[1] Messrs. Davidson & Co.

Navy 'phones are water-tight and very solid in construction; other features are reliability and *loud* speech combined with clear articulation. These telephones also have what is known as "voice call", i.e. by operating the speaking key (or lifting the arms of a side-tube instrument) and speaking into the transmitter, the message is at once heard at the other end of the circuit as loud as a normal speaking voice without the person listening having to approach his instrument. These instruments are distinct from telephones of the ship used for domestic service.

Ordinary Telephone System.—The internal system provides inter-communication between a number of cabins through a central exchange for 50 to 100 lines, first-class state-rooms and also the rooms of the chief officials and various service-rooms. In addition to the exchange system, a separate group of circuits is provided between pantry and galley, pantry and baker's shop, also butcher's shop (both first and second class) independently. We will have more to say about telephones in Chapter VIII.

The navigation bridge is on the boat deck, and on it there are the wheel-house, the chart-house, and abaft that the officers' quarters.

Upper Bridge.—There is, however, an upper navigation bridge which is above the boat deck, extending the full width of the ship (Fig. 56). Here are the engine telegraphs to each of the turbine-rooms, with instruments showing direction and rate of revolution of each shaft, and the capstans and windlass gear stations. Loud-speaking telephones are provided to the look-out on the bow and crow's-nest as well as the engine-rooms and other parts, as already described.

Docking Bridge Aft.—On the docking bridge aft there is placed a third telemotor transmitter. Each transmitter has a separate lead of piping to change valves in the main steering-house.

So far we have mentioned the means of communication used by the captain and his officers from the distant parts of the ship to the centres of power.

Compound and Triple Expansion.—Before proceeding to show "how it works" in the engine-room, it is well to say that there were two great changes in steam power—when the *compound* engine was thought of and when the *triple-expansion* engine was designed. "Compounding" means the using of the waste steam from one cylinder to do further work in a second cylinder. "Triple expansion", whereby the exhaust steam is utilized in a third cylinder, also quadruple expansion reciprocating steam engines, resulting in great economy. Apart from economy, the adoption of these various forms of engines has helped to facilitate one very important improvement.

Some years ago the writer had a most disagreeable experience of vibration from the single-propeller engine of a steamer between Aden and Bombay. The incessant vibration was greatly increased when the propeller occasionally raced in the air as the vessel plunged in the sea! This was due to the old compound engine with a single screw. Nowadays passenger ships have two, three or four screws, and triple or quadruple expansion reciprocating engines or turbines; sometimes a combination; and there is no

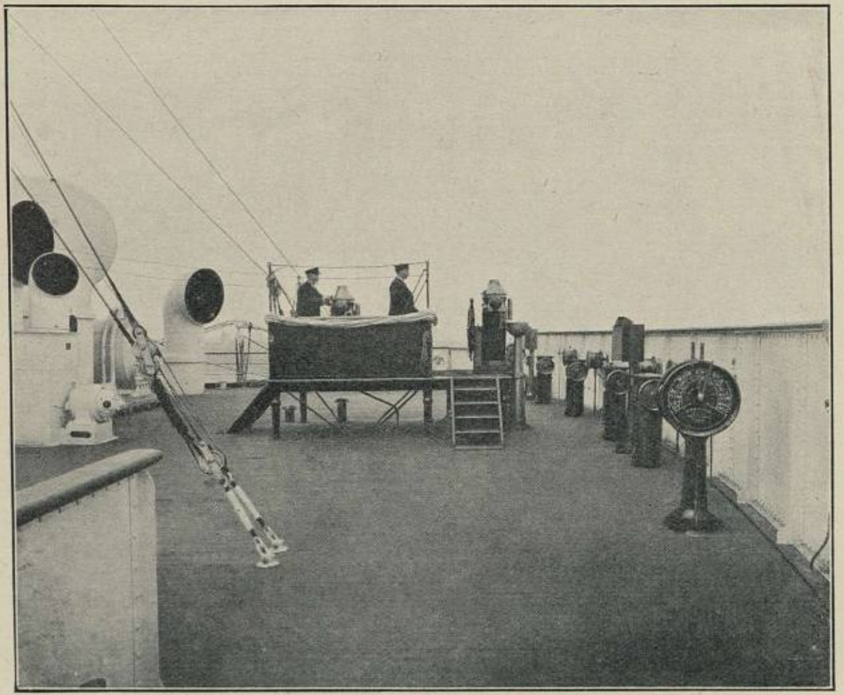


FIG. 56.—UPPER NAVIGATION BRIDGE, "AQUITANIA".

disturbing vibration or sound, but you experience a very extraordinary sense—the moment, the pulse of the engines cease to throb, so to speak—a dead stillness at once causes uneasiness.

Sometimes it has been arranged to stop the engines for a special purpose, as when ships cease work for the observance of the two minutes' *Silence* on Armistice Day. Only once a year do the wheels of routine slow down to a stop. Every man on board every British ship stands motionless. The sounds of the ship's bell, the bugle-call, and the clash of gongs in the engine-room mingle in announcing the eleven o'clock *Silence*. Even the hiss of escaping steam from the funnel does not prevent the hearing of the gentle lap of the waves along the ship's side.

Engines.—As regards propelling machinery, we are not here concerned with the long years of experience—the stepping-stones—to our marine-engine knowledge of to-day. It is rather important to explain what is in use in giant ships and "how it works". Science is moving so fast that what is called the last word in engines to-day may be a "back number" to-morrow. Safety and economy are the governing factors in all marine work. The

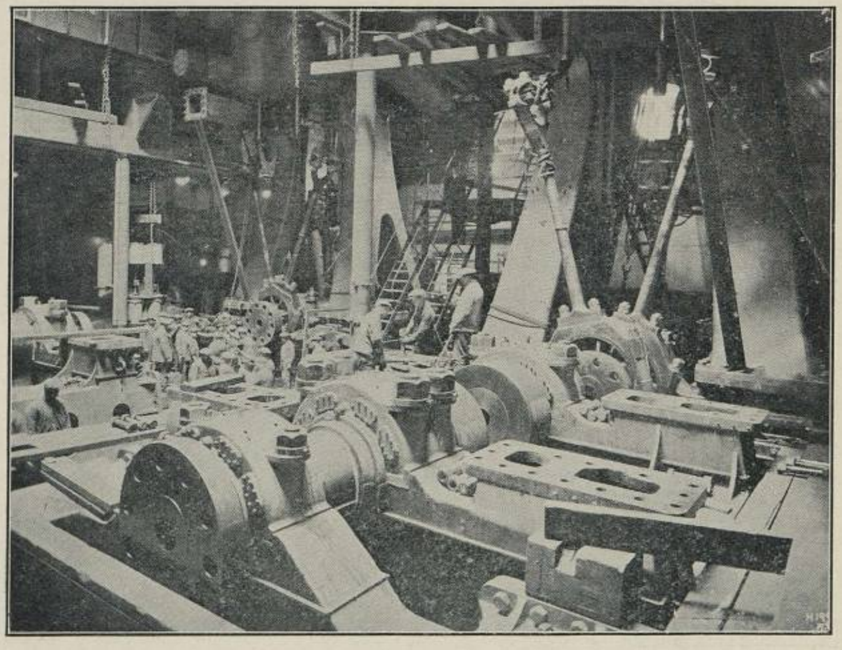


FIG. 57.—RECIPROCATING ENGINE BEING ERECTED IN THE "BRITANNIC".

engines in the twelve largest ships afloat are turbines or combinations of reciprocating engines with low-pressure turbines.[1] The triple-screw White Star liners *Olympic*, *Titanic* and *Britannic* were fitted with reciprocating engines and low-pressure turbines (Fig. 57). Here is a reciprocating engine being erected in the *Britannic*, each propeller being driven by one set of reciprocating engines and the centre propeller by a low-pressure turbine. The steam, after passing through the reciprocating engine, flows into the low-pressure turbine on the centre shaft. The *Olympic's* turbine, which was made entirely at the Belfast works, is the largest marine

[1] *The Shipbuilder*, March 1914.

exhaust turbine yet made, the weight being nearly 500 tons. It exhausts its steam into two condensers; but provision is made by special valve so that the exhaust steam from the reciprocating engines may pass direct to the condensers instead of through the turbine to the condenser; no reversing or astern turbine is necessary on the centre shaft. Astern driving of the ship and all manœuvring in port is done by the reciprocating engines on the wing shafts. In manœuvring, the ship's machinery is the same as a twin-screw vessel.

The steam, at about 200 lb. pressure, after passing through the successive cylinders of the reciprocating engines, enters the low-pressure turbine at only 9 lb. absolute. Even this low initial steam-pressure develops about 18,000 h.p., which is slightly more than the power developed by each of the two reciprocating engines. The result is very much higher economy than is possible with reciprocating engines only. The steam-pressure at exhaust is at 1 lb. absolute.

Large Pipe for L.P.T.—From each low-pressure turbine the steam exhausts through a large rectangular duct, 15 ft. by 6 ft., to the main condenser. During one of those annoying delays on the railway, when a train was held up just outside a big station one very hot day in summer, the silence was broken by an inquisitive small boy. He was watching a shunting engine and blurted out: "Why does white smoke come out of that engine, mummy?" "Because steam is making the engine go," she replied. "Why does the steam make the engine go? When I draw engines I put black smoke." "Yes, dear, that is from the coal," was the reply. Here is the truth—it is, that the locomotive engine wastes a large amount of its power by letting steam go up the funnel. This steam, then, is not used two or three times over as in steamships, because there is no room on a locomotive for the extra machinery required!

Railway Locomotive Engines.—Railway locomotive engines work on a pressure of about 220 lb. per sq. in. This energy is run to waste; at each stroke of the piston the steam passes out of the engine funnel, and the only work it does is to cause a forced draught on the engine furnace as it goes.

Turbines in Series.—Turbines in series in the *Aquitania* consist of one high-pressure, one intermediate-pressure and two low-pressure units. Astern turbines are provided on all four shafts. Reversing turbines run idly when the ship is going ahead.

Turbines in Parallel.—Turbines in parallel in the *Mauretania* consist of two high-pressure ahead turbines driving the wing shafts, and two low-pressure ahead turbines and two astern turbines connected to the two centre shafts.

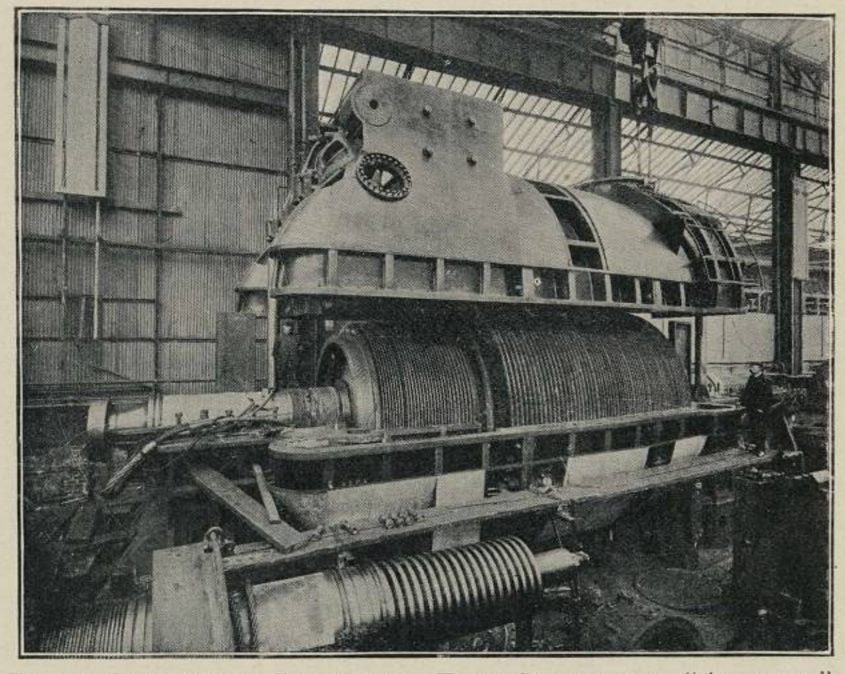


FIG. 58.—LOW-PRESSURE TURBINE WITH UPPER CASING LIFTED, "AQUITANIA".

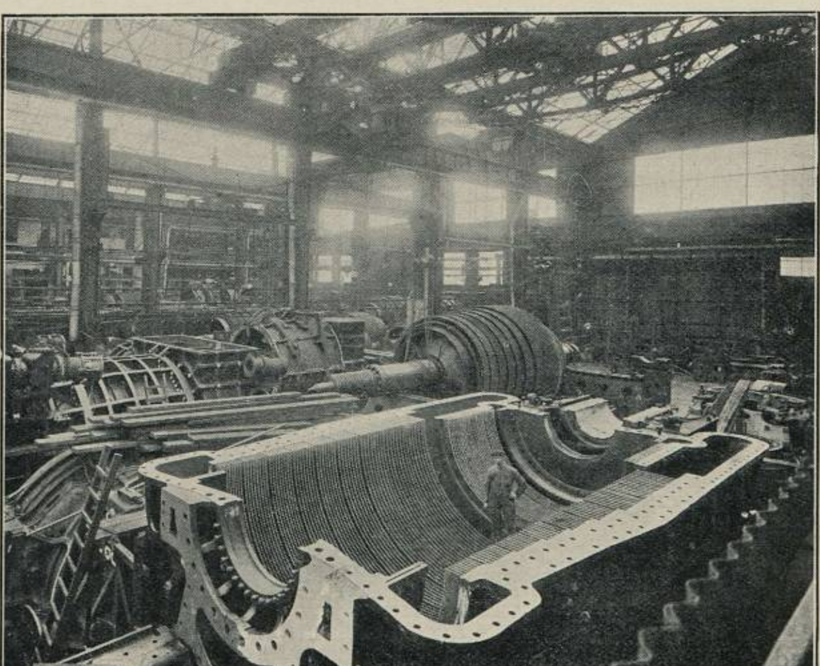
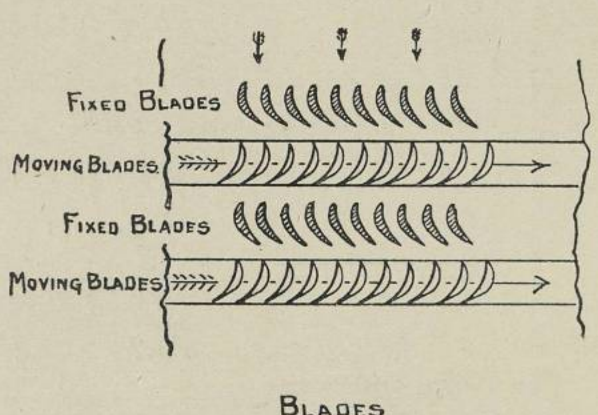


FIG. 59.—BOTTOM HALF OF A LOW-PRESSURE TURBINE CASING SHOWING FIXED BLADES.

In the engine-rooms of "combination systems" there will be the two sets of reciprocating engines, each with four-cylinder triple-expansion direct-acting inverted type, balanced system.[1] In the *Olympic* the cylinders are 54 in., 84 in., 97 in., and 97 in. diameter, all having a 75-in. stroke. The two 97-in. low-pressure cylinders are placed one at each end of each set of engines. This is all that is to be seen of the main engines.

Let us see what Sir Charles Parsons' steam marine turbine is like (Fig. 58). One of the low-pressure turbines, with upper casing lifted. The men, one standing at each end of the rotor drum, give some idea of the immense size and massive construction of the turbines.

Blades Fixed and Moving (Fig. 59).—In the bottom half of a low-pressure turbine casing you see bronze blades are



By courtesy of] [*Sir Charles Parsons, Ltd.*

Fig. 60.—Blades.

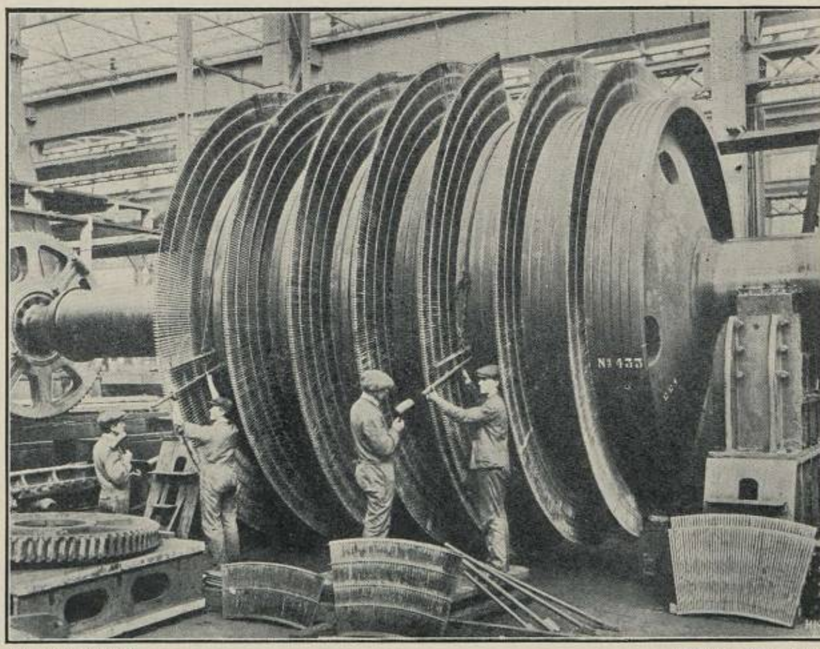
fixed in rows with spaces between, covering the inner surface of the casing, top and bottom. The rotor also has similar blades in rows to pass between the fixed blades on the casing; these are the moving blades, and they are fixed in an opposite direction to those fixed blades of the cylinder or casing. We get this information from Sir Charles Parsons' description (Fig. 60): "The steam entering the cylinder passes through the first row of fixed guide blades, which direct it in a number of streams in a tangential direction on to the first row of moving blades, forcing them to move round. The curved shape of the passage through the blades reverses the direction of the stream, so that it issues from the moving blades tangentially but in the opposite direction, and by its reaction imparts additional force to the moving blades. The steam then

[1] *Olympic* souvenir, *The Shipbuilder*, p. 55.

reaches the next rows of fixed and moving blades, where a similar operation takes place at each. The characteristic action of the steam is equal impact and reaction between the fixed and moving blades. This is known as "Parsons' reaction type".

The blades increase in length according to increased passageway for the steam to expand. Notice the step-down on the rotor. There are seven visible in the illustration of the casing.

These blades are made up in segments; nearly a million blades are so fixed, as seen in the illustration (Fig. 61). The blades



By courtesy of] [*White Star Line.*

FIG. 61.—TURBINE ROTOR BEING BLADED, "BRITANNIC".
(Segments in foreground.)

are securely fixed by hand into slots prepared in the foundation ring by a special automatic tool, and formed into finished segments, the number of segments to form one complete ring of blades being ten. The resistance to the movements of propellers in the water is very considerable.

Thrust Blocks.—The ahead motion tends to push the engines forward, while astern movement would pull the other way; to counteract this there are thrust blocks with seventeen collars, which come into operation for both ahead and astern motion. The rings are of phosphor bronze lined with white metal. One of these is seen in the fore part of the illustration of the turbine on page 80.

Now we come to *condensers*, from which a stream of water continually flows from steamships on the move. Mr. Beezley, the English schoolmaster, describes the difficulties his boat had when full of survivors of the ill-fated *Titanic*. He said: "Immediately below our boat was the exhaust of the condensers, and a huge stream of water was pouring all the time from the ship's side just above the water-line. It was plain that we ought to be smart away from it if we were to escape swamping when we touched the water. We had no officers on board, and no petty officer or member of the crew to take charge, so one of the stokers shouted: 'Someone find the pin which releases the boat from the ropes and pull it up!' No one knew where it was. We felt as well as we could on the floor and along the sides, but found nothing. It was difficult to move among so many people. We had sixty or seventy on board. Down we went, and presently we floated with our ropes still holding us, and the stream of water from the exhaust washing us away from the side of the vessel, while the swell of the sea urged us back against the side again.

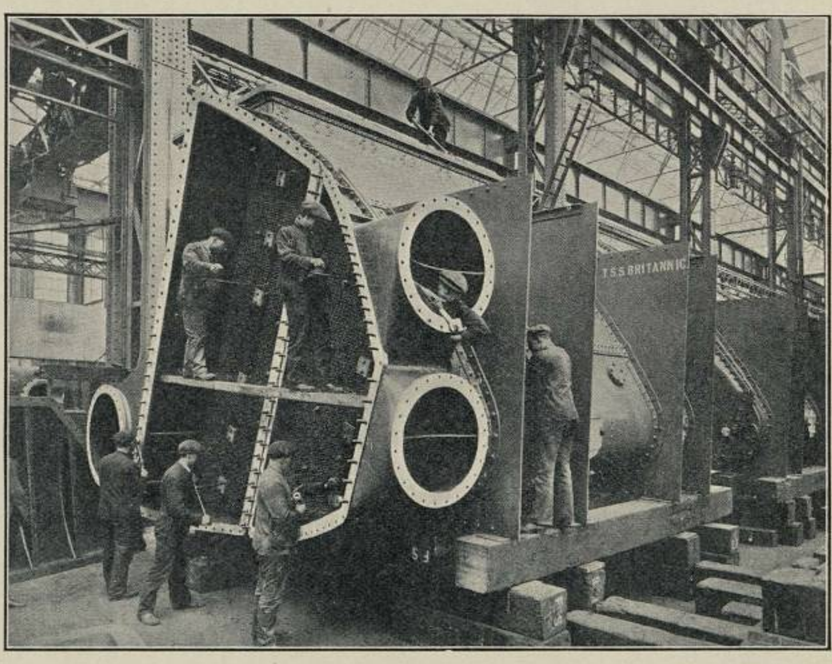
"The result of all these forces was that we were carried parallel to the ship's side, and directly under boat No. 14, which had filled rapidly with men and was coming down on us in a way that threatened to submerge our boat. 'Stop lowering No. 14,' our crew shouted; and the crew of No. 14, now only 20 ft. above, cried out the same. The distance to the top, however, was some 70 ft., and the creaking of the pulleys must have deadened all sound to those above, for down she came, 15 ft., 10 ft., 5 ft., and a stoker and I reached up and touched the bottom of the swinging boat above our heads. The next drop would have brought her on our heads. Just before she dropped another stoker sprang to the ropes with his knife open in his hand. 'One,' I heard him say, and then 'Two', as the knife cut through the pulley rope.

"The next moment the exhaust stream carried us clear, while boat No. 14 dropped into the water, taking the space we had occupied a moment before. Our gunwales were almost touching. We drifted away easily, and when our oars were got out we headed directly away from the ship."

We know that this boat was picked up by the *Carpathia*. The story is typical of incidents of a ship's lifeboat, but incidentally it draws attention to the oft-repeated question, "Why does water come out of the side of a ship?" Whenever the engines of a steamer are working, a big stream of water is to be seen pouring out of her side just above the water-line. The condenser contains a vast collection of tubes through which cold sea-water is pumped to cool them. The exhaust steam passes into the condenser and is caused to circulate among the cold tubes, where it at once condenses and falls to the bottom.

Condenser.—Here is a condenser (Fig. 62) of the *Britannic*; it has 19,240 condenser tubes. If these were placed end to end they would cover a distanceof 50 miles. The men are seen screwing up ferrules to make it vacuum-tight. In the *Aquitania* there are two of these condensers and two auxiliary condensers each with 2,000 sq. ft. of cooling surface, one in each wing.

Air-pump.—"The water at the bottom of the condenser,



By courtesy of] [*White Star Line.*

FIG. 62.—CONDENSER, "BRITANNIC".

together with any air which may work through, is drawn by the air pump. Passing through the delivery valve of this pump, it goes to the filter, where any impurities, such as oil from the cylinders, are removed. The feed-pump draws the water into the feed-water heater, and from thence it passes through the feed-pipe back to the boiler again. The advantage of this system is that there is no back-pressure: the exhaust steam gets away quickly and is used again in the return as distilled water which has been filtered and heated. In the use of the surface-condensers the boilers are fed only with distilled water. Sea-water contains solid matter amounting to nearly 3 per cent. of its weight, chiefly common salt." [1]

[1] Howden *Steamships*.

Feed-heater.—The water is first heated from 90° to 155° F. and again heated from 155° to 220° F. The speed of the hot-well pumps is regulated by automatic control-gear. The feed-heaters utilize as heating medium the exhaust steam from all the auxiliary engines. So the engineer of to-day is able to use nearly all the energy latent in steam from the time it leaves the boiler till it is exhausted into the condenser.

Some factories are lighted throughout by electricity generated by an exhaust turbine which is run entirely by exhaust steam which previously was allowed to run to waste.

Main Circulating Pumps.—There are two sets of main circulating pumps, one in each condenser-room, and each pump is capable of delivering 18,500 gallons per minute. There are two auxiliary circulating pumps, one in each wing engine-room. Each pump is capable of delivering 2,500 gallons of water per minute.[1] The number and variety of pumps in a large liner is bewildering. There are forced lubrication pumps, oil-service pumps (one of the oil pumps can pump 90,000 gallons of oil per hour from one tank to another), fresh-water pumps, one condensed-water pump, hot salt-water pump, hydraulic pressure pump for operating the system of water-tight doors, bilge and fire pumps and others.

In 1897 a great naval review was held to commemorate the completion of the sixtieth year of Queen Victoria's reign. The newspapers reported that a very fast vessel darted in and out of the lines of stately battleships at such high speed that the fastest naval craft was unable to catch her. This proved to be a splendid advertisement for the engines of this craft, which was destined to render obsolete those in the imposing lines of warships between which she had dared to steam.

"Turbinia."—This was the *Turbinia*, 44½-ton launch, 100 ft. long (see page 188), Sir Charles Parsons' first marine steam turbine. She is seen here with the *Mauretania*.

For maximum efficiency it is desirable that a turbine should run at a high rate of revolution, but for maximum propeller efficiency much lower rates of revolution are necessary.

In a paper read by Mr. R. J. Walker, M.I.N.A., before the British Association in 1919, it was shown that the satisfactory combined efficiencies of turbines and propeller were obtained for high-speed vessels, resulting in increased speed of ship and decreased coal consumption. It proved economical for vessels of 18 knots and upwards, besides being less in weight and also in first cost. We have seen that expansion of steam is used to the last pound in the *Olympic* and her type of triple-screw steamers. This is due to the use of a low-pressure turbine. Vessels of about 18 knots

[1] *The Shipbuilder.*

speed and under are able to use turbines through the introduction of single and double reduction gear.[1]

Geared Turbine.—In 1909 the old steamer *Vespasian* (Fig. 63) was fitted with geared turbines in place of her original triple-expansion reciprocating engines, with the result that a reduction of 15 per cent. of coal consumption was obtained, and the efficiency of the mechanical gear was found to be about 98½ per cent. If a large ratio between the revolutions of the turbines and

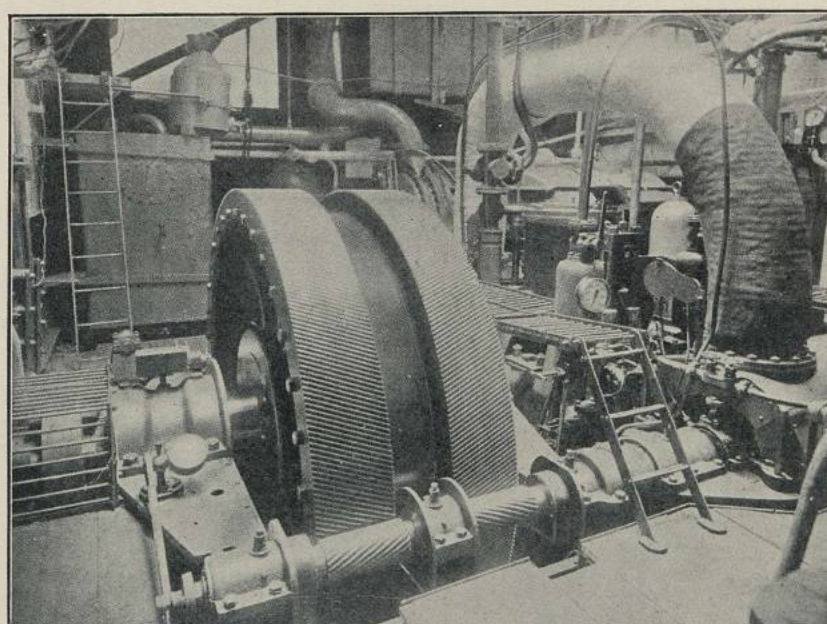


FIG. 63.—"VESPASIAN" ENGINE-ROOM, SHOWING GEARING WITH COVER REMOVED.

the propellers is needed, the gear-wheel would require to be of excessive size and weight. Instead of increasing the size of one gear-wheel, double-reduction gear is used ; so that even in very slow-speed vessels the turbines may be designed to run at a speed for maximum economy. The increased efficiency obtained with double reduction is in some cases as much as 7 per cent. To-day the steam consumption of the turbine is one-half of what it was twenty years ago.

The first use by the Admiralty was in 1910, when H.M.S. *Badger*, destroyer, was fitted with gearing for high-pressure turbines, the

[1] Geared turbines are now being used for both fast and slow ships, both above and below 18 knots.

low-pressure turbines being direct-coupled. The writer was shown the bearings of this vessel on Messrs. Parsons' stand at Wembley Exhibition. After fourteen years, including very rough work during the war period, there is apparently no appreciable wear on the teeth of the pinions or gear-wheel.

Practically all ships, from patrol-boats to battle-cruisers, including H.M.S. *Hood*, are fitted with geared turbines.

Oil Separator.—An oil separator of the De Laval type is fitted in geared turbine vessels. It frees the oil (which it collected after use from the casings) from grit and also from water. Lubrication is by pressure or by gravity, so the same oil is used over again, hundreds of gallons being in circulation.

Comparative Trial : Triple-Expansion *v.* Geared Turbine.—A comparative trial between the triple-expansion engine and geared turbine in cargo steamers was arranged, and two vessels (*Cairnross*, geared turbine, and *Cairngowan*, triple-expansion), belonging to the Cairnross line, left Cardiff in February 1913. Both ships were burning coal and they were of equal tonnage. The geared turbine consumed 27·8 tons of coal per day while the triple-expansion engine used 32·7 tons per day. The length of the voyage and time spent being equal, shows that the advantage in economy is on the side of the geared turbine.

Water Separators.—It is very important that no water should be allowed to enter the turbine. From the valves the steam is led to two separators, which extract all water from the steam before it passes into the turbines ; they must have *dry* steam. Reference has been made to engines for operating the manœuvring valves by levers from the starting platform.[1] There are seven combined steam and hydraulic engines for this purpose on the *Aquitania*.

Motor-driven Gear of Turbines.—The turbines are so large that motor-driven gear for turning them when in port and under repair is provided upon each shaft, two of 40 h.p. and two of 30 h.p. Four similar motors, each of 30 h.p., have been provided for lifting and overhauling purposes, and also for lifting the upper half of the turbine casing. One of these weighs as much as 185 tons.

Large liners have the outer shafts enclosed in the plating of the hull right out to the screw. At the after end, for a distance of 60 ft. from the stern, the hull is cut away into a great *open arch*, leaving the water much freer access to the inner propellers, and a much better balanced rudder, as in the *Aquitania*. The *outer screws* are 86 ft. forward of the inner propeller on the same side of the ship. This arrangement removes the possibility of the propellers being interfered with by broken water made by the outer

[1] *The Shipbuilder*, *Aquitania* souvenir. p. 69.

propellers. The four shafts are hollow and nearly 2 ft. in diameter.

Propellers.—The four propellers are four-bladed, the blades being cut solid in high-tension manganese bronze to resist erosion; those of the *Aquitania* have a total weight of 65 tons, representing an outlay of nearly £10,000. They are so perfectly balanced that they can be made to revolve simply by pressure of the hand.

Wooden Screw.—It is interesting to note that the inventor

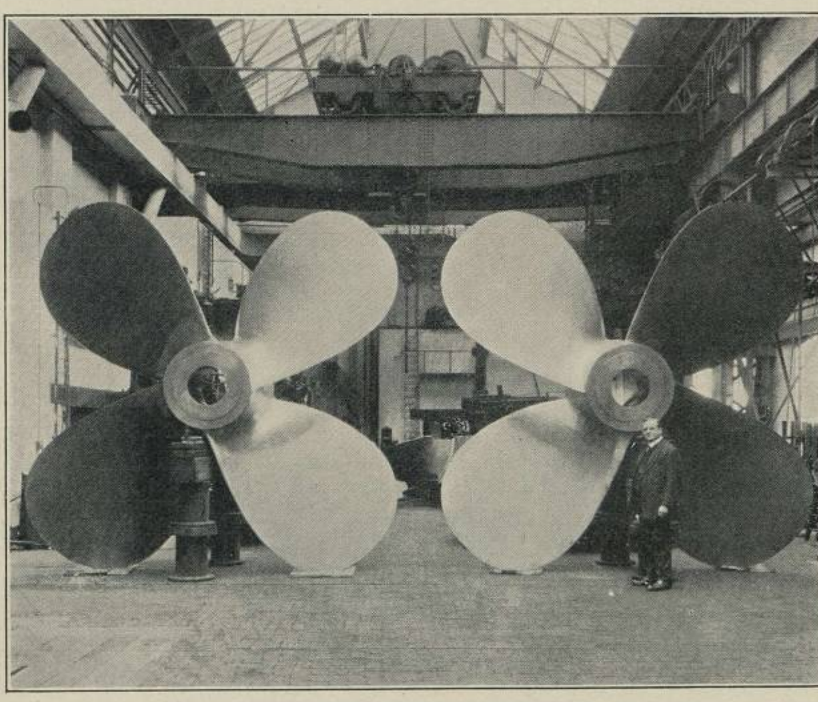


Fig. 64.—Two of the Propellers of "Majestic".

of the screw really provided for the whole screw of two complete turns, which was intended to bore its way through the water. This screw was made of wood. While a trial of this wooden screw was being made a part of the screw was accidentally broken off. This mishap, however, increased the speed of the boat; thus we came to the screw—or part of the screw—which is used to-day.[1]

As often happens, two men were at work on the same idea at the same time—Mr. F. P. Smith and Captain Ericsson.

An illustration of the propellers of the *Majestic* (Fig. 64) is given

[1] Howden's *Steamships*, p. 112, and Fletcher's *Steamships*, p. 216.

by the makers, Messrs. J. Stone & Co., of Deptford, who have also given us illustrations and particulars of their safety doors mentioned on page 34.

The casting weight of each of these propellers was over 22 tons;

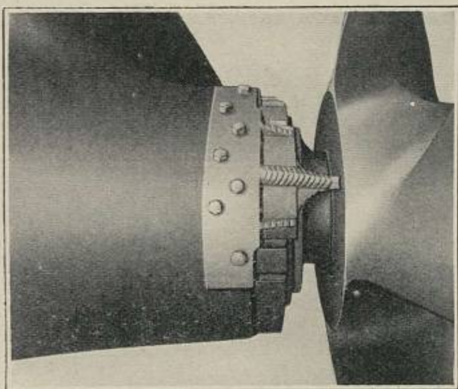


FIG. 65A.—ROPE GUARD.

= 5,00 Meter, dus exact.

the diameter 16 ft. $4\frac{7}{8}$ in. All four are made of Stone's improved *manganese bronze*.

Rope Guard (Figs. 65A and B).—Trailing ropes in harbours, rivers, etc., or seaweed are a danger to a ship's propellers. The

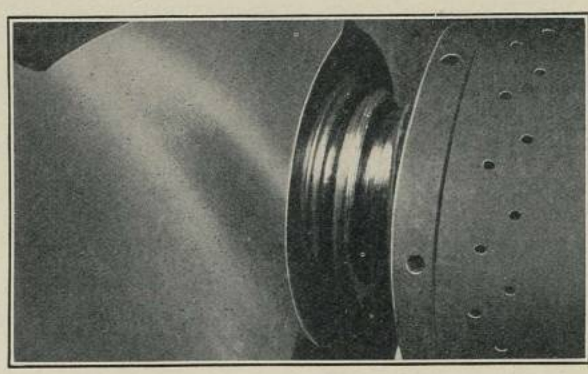


FIG. 65B.—SHOWING DAMAGE DONE.

fouling of a propeller is often of a very serious nature, involving the docking of a vessel, with consequent loss of time and money. The Stone-Blake rope guard fitted on the *Majestic*, *Olympic*, etc., consists of a number of cast-steel segments provided with ribs, on which are formed internal and external serrated cutting edges, the ends of the ribs projecting aft until almost in contact with the propeller boss face. It is thus impossible for a rope to slip between the guard and propeller boss. A rope which is drawn across or flung against these edges is severed before any winding up of such rope can occur.

CHAPTER VI

HOW IT WORKS WITHOUT

The sea—The land—The moon—Bridge instruments—Kelvin compass—Gyro-compass—Anschütz gyro-compass—Sperry gyro-compass—Gyroscope—Course-recorder—Gyro-pilot—Hand steering—Two-unit gyro-pilot—Hand steering by magnetic compass *v.* the gyro-pilot steering—Lord Kelvin—Sounding machine—Sinker—Speed and depth tables—Glass tube—Longitude and latitude—Meridian—Chronometer—Sextant—Time-ball—Searchlight—Morse signal lights—Speed of ships—Tidal wave—Wake—Speed record—Punctuality—Spring cleaning—Board of Trade—Kennels—Conservatory.

In the first part of Chapter V we dealt with the wonderful machinery *inside* the ship—creating and maintaining power to move and to guide her, power for lifting hundreds of tons of dead-weight, power for generating electricity, which in turn gives light and heat as well as many electrical safety warnings. All this is the bone and muscle of the ship's being, and relates to " how it works " inside her hull.

The Sea.—We will now consider the all-important subject of her environment, *water*, on which she depends for safety and her contact with the outer world. At sea the ship is vitally concerned with the depth of water beneath and open space around her for free movement on the surface.

The Land.—The sea, we know, rests in the hollows of the earth's surface, and its boundaries are land,[1] and our chart tells us where to expect it, and also the rocks and shoals dangerous to navigation. The pilot of the air feels safer when he is at a great height, with plenty of air space below him ; the sailor is always endeavouring to keep his ship well out to sea in deep water.

The ship, when in shallow water, feels her way by sounding—her " hand " is the sounding machine.

In shoal and narrow waters there are buoys and warning bells with lights marking the channel at night. The familiar lights of a harbour, a lightship, or a lighthouse all appear in turn as placed

[1] " And God said, Let the waters under the heaven be gathered together unto one place, and let the dry land appear " (Genesis i. 9).

on the chart to help the mariner. (See frontispiece, an excellent picture by Mr. Charles Dixon, R.I., showing the *Majestic* in touch with her guides.) When the ship passes a Lloyd's station, she will be politely asked her name and nationality; he is a friend, and will report her safety. At length, when she has sailed beyond these familiar aids, there will come from far across the waste of waters, as if by magic, a whisper, a human thought as in confidence: it is the wireless call—first the name of the ship (her call signal) followed by her position at sea and then the message. Though out of sight, the ship can still hear and be heard. What a comfort!

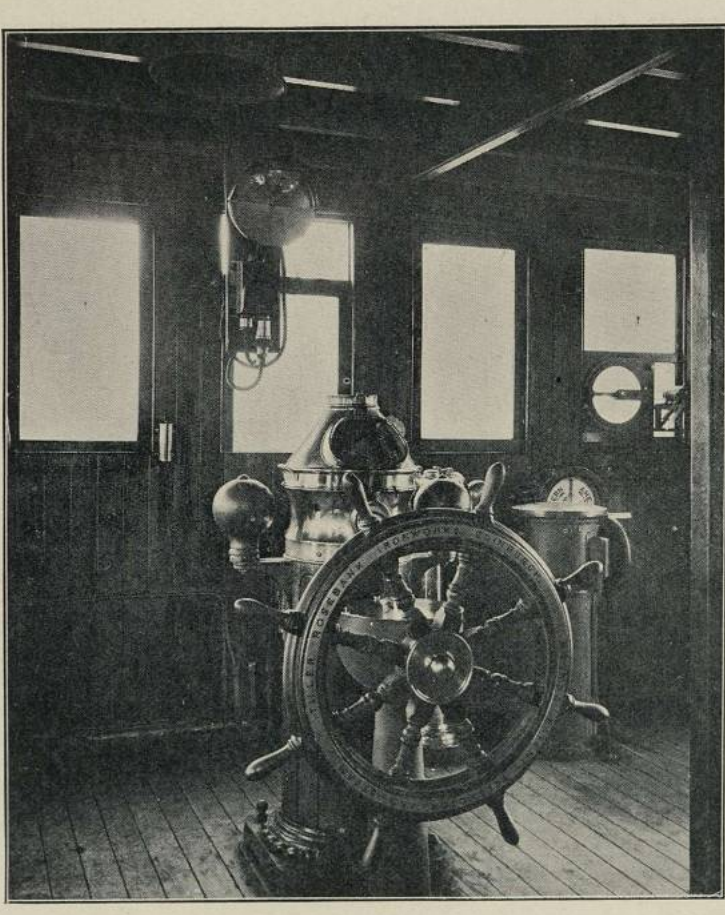
The Moon.—One of the most striking scenes when on a voyage is moonlight on a vast expanse of waters, when out of sight of land and ships. The best place for observation is to stand on the bow of the ship, high above the surface of the sea, and look out across the trackless space. Even a great liner is a mere speck of power in the wide scene. But she is endowed with intelligence, turning to her advantage the many forces of Nature she requires. Here is food for thought. Those heavenly bodies the mariner has always needed.

Suddenly a clang of the gong breaks the silence. Instinctively the real sub-conscious self counts eight bells; this is followed by the well-drawn-out call, "All's well", so it is time to retire and find our way through the already silent alley-ways to our cabin or state-room for a period of rest.

Bridge Instruments.—On the bridge of the *Aquitania* the reader will notice the binnacle containing the magnetic compass. The binnacle is merely the "dwelling-place"—a turret-shaped box in which the compass is fixed. Magnetic compasses are liable to error. Sometimes four magnetic compasses are in use; three are in other positions—one is situated on the roof of the bridge, perched high on supports of non-conducting material, and far removed from the influence of metals liable to magnetic action—this is a compass for a check.

Kelvin Compasses (Fig. 66A).—The Kelvin compasses of to-day are provided with many contrivances to correct errors. The two large *iron globes* on either side of the compass are (solid or hollow) iron globes unmagnetic for quadrantal error. Then there are also bar-magnets inside the binnacle to correct errors. The adjustments for errors require some patient study. The liners of to-day also possess a gyroscopic compass. In this view the gyro-compass is hung just above the Kelvin compass. Two or three forms are in use. The first in the market are the "Anschütz" and the "Sperry". The latter is in use in the Navy, and is the one used in our liners. The gyro-compass is unlike the magnetic compass, for it is unaffected by electric storms or magnetic changes so prevalent in steel ships. It indicates true North and not the "magnetic North," and requires no correction (the "magnetic North" of the old compass is sometimes incorrect and variable). We call it "the Old Compass" because the Chinese claim to have used it as far back as 2400 B.C.

Gyro-Compass.—The gyro-compass consists of a heavy



By courtesy of] [*Cunard Steamship Co.*
[*Photo, Steward Bale, Liverpool.*

FIG. 66A.—MAGNETIC COMPASS—GYRO-REPEATER OVER WINDOW AND CIRCULAR CLEAR VIEW SCREEN ON RIGHT END WINDOW.

wheel having a speed of 20,000 rev. per min. (Anschütz) or in the Sperry about 8,500 rev. per min., so mounted as to have freedom of movement in every direction and by addition of a suitable arrangement whereby the action of gravity can produce an effect, the axles of the spinning wheel will take up a position parallel to the spinning axis of the earth, and thus give a geographical North and South direction.

Anschütz Gyro-Compass.—The spinning wheel of Anschütz is carried upon a float free to move in a bowl of mercury. The wheel is inside the pendulum hanging through the open centre of the mercury bowl. The axle of the gyro is directly under the North and South line on the card.

Sperry Compass (Fig. 66B).—The spinning wheel of the

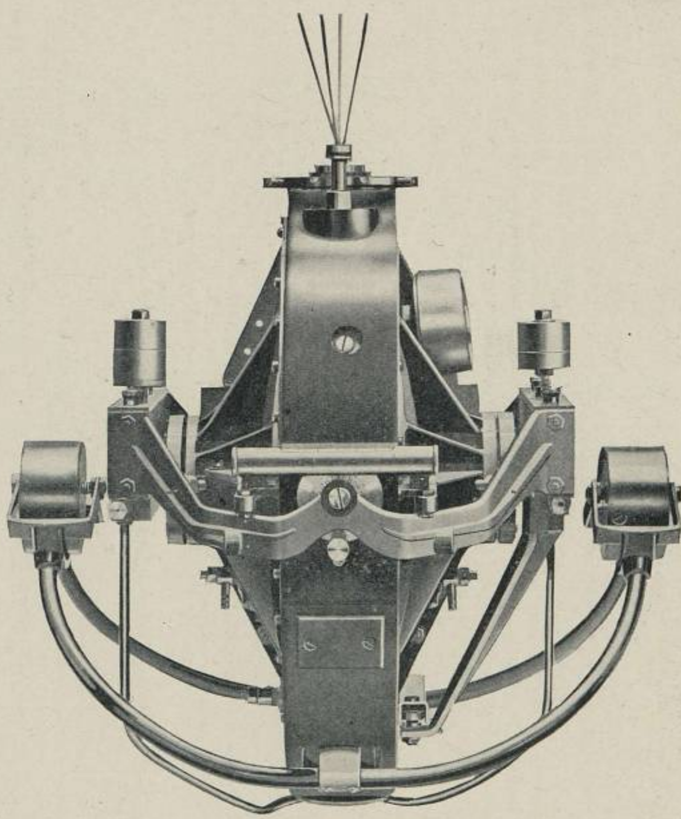


FIG. 66B.—EAST ELEVATION—SPERRY GYRO-COMPASS.

Sperry gyro-compass is in a vacuum casing pivoted on a horizontal axis and carried by a vertical ring. The ring is suspended by a torsion strand, the whole free to move N.S.E.W. (Fig. 66C). The card has its N. and S. in a line with the axle of the wheel or gyro. The Sperry gyroscopic compass has a directive force some 291 times more powerful than the magnetic compass. Now in both these forms of gyro-compasses there is one binnacle (Fig. 66D) (usually in some unexpected part of the ship), and many repeater compass dials are electrically connected with it, all giving instantaneous and correct readings. There is also a synchronizer, which brings any single repeater or any number of them into exact step when starting.

In the gyroscope we use an instrument which is acted on by invisible forces of Nature *outside the ship*—the rotation and the gravity of the earth.

" As everyone knows, the magnetic compasses of a ship have to be adjusted by steering a circular course. H.M.S. *Invincible* and *Inflexible* when commissioned were fitted with the Sperry gyro-

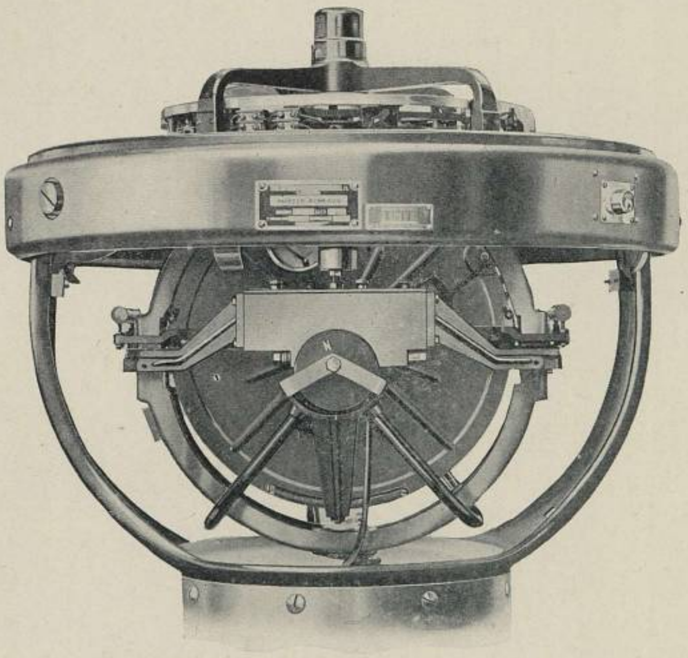


FIG. 66C.—NORTH ELEVATION—SPERRY GYRO-COMPASS.

compass as well as magnetic compasses, but at the last minute the dockyard authorities wanted to swing the vessels for the usual adjustment of compasses. Fisher ordered them to proceed at once, and trust to their gyro-compasses. That he was right was proved by the fact that both vessels ran a straight course to their objective (the Falkland Islands), doing the 9,000 miles in record time."[1]

Gyroscope.—" In its various applications, the gyroscope is steadily gaining in importance on shipboard as an aid to navigation in the gyroscopic compass, in contributing to increased

[1] *Journal of Commerce*, May 12, 1925.

comfort and speed in the stabilizer, in actual steering, and now in making possible an accurate record of a ship's motion under all conditions." [1]

Course-recorder (Fig. 67).—The gyro-compass has "sufficient precision and directive power to act" on instruments which record the ship's course so accurately that it "shows a change of heading of one-sixth of a single degree". The record is made "in ink and carefully synchronized with the ship's clock", which is valuable as a permanent reference. By means of a stabilized gyroscopic pendulum a continuous record can be taken of the ship's roll and

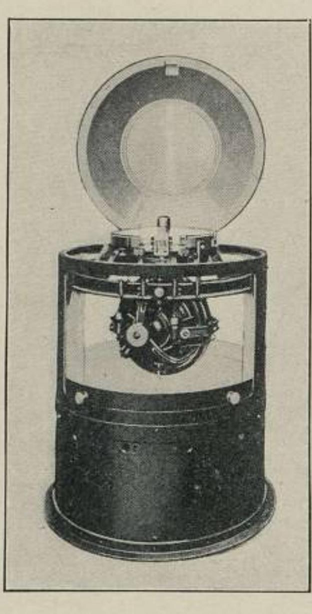


FIG. 66D.—"THE AUTOMATON"—MASTER GYRO-COMPASS. (P. 94.)

pitch also. The course-recorder in the S.S. *City of Cairo* faithfully recorded the fact that there was a man overboard, as it showed the exact time when the ship's helm was altered to take the vessel in a circle in order to pick up the man.

Gyro-pilot.—In addition to this new instrument there is a new invention called a "Gyro-pilot", which automatically steers the ship without the need of the quartermaster.

On January 15, 1924, the Cunarder *Laconia* (Fig. 68A) sailed from New York for a world's cruise, steered by a Sperry gyro-compass, and the gyro-pilot connected to the steering-wheel. She is the first vessel to start round the world without a man at the

[1] *The Sperryscope*, vol. iv, No. 6.

wheel. When a large alteration in course is required the pilot or control-wheel is pushed to the "in" position, when the vessel can be steered in precisely the same manner as with the ordinary hand-steering-wheel. On entering or leaving port, or at any time it is desired to steer by hand, the gyro-pilot is instantly disconnected by pulling out the clutch-lever shown at the top of the gyro-pilot case.

Hand-steering-wheel.—During the voyage of the U.S. liner, *President Adams,* across the Atlantic, the ordinary hand-steering-

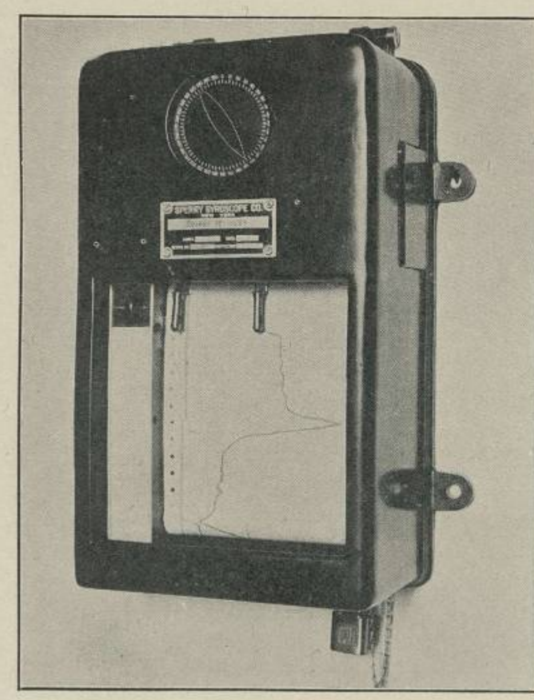


FIG. 67.—THE COURSE RECORDER.

wheel was not used at all. The small auxiliary wheel for altering the course was the only steering-wheel used on the voyage, which was made in a series of straight runs; during each straight run the ship steers itself automatically.

"The master gyro-compass is the soul or brain of what may be termed the gyro system, for it is there that the direction of the geographical pole is sought and maintained, like an electric clock which transmits its indications to time-dials in various public rooms."[1] The transmitter on the master gyro-compass is the

[1] *The Sperryscope,* vol. iv, No. 7.

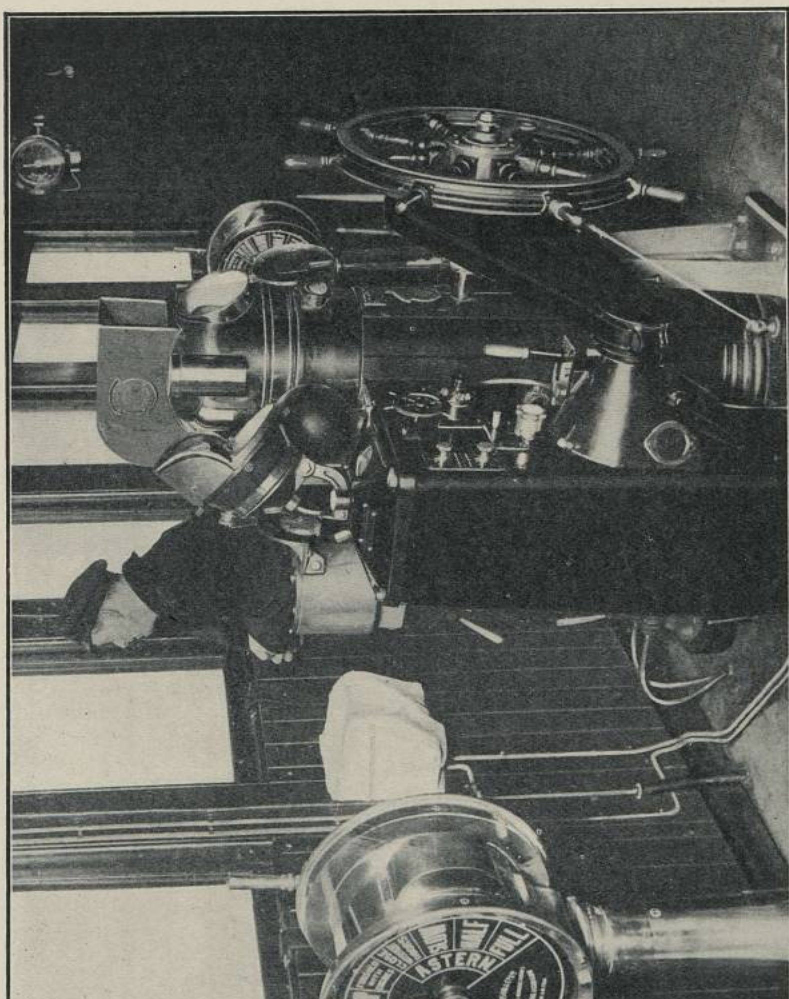


FIG. 68A.—GYRO-PILOT ON "LACONIA". (P. 96.)

means by which the geographical pole is communicated to the repeater compasses by a system of electrical impulses. The bridge unit of the gyro-pilot is shown in Fig. 68B, and the pedestal con-

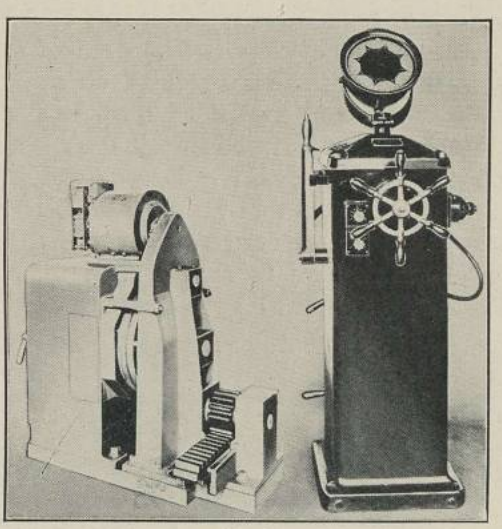


FIG. 68B.—TWO-UNIT GYRO-PILOT.
(The bridge unit on the right and that on the left is situated in the steering engine-house.)

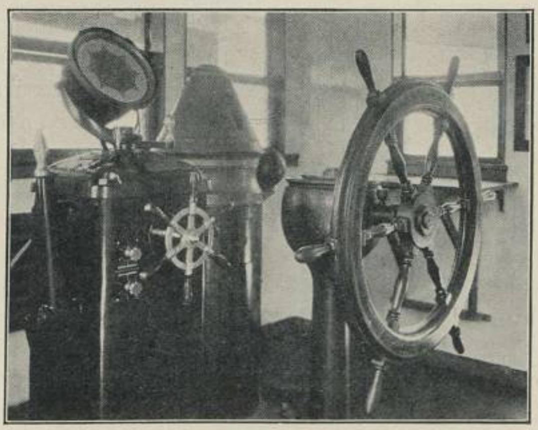


FIG. 68C.—GYRO-PILOT, S.S. "OLEAN".

tains a motor similar to that found in each repeater compass, and which is operated from the master gyro.

This small motor controls a suitable contact mechanism which operates clapper switches contained in the after unit of the gyro-pilot, which is situated in the steering engine-house—on the left of the picture. Switches in turn control the starting, stopping and reversing of a small ½-h.p. electrical motor, which operates the throttle valve on the steam steering engine.

It will thus be seen that this new system of steering control enables the ship to be manœuvred or kept on any desired course, without in any way depending on the telemotor system. In some ships the telemotor system may be installed as a stand-by, but it is not too much to say that with the increased reliability of electrical apparatus, it would not be surprising if, as time goes on, the telemotor system is eliminated altogether.

As the vessel commences to swing back to her course, the repeater motor, obeying the gyro-compass indicator, causes the drive motor to rotate in the opposite direction and apply the

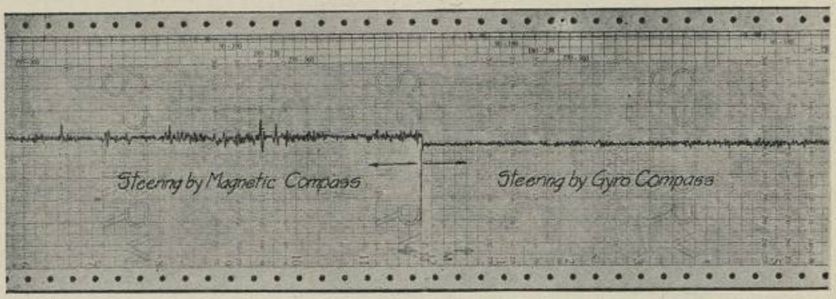


FIG. 69.—COMPARISON BETWEEN HAND AND AUTOMATIC STEERING

necessary " steadying " helm. The ship is automatically " met " with rudder proportioned to the *yaw* as it returns to the course, thus damping out the motion very quickly.

There are adjustments for " Characteristics of Ship ", and also for bad " weather " yaw due to roll and pitch ; the gyro-pilot permits of an adjustment which rejects such artificial motion.

It is well known " that the magnetic compass will not instantly indicate an alteration in direction, but does develop an oscillatory period ", due partly to low directive force and partly to magnetic influence often set up by steel and iron structure in modern vessels.

Hand Steering by Magnetic Compass.—Fig. 69 is a reproduction of part of a chart made by a helm angle recording instrument in a well-known passenger vessel. Although a strong north-westerly gale, accompanied by a heavy following sea, was in progress, it will be seen that the angular movements of the helm, when steering by gyro-pilot, was suppressed by approximately 80 per cent.

Sperry gyro-compasses have been installed in every conceivable type of ship, from the six Southampton giants down to the little *Quest*, of 100 odd tons.

The total gyro-compasses in the merchant services number nearly 300. The Sperry gyro-pilot has only been on the market a short time, but the installations already exceed seventy-five. Among them are *Majestic*, *Leviathan* and *Berengaria*, and the new motor-ship *Aorangi*.

Lord Kelvin.—The captain of a popular P. & O. liner once said he considered that Lord Kelvin was the mariner's greatest benefactor. Amongst his activities Lord Kelvin greatly improved the reliability of the magnetic compass, and invented the best of sea-sounding apparatus, known as "Mark IV Sounder". Lord

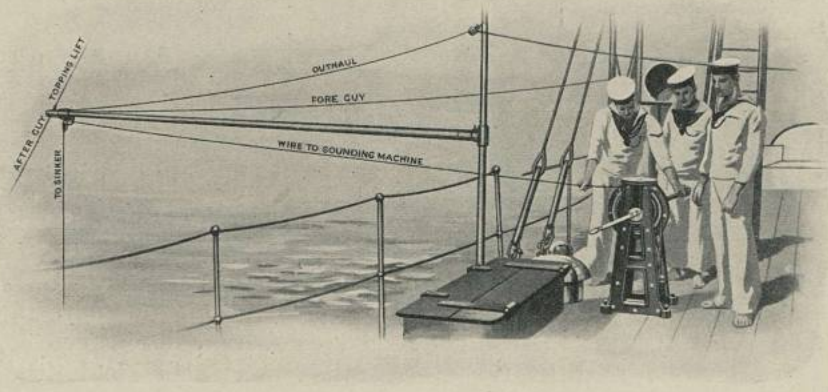


FIG. 70.—SOUNDING MACHINE WITH 40-FT. SPAR.

Kelvin carried out experiments on board his schooner yacht, *Lalla Rookh*. The first sounding-machines were specially designed for the use of a pianoforte steel wire ; this resulted in the invention of Mark IV universally used at sea to-day.

One day Dr. Joule paid Lord Kelvin a visit and found him busy with some pianoforte wire. Noting the musical jangling of the wire, he asked Lord Kelvin what note he was sounding. "The deep C" was the only reply !

Stranded steel wire now in use is small in bulk, smooth in surface, ductile, and of great strength.

Sounding Machine (Fig. 70).—Here is an illustration of Mark IV sounding machine.[1] On large liners one is fixed on each side of the ship in view of the officer on the bridge. These are both hand- and motor-driven. The sounding instrument is the "hand"

[1] Kindly provided by Messrs. Kelvin, Bottomley & Baird, Ltd.

of the ship for feeling the bottom of the sea as she passes over it. When navigating in less than 100 fathoms, and there is any doubt as to the depth, the sounding machine is kept going. The chart will give numerous soundings, and the lead sinker will bring up specimens of the bottom touched ; these greatly assist the navigating officer.

Sinker.—The wire is kept clear of the ship's side by a spar about 40 ft. long, the sinker being 24 lb. in weight. When the sinker touches bottom, the counter on the dial will show how many fathoms of wire are out.

Speed and Depth Tables.—The officer reads off the depth position, and with his speed and depth tables is able to get the correct sounding according to the speed the ship is running. The sounding includes touching the bottom of the sea and securing samples of the ground which are brought to the surface ; this information gives the captain confidence.

Glass Tube.—The tube method is a check on the depths so found. A long tube of glass closed at one end, and coloured red on the inside surface, is fixed in a " guard " with the open end of the tube downwards. The pressure of the water drives the air in the tube farther and farther up as it goes down. The tube on being examined then shows the " cut " made by the sea-water (as it rises in the tube) ; the length of this is measured off and gives the depth to which the tube has been, in company with the sinker.

How does a ship find her way across the pathless ocean ? By finding her position she can correct her course.

Longitude and Latitude.—A sailor ascertains his latitude by the altitude of the sun at noon or by the pole star at night by means of a *sextant*. Briefly, the longitude is the difference between the local time at the place of observation (the place the ship is in) and the local time of the meridian—Greenwich—which is accepted as the standard meridian by nearly all countries. This is where the ship's chronometer plays the most important part.

Before sailing, a navigator must know the error of his chronometers on Greenwich mean time. Greenwich is the 0-line of longitude on all our maps—and that is our meridian ; and when the sun arrives at this line it is midday. The ship's chronometers (usually four) must be checked with the standard chronometer. The word chronometer means " to measure time ", and a dictionary adds, " with extreme accuracy ". The navigator requires this to determine his longitude.

Chronometer.—A marine chronometer is built like a watch, but has compensation adjustment to prevent expansion or contraction of the important metal parts, and the instrument is hung in gimbals in boxes 6 or 8 in. square. It is compensated for effects of changes of temperature, and protected from the vibrations of a ship.

It often happens that for days together the heavens are hidden by clouds or fog, and as in the case of submarines, which during the war were compelled to take long stretches of a voyage submerged, groping their way, as it were, in the dark, the vessels have to travel by the weary method of " dead-reckoning ", which means keeping the last accurate record of the ship's position, and calculating by speed and course, making allowances for known currents, and if on the surface, the effect of the wind too.

Sextant.—At length, when the sun or stars appear, observations are made with a sextant (the word means the " sixth part of a circle "). It is a portable reflecting astronomical instrument for measuring angles, for navigation is based on the height of the sun or other celestial body above the horizon at a known moment of time. It is here that the correctness of the chronometer is of the greatest importance. Of course, no chronometer is interfered with at sea, but the error is carefully recorded in a book. In these days we can know the exact time when the time-signal is broadcast from the Eiffel Tower and other stations daily.

Time-ball.—There is a time-ball signal on a prominent building in many ports round our coasts ; these are electrically connected with Greenwich, and the ball is dropped at a stated hour.

At one time searchlights were not popular, but since the *Titanic* disaster the use of searchlights on liners has become more general.

Searchlight (Fig. 71).—It is claimed that the *Leviathan's* searchlight at the mast-head is the most powerful ever installed on a merchant vessel. It consists of a Sperry 36-in. high-intensity searchlight, and gives a 450,000,000-c.p. beam. It is mounted on the foremast, and is moved both in azimuth and elevation by an electric controller on the bridge several hundreds of feet away. This high-intensity projector is also in use for the Air Mail in America, to fly by night as well as by day. They are at fixed positions across that part of the continent which would be reached by aircraft at sunset, to enable the flight to be continued during the hours of darkness.

Morse Signal Lights.—The *Majestic* uses Navy pattern searchlights—one is mounted on each end of the bridge. No searchlight is used on the mast. Morse signal lights are also fixed on either end of the bridge. The *Leviathan's* searchlight can be operated as a signal if required.

Speed of Ships.—We now come to a consideration of speed of ships. In connection with the suggestion of driving the battle-cruiser H.M.S. *Hood* across the Atlantic in an attempt to set up a new steaming record on her "showing the flag" world cruise, the contingent expense was considered prohibitive. A marine engineer states that the normal fuel cost of running an 18,000-ton coal-fired liner at 20 knots is about £1,250 per day. At 25 knots the daily cost would be £2,650, so that for an extra 5 knots it would cost some £1,400 per day. Surface friction, due to growth of seaweed and barnacles, would greatly increase in the case of the

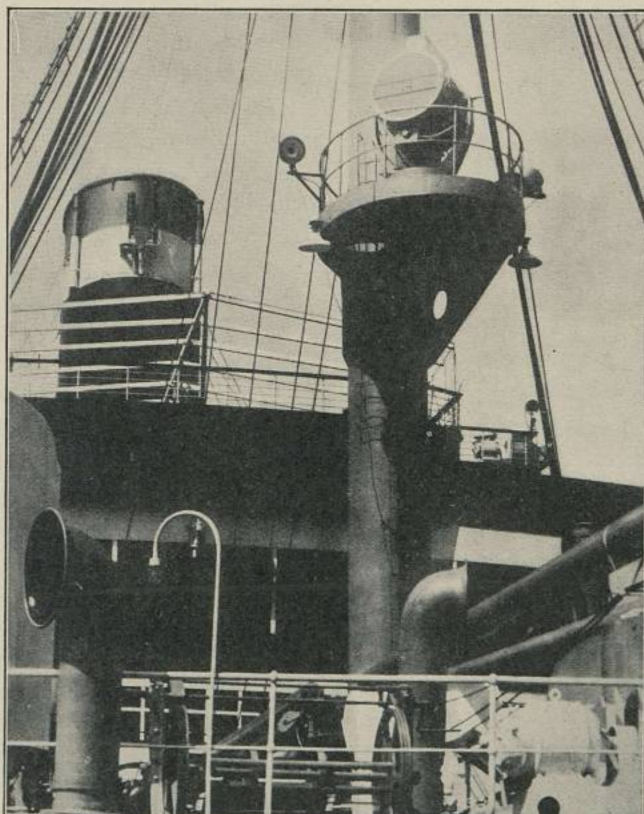


FIG. 71.—SEARCHLIGHT ON "LEVIATHAN", 450,000,000 C.P. (P. 103.)

Hood after a cruise of nine months. Furthermore she is a vessel of 41,200 tons!

New records are being made by all the largest liners. The points of departure and arrival are confusing to the uninitiated.

Speed Record.—The *Mauretania's* record passage between Daunt's Rock, Queenstown, and Ambrose Channel lightship—across the Atlantic Ocean in four days, ten hours and forty-one minutes—and the *Lusitania's* record speed of 26·66 nautical miles per hour between Fishguard, the Welsh port, and Liverpool is well known. In the latter case this great speed was attained in order to catch the tide at Liverpool. Both these records by the Cunard express turbine-steamers were made in September 1910, and do not appear to have been beaten yet.

Tidal Wave.—" It is reported that the *Mauretania's* speed has been creating a 'tidal wave'. On her last outward voyage the *Mauretania* sent into Cowes a tidal wave-like wash which caused water to rush up the slip-ways into the main street, flooding premises on the sea-front, washing away boats lying 15 ft. above high-water mark, and causing considerable damage to boat-building sheds. Doubtless this will result in a speed limit being fixed by large vessels in the Solent and at Spithead." [1]

Wake of a Ship.—Another interesting fact is the beautiful line or track, the wake of a ship, made when she is moving rapidly on her course. This is often a visible white road extending for miles astern of the great liner. In tropical waters it is lighted up at night by the millions of microscopic animalculæ.

The *Mauretania* was converted into an oil-burning ship in 1922, and it was expected that she would beat her record, but whether this is achieved or not, there is a great saving in the engineering staff, which has been reduced from 446 to 175 owing to the smaller number of stokers and trimmers required. Her steaming radius has also doubled. The oil tanks carry enough oil for the double Atlantic journey, and they can be filled in twenty-four hours.

Punctuality.—The punctuality of great liners is in a sense more laudable than speed for the purpose of record-making. At Plymouth the punctuality of S.S. *Paris* is said to be remarkable. Here is another case of punctuality. In March 1924, when the White Star liner *Majestic* was forty-eight hours from New York, her commander sent a wireless message to England that he expected to reach Ambrose Channel lightship at 1 p.m. on the Tuesday. The ship got there at 12.58 p.m.

On the return journey a wireless message was sent, when the *Majestic* was forty-eight hours from the French coast, that she was due at Cherbourg at 7 a.m. The ship dropped anchor at Cherbourg at 6.59 a.m. In view of the distances covered, and many forces to be reckoned with in the calculation, this precision is wonderful.

Spring Cleaning.—Spring cleaning a liner is not a job for once a year, but at the end of every voyage. The carpets and stair-mats in all the public rooms, stairways, passages, cabins, etc., have to be cleaned and renovated ; this entails the removal of all tables, chairs and fixtures in the way. Walls and floors all

[1] The *Daily Mail*, November 15, 1924.

over the ship are scrubbed ; mattresses, pillows and soft materials of the furniture have to be cleaned and sometimes burnt and replaced with new stuffing. Disinfecting patents are used in large quantities, and the painters have much to do. Plumbing is very important. Carpenters are set to work repairing all furniture. All this has to be done at high pressure, in order to let the great ship continue earning money as soon as possible.[1]

No vessel can afford to miss the advertised date of departure. Through trade difficulties existing at Southampton, the Cunarder *Mauretania* was sent to Cherbourg to refit, and the ship took with her workmen who could not be employed when in Southampton. A bold step, but it was successful.

Board of Trade.—Once a year at least every British passenger vessel must be examined by the Board of Trade, or she is not qualified to renew her British Passenger Certificate. In order that the ship's bottom may be inspected, she is put into dry dock, and the "sighting" of the exterior, which includes propellers, rudder and other hidden fittings, is commenced. No painting is allowed until this examination is completed. The survey of engines and boilers is even more frequent, as we have already stated. Even the ship's double bottom is opened up for this purpose.

Deck survey includes all appliances for signalling and the life-boats, and some are tested in the manner described in the previous chapter. This is by no means all, but enough has been shown to ease the minds of the passengers, for many of whom this may be interesting news.

Kennels. Conservatory.—Excellent kennels are provided for dogs on the hurricane-deck. There is also a conservatory on the same deck, but in a more prominent position than the kennels. Flowers are grown, and doubtless the gardener who has care of all the plants on board will sometimes give his plants a change on deck in order that they may see more of the sunlight than they do when on duty below.

[1] *The Boy's Book of Steamships*, by Howden.

CHAPTER VII

SAFETY AT SEA

Double-skin-water-tight compartments—Centre of gravity and buoyancy—Shape in design—Wireless, drift of aerial—Single-wire C.W. marine receivers, Devizes, news service—*Volturno*—Station call signal, time signal, wave-metre of ship, cyclone, direction-finder, Marconi-room—Call for a doctor—Lost rudder—Fog, submarine signalling—Buoy bell, Fessenden oscillator—Four-second alarm—Cable "Lead"—Lifeboats—Lifeboat practice, motor-boats, lifebelts—Davits, Martin transporter, emergency lifeboat—Man overboard, emergency lifebuoy, oil on troubled waters, oil separating barges—Detection and prevention of fire, fire brigade, "Rosette" system, manual fire alarm, smoke indicator, Grinnell sprinklers—Icebergs, ice patrol ship, iceberg detector—International Hydrographic Bureau, Chart—Avocet Rock—Volcanic eruptions recorded—China sea survey—Lighthouse, lightship—Flash revolving—Light valve—Dalen invention—Aerodrome lights—Mersey lights—Lifeboat Institution—The Original, Self-righting Lifeboat—Motor lifeboats—Coastguard—Lloyd's Register, Board of Trade—Lloyd's Signal Station—Engine and boiler tests—Casualties.

A NAVAL architect, writing on Safety at Sea, says: "The large number of souls she carries and the enormous value—some two or three million pounds—and the regularity of the service, render the safety of a liner of paramount importance. No builder ever admitted that a vessel is unsinkable, although unsinkability in the future is not impossible; some day science will do it."[1] Safety at sea is a matter of ship design and careful handling of the ship, with lifeboats as a last resort.

Double Skin.—We have seen how the largest vessels have been constructed with a double bottom extending under the whole ship—a double skin running right round the ship, reaching from the double bottom bar above the water-line, the protection being further increased by coal or oil bunkers.

Bulkheads are all vertical partitions, which, in a ship, separate compartments from one another. They are of value as elements of strength; as safeguards against fire, and as preventatives against foundering if the ship's skins are pierced by striking a rock. There

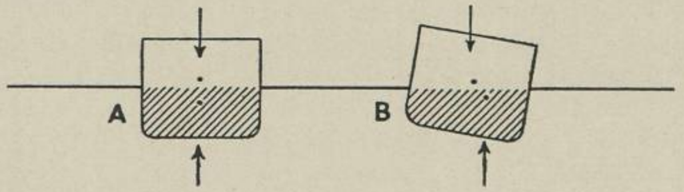
[1] *Ship Construction and Calculation*, by Geo. Nicol.

are rules as to the size of these compartments, and also their strength.

Water-tight Compartments.—The interior of the vessel is divided, as already stated in Chapter II, into a large number of water-tight compartments, both transverse and longitudinal; these steel walls of great strength run from the double bottom 50 ft. or more upwards. Forward collision bulkheads extend through the top deck. Water-tight compartments are fitted with water-tight doors under control. The entire hull has been tested by flooding to prove the partitions are perfectly water-tight under extreme conditions.

That a ship so constructed cannot easily be sunk was proved in the war. H.M.T. *Justicia*, 32,234 tons, which was built at Belfast by Messrs. Harland & Wolff, was attacked by three German submarines. The U boats managed to fire nine torpedoes at her. The attack commenced at 2.30 on a Friday afternoon, and she remained afloat until Saturday afternoon. Although she was hit well below the water-line, in the after end of the engine-room, and this compartment was flooded, the electric plant put out of action, and practically the whole of the auxiliaries stopped, she remained afloat for nearly twenty-four hours. Lives saved—all except those killed in first explosion. This speaks well for the water-tight doors and water-tight compartments, and it is only one instance out of many.

Centre of Gravity and Buoyancy.—For the sake of safety, the designer must give his vessel a size and form so that it will sink to the required depth under the required load, and that it will float in an upright position. If he makes his centre of gravity too low, the ship will be safe from the risk of capsizing, but it will roll terribly.[1]



Midship section A of a ship showing why it floats upright.

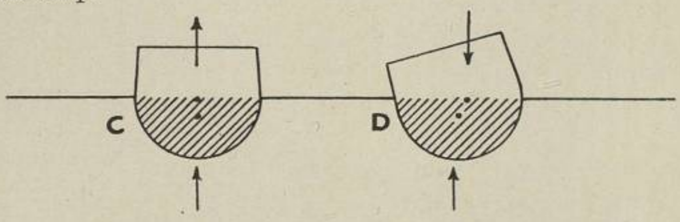
Normally the centre of gravity and the centre of buoyancy are in the same vertical line. If the ship inclines to one side, the centre of buoyancy moves to that side too, and tends to push it back to the upright position.

We see in A the midship section of a ship in its upright position, and it will be seen that the two "centres" are exactly in a line vertically.

[1] *Steamships*, by Fletcher.

In B the same ship is shown when leaning over to one side.

Shape in Design.—The shape of the displaced water (shown shaded in both figures) is different in these circumstances from what it is when the ship is upright; and this difference in shape shifts the centre of buoyancy to the right. The upward force of buoyancy and downward force of gravity, acting together, will then tend to right the ship.



A ship of this shape would be unstable for the centre of buoyancy and would remain under the centre of gravity (or move to the opposite direction of inclination of the ship). There would be no tendency to right itself.

In C and D we see a form of vessel which will tend, not to keep upright, but to turn over.

We see, then, that the stability of a ship depends upon its shape.

The designing of a large ship to meet all the demands of safety, speed, strength, carrying capacity and comfort is the most difficult feat in all engineering practice.[1]

Brunel made his designs for the *Great Eastern* follow the form of structure employed in the building of the Menai Bridge between Anglesea and Wales.

A passing allusion has been made to wireless and submarine signalling. Hardly a ship is without these two means of hearing—a sense from which we receive knowledge and can then act. This warning of dangers is so valuable in life-saving.

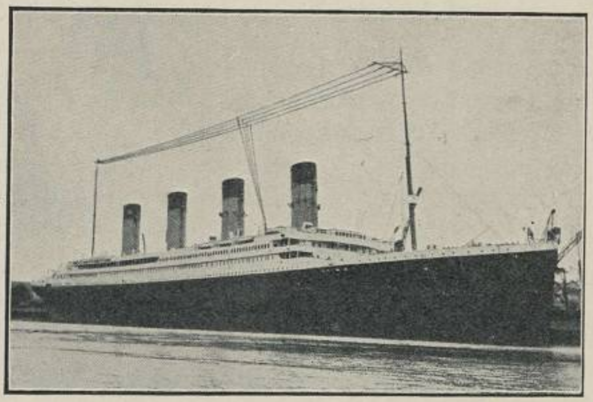
First Wireless on a Liner.—In June 1900 the Cunard Company's S.S. *Lucania* was fitted with the first installation of wireless telegraphy. It was on board the Cunard steamship that Chevalier Marconi made many experiments of crucial importance. Before the first decade of the twentieth century came to an end the necessary apparatus for wireless telegraphy and submarine signalling was added to every vessel of the Cunard Fleet.

Drift of Aerial.—Here is an illustration (Fig. 72) showing the *Olympic* (White Star Line) fitted with wireless. The stretch of wires on spreaders between the masts, well over the top of the funnels, is called the "drift of aerial"—in this case about 600 ft. long. As everyone knows, it is from these wires that impulses jump

[1] Fletcher's *Steamships*.

off on their journey at the speed of light, i.e. 186,000 miles in a second (at present our instruments have a limit of a few thousand miles). The same aerial receives messages.

Look at the lonely tramp out of sight of land and ships—perhaps for days together. But is she quite alone ? See what Mr. Filson Young says : "The sea is now no voiceless solitude. It is full of whispers, summonses, questions, narratives : full of information to the listening ear. High up on the boat deck the little white house to which the wires straggle down is the Marconi officer's cabin. The air is full of voices of invisible ships that are coming and going beyond the horizon. Wireless is the greatest gossip in the world. It repeats everything it hears ; it tells the listeners everyone else's



By courtesy of] [*Marconi Co.*

FIG. 72.—DRIFT OF AERIAL ON THE "OLYMPIC".

business ; it speaks to him of the affairs of other people as well as his own."[1] Ships are really never lonely.

Aerial Single Wire.—Daily experience, together with scientific research, is rapidly improving these wonderful instruments. For instance, ships are now fitted with single-wire aerial in place of the twin or four-wire aerials. It is found to be equally efficient, and as there are no spreaders and consequently less dead-weight, the aerial can be carried higher. A single wire is only used when the span is over 225 ft., and for spans between 130 ft. and 225 ft. a twin-wire aerial, separated by 10-in. steel strips, is fitted at intervals of 20 ft. Below 130 ft. the old 12-ft. spreader system is still used.

Warships use 50-h.p. engines for wireless, because their aerials are low and they require to have a great radius of call.

Liners have aerials fitted high up, and 10-h.p. engines are used.

[1] *Titanic*, p. 64.

"C.W." Marine Receiver.—An innovation of considerable importance is the introduction of *continuous-wave* working in the Mercantile Marine. Large passenger vessels are equipped with "C.W." apparatus. For a given expenditure of power the ranges are approximately double those obtained with *spark* transmitters, and at the same time the tuning is sharper. Such ranges are very greatly exceeded under favourable conditions at night. The distance over which signals from large shore stations can be received depends upon the large shore stations in question. With a *marine receiver* the largest of these stations can be read all over the navigable portion of the globe.

Devizes.—Devizes station is the station for long-distance communication with ships equipped with "C.W." transmitters.

News Service.—The *News Service* is carried out by Leafield station, and this is usually after 6 p.m., at a fixed hour, when all ships on the high seas may obtain the world's news and information required for "press" on board liners.

S.S. "Volturno."—Here is a true story showing how wireless was the means of saving lives. "In October 1913 the emigrant ship *Volturno*, with 657 souls on board, caught fire in mid-Atlantic. Her distress wireless call (S.O.S.) was received by Captain Barr, of the Cunard liner *Carmania* when 78 miles distant" (Sir Arthur Spurgeon has kindly provided a picture of this, see Fig. 73.) Some idea of the turbulent state of the ocean may be gained from this photograph, which was taken while the *Carmania* was manœuvring round the burning vessel. "A wild storm was raging, and terrific beam seas were running which proved to be altogether impossible for boats. Several boats full of passengers had been lost, one boat, after being safely floated in the great heaving ocean, drifted under the *Volturno*, where the waves carried her just as the ship rose high at the stern and came down upon the frail craft. The ship sat upon her, and the occupants met with a horrible death." [1]

Here were gathered together, thanks to "wireless" calls, the finest fleet of liners ever assembled in mid-ocean, ships representing Great Britain, the United States, France, Germany, and Russia; but as they were all absolutely powerless, Captain Barr, the senior officer, had sent out wireless calls inquiring whether an oil-tank steamer was about. The captain of the *Narragansett* replied that he would arrive at six o'clock, and he did. Oil was at once pumped in huge quantities round the burning vessel—literally pouring oil upon the troubled waters. The effect was marvellous—for a breaking sea was turned into a swell, and the lifeboats of all the ships very soon reported the number of souls each had rescued from the burning ship. The success of Captain Barr's wireless call for an oil ship

[1] "The Burning of the *Volturno*," Sir Arthur Spurgeon.

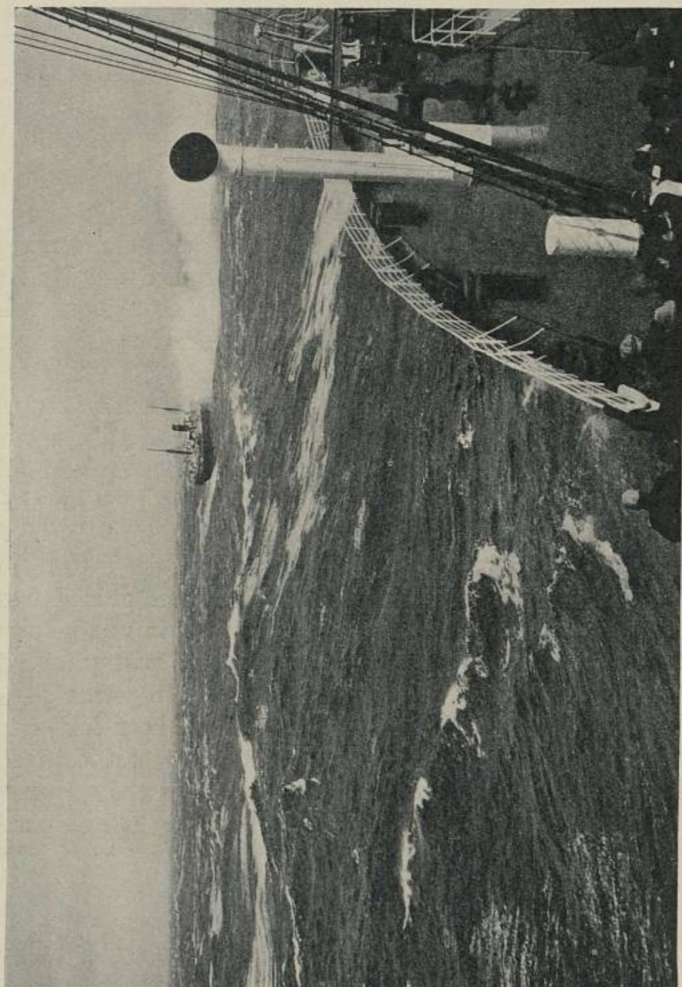


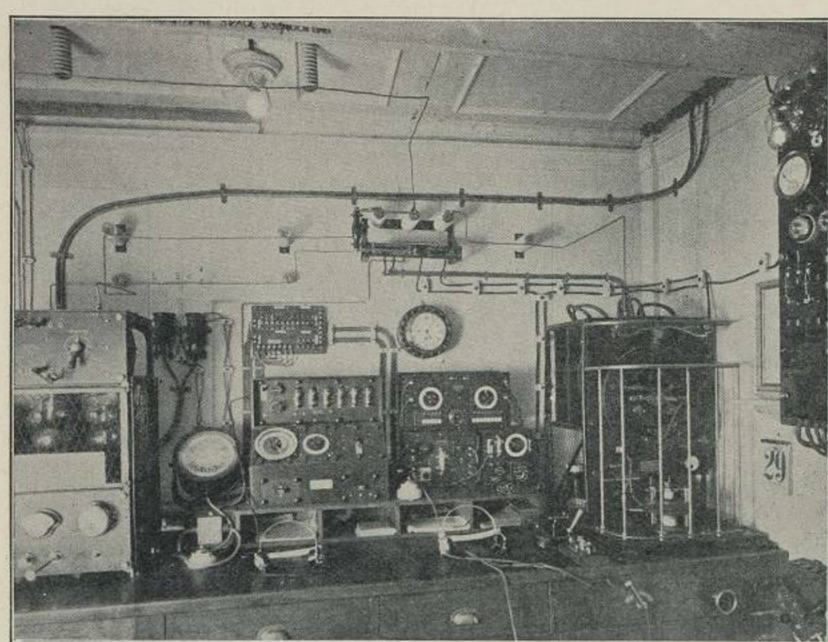
FIG. 73.—THE BURNING "VOLTURNO" AS SEEN FROM THE DECK OF THE "CARMANIA". (P. 111.)

proved to be the saving of 520 lives, and, as already shown, 136 lives were lost in the gallant attempt at rescue before the oil-tank ship arrived.

Few ships are without this wonderful invention, and no passenger ships can be without it. There are definite rules, and inspection tests are continually being made as a precaution.

Station Call Signal.—Every ship has its *station call signal*—letters which are registered and can be found in *The Year Book of Wireless*. For instance, *Narragansett* is M.E.C.

Time Signals. Wave-metre of Ships.—We have mentioned



By courtesy of] [*Marconi Co.*

FIG. 74A.—MARCONI-ROOM, SHOWING GYRO REPEATER DIRECTION-FINDER AND "FOUR-SECOND ALARM" ON "EMPRESS OF SCOTLAND". (P. 114.)

time signals—these are broadcast by telegraphy and telephony land stations such as Eiffel Tower (Paris) twice daily, at 10 a.m. and at midnight; meteorological information is (broadcast) transmitted each day, one immediately after the morning time signals, then again at 5 p.m. Usually ships have transmissions on 300 and 600-metre wave-lengths, and some have three different wave-lengths.

Cyclone.—The value of wireless in tropical waters was proved in 1922, when a cyclone swept through the Bay of Bengal. A broadcast message was sent from Calcutta every three hours warning shipping of the rate and the direction the cyclone was travelling. No fewer than eight big steamers were able to get out of its track, while the news was picked up by 450 wireless stations in Bengal. The average velocity of the wind was 100 miles an hour.

Direction-finder.—A message transmitted by wireless (unless preceded by the call signal and ship's position, etc.) leaves the receiver in doubt as to the direction from whence the call is made. In order to detect this we now have the Marconi Direction-finder. Here is a photograph (Fig. 74A) of the Marconi cabin on the *Empress of Scotland*,[1] and on the left, below the clock, is the direction-finder. The top panel comprises four high-frequency amplifiers, one rectifier, and one note-magnifier with necessary resistances. On the left of the sloping panel is the goniometer coil (for measuring angles) with search coil, in the centre the tuning condenser, and on the right the necessary switches for using the aerial as a non-directive receiver.

Vessels equipped with the Marconi Wireless Direction-finder are able to take relative bearings of any wireless stations which may be transmitting. Similarly the bearings of other vessels equipped with wireless and known to be in the neighbourhood can be obtained under adverse weather conditions.

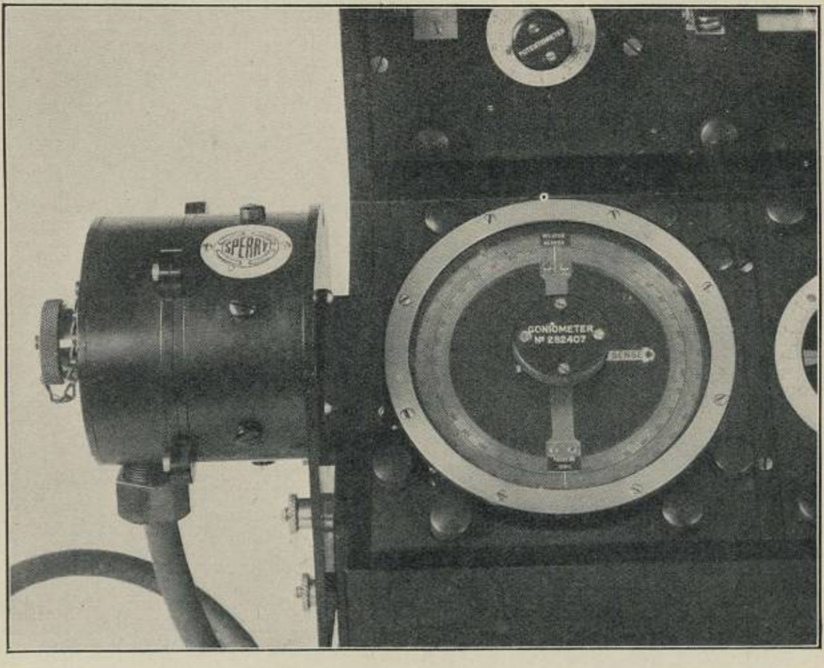
Marconi-room.—The bearings obtained are relative to the keel line of the vessel, and must be translated into true or compass bearings before they can be used for navigational purposes. In the illustrations of the Marconi-room the gyro-compass repeater is placed next to the direction-finder, where it can be readily seen. A new instrument just invented is attached to the goniometer, connecting it directly with the repeater gyro-compass. This is now a "wireless compass" (Fig. 74B).

Call for a Doctor.—There is no end to the variety of ways in which wireless has proved its use at sea. "The Prince Line steamship, *Saxon Prince*, from Newport News to Rio de Janeiro, reported one of the seamen was taken seriously ill, and wirelessed a message asking for a ship in the vicinity carrying a doctor. The Spanish steamship *Manuel Aruns*, bound from Teneriffe to San Juan (Porto Rico), replied and altered course to meet. As they were approaching each other instructions as to treatment were wirelessed from the Spanish ship—fortunately, the latter vessel also had a wireless direction-finder, and, as the result of bearings taken, the vessels were able to meet without any loss of time in searching for each other."

Lost Rudder.—Here is another received from the ship's wireless through the Marconi International Marine Communication Co., Ltd.: "The Furness liner *Sachen* reported that a Norwegian ore-

[1] Supplied by Marconi Wireless Telegraph Co., Ltd.

carrying steamer *Capto* lost her rudder in a great Atlantic storm. Her call for assistance (these are International Code in Morse) was picked up when the vessels were 100 miles apart. The *Sachen* could not locate the disabled ship. The Canadian-Pacific liner *Montclare*, equipped with Marconi direction-finding apparatus, hearing the calls, plotted the exact position of the two ships from their signals and communicated to the *Sachen*, which then soon came up to the *Capto*. The vessel without a rudder had to be towed through storms for a distance of 750 miles, and it took ten days.



By courtesy] [*The Sperry Gyroscope Co.*

FIG. 74B.—A WIRELESS COMPASS.

During this strenuous work the hawser parted several times, but the Marconi wireless operators maintained communication between the two ships, and at last the worn-out mariners made Cape Spear in safety.

"All this time the two ships were receiving warnings and ice reports from ship and land stations, and in this way were enabled to avoid dangerous ice-fields. These two ships took advantage of the bearings given at regular intervals by the Canadian Shore Direction-finding Station at Cape Race."

In an article on the *Titanic* disaster and the safety of ships at sea, in defence of the wireless arrangements, the editor of *The Shipbuilder* said: "That without the aid of wireless telegraphy it is probable no lives would have been saved at all"[1] (703 souls were saved). One of the questions raised at the inquiry was whether every ship having wireless apparatus should be compelled to carry two operators, one of whom would always be in attendance at the instruments. Mr. Marconi, in his evidence before the British *Titanic* Commission, suggested that the most satisfactory solution of the difficulty would be the invention of some automatic alarm device. He did invent such a device.

The Four-second Alarm.—In Fig. 74C we have an illustration of the *Marconi four-second alarm*, for use on shipboard when the operator is off watch. A ship sending four dashes of four seconds' duration, with a separating interval of one second,

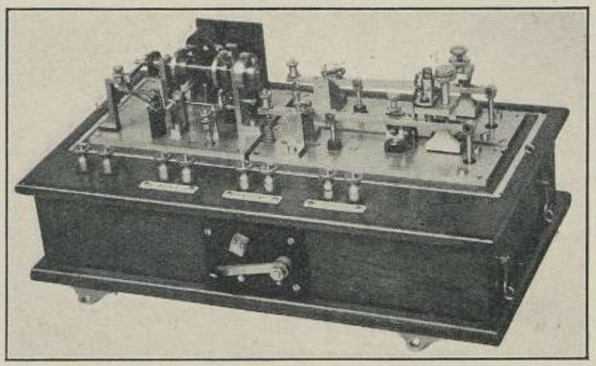


FIG. 74C.—THE FOUR-SECOND ALARM.

causes this device to operate and ring bells in various parts of the ship to draw the operator's attention.

This device is not yet in commercial use.

When it is on the market there will be no need for continuous "watchers" to receive possible distress signals. The Marconi officer will be relieved of much that is irksome.

Fogs.—"Little by little many dangers which beset the early navigator have been overcome. The chart told him the best course to take from one point to another. The mariner's compass enabled him to maintain his course when the stars were blotted out by clouds. With sextant and chronometer he located his position; when a sight could not be obtained, he relied on his log and soundings. By wireless telegraphy he is enabled to call assistance in time of danger. Even this will not reveal his position in a fog. There are

[1] *The Shipbuilder*, Summer Number, 1912.

fogs around the British Isles, the New England Coast, the Western Coast of the United States, British Columbia and Alaska, and many other localities on trade routes sometimes lasting for weeks at a time." [1]

"Ships have signalled by wireless that they were in distress, but have to remain without assistance for many hours, and in one instance for more than a day, because their exact location could not be determined by vessels coming to their aid." [2]

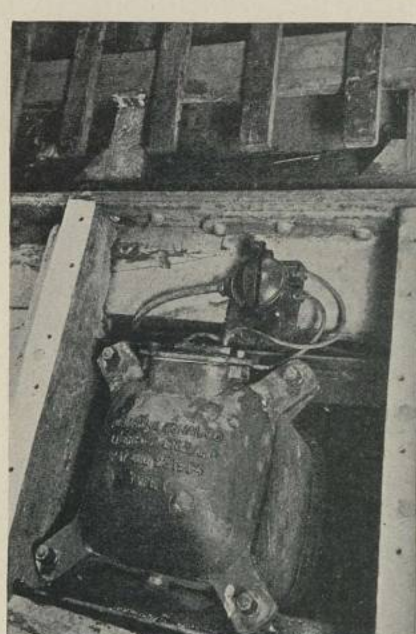


Fig. 75A.—Submarine Signal Tank, in which Two Microphones are immersed. Two of these Tanks, One on Either Side, are located in the Fore-hold of a Ship.

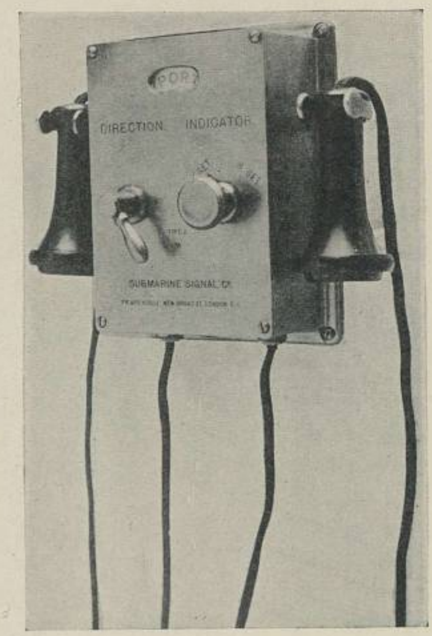


Fig. 75B.—Direction Indicator-box, placed in Chart-room or Wheel-house, by Means of which the Direction of the Source of Submarine Signal is determined.

The submarine signalling apparatus gives the ship *ears* to hear sound through the water—one is fitted on each side below water.

Submarine Signalling.—A small water-tank containing a microphone of a special type is attached to each side of the bow, inside the skin of the ship (Fig. 75A). From each tank wires are run to a device which is called the indicator-box (Fig. 75B), so arranged that on throwing the handle to one side the starboard

[1] *Submarine Signalling*, 1915, p. 5. [2] Ibid., 1912, p. 42.

microphone is connected to the telephone, and by switching over to the other, the port microphone is connected. As a precaution against error the microphones are duplicated, and each pair can be utilized independently. When once the bell is picked up, the captain has only to turn his vessel until the sound is heard with equal intensity on each side to assure himself that his ship is then pointing in the direction from which the sound is coming, and he can then take exact compass-bearings of the lightship on which the bell is situated. A vessel in distress has only to ring a submarine bell, called the "emergency bell", which can be lowered over the side of the ship and sounded under water, and no matter how foggy the weather may be the ship's position will be found by other ships.

Buoy's Bell.—There are buoys anchored off a shoal or other required position fitted with a floating flap, which as the buoy rises or falls in wave action, by means of a ratchet, compresses a spring which automatically releases and operates the bell-hammer, thus ensuring uniformity in the force of successive blows, as well as an exact number of them. By counting the number of the strokes of the bell, the lightship or buoy, as the case may be, can be identified. The radius of sound wave is from 12 to 15 miles round.

Fessenden Oscillator.—Sound waves under water travel at a speed of 4,700 ft. a second, which is nearly four times as fast as in air. There is an electro-magnetic form of submarine signalling, an invention known as the Fessenden oscillator. It can be used both for sending and receiving signals; and its radius of action is 50 miles. This apparatus was used in submarines. It consists of a flat steel plate 30 in. in diameter, fitted in the side of the ship under water, in which vibrations of very small amplitude but very high frequency are induced by an electrical apparatus fitted for that purpose. One of these plates is fitted on each side of the vessel near the bow. Its operation is likewise controlled by a Morse telegraph instrument which alternately sets up and interrupts the vibrations in the steel plate by closing and opening the circuit. It is part of the ship's means of external communication.[1]

Light-vessel Oscillator.—As the submarine signal bell of the light vessel of 1903 superseded the aerial fog-signals, for the reason that they were heard double the distance, and with the advantage that they could determine the direction of the sound, so to-day a modified form of the Fessenden oscillator, already mentioned, is taking the place of the submarine pneumatic bell, for the radius of sound has again been doubled.

The light-vessel oscillator shown in Fig. 75c is substantially the same weight as the pneumatic bell. The electrical energy

[1] *Secrets of the Submarine*, by Marley F. Hay.

required for the operation of the oscillator is from a 2-kw. 1,050 frequency motor-generator. In trials of both, the submarine bell and the oscillator sounded at intervals on a lighthouse tender running three different courses.

The bell code signals were lost at 29 miles, while the oscillator was strong at 60 miles, and the last boat did not run out the limit

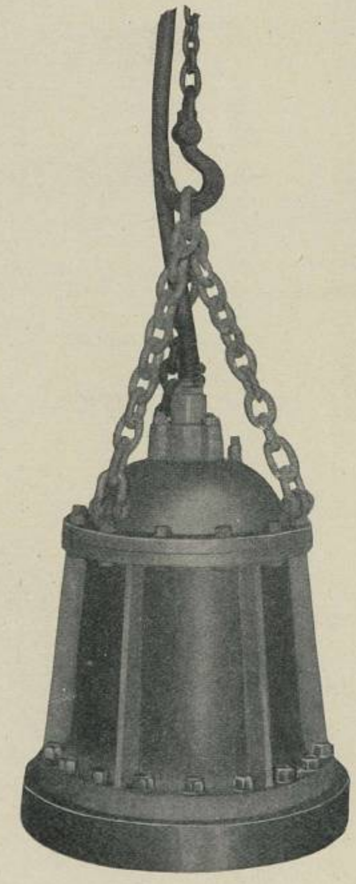


FIG. 75C.—LIGHT-VESSEL OSCILLATOR.

of the range. By the kind permission of the Submarine Signal Corporation I am able to give a picture of this oscillator. A view of the old pattern light-vessel bell and the light-vessel are also given (Figs. 75D and E).

The captain receiving the submarine signal is shown in Fig. 76.

The maps show all the submarine signal stations in our part of the world.

Through the kindness of the inventor, Professor J. J. Dowling, of Dublin University, we have here a description and illustration of the automatic fog-signalling apparatus.

Automatic Fog-signalling (Fig. 77A).—"A light is mounted at the focus of a large lens, which forms a window in the side of a hut. An almost parallel beam of light is thus sent across to a distant lighthouse, where it enters through a similar lens. This beam is interrupted very rapidly by being passed through a revolving disc furnished with a number of apertures (Fig. 77B). This interrupted beam of light is in constant operation day and night, and means are provided for automatically replacing the

Fig. 75D.—Light-vessel Submarine Bell on the North-west Light-vessel.

Fig. 75E.—North-west Light-vessel, showing Submarine Bell.

lamp. The intensity of this light, as received at the lighthouse, diminishes during a fog, and when the density of the fog reaches a certain pre-determined point, the receiving apparatus at the lighthouse causes the fog-signal there to start. As the fog lifts, the light regains its strength and operates the receiving apparatus so as to stop the signal.

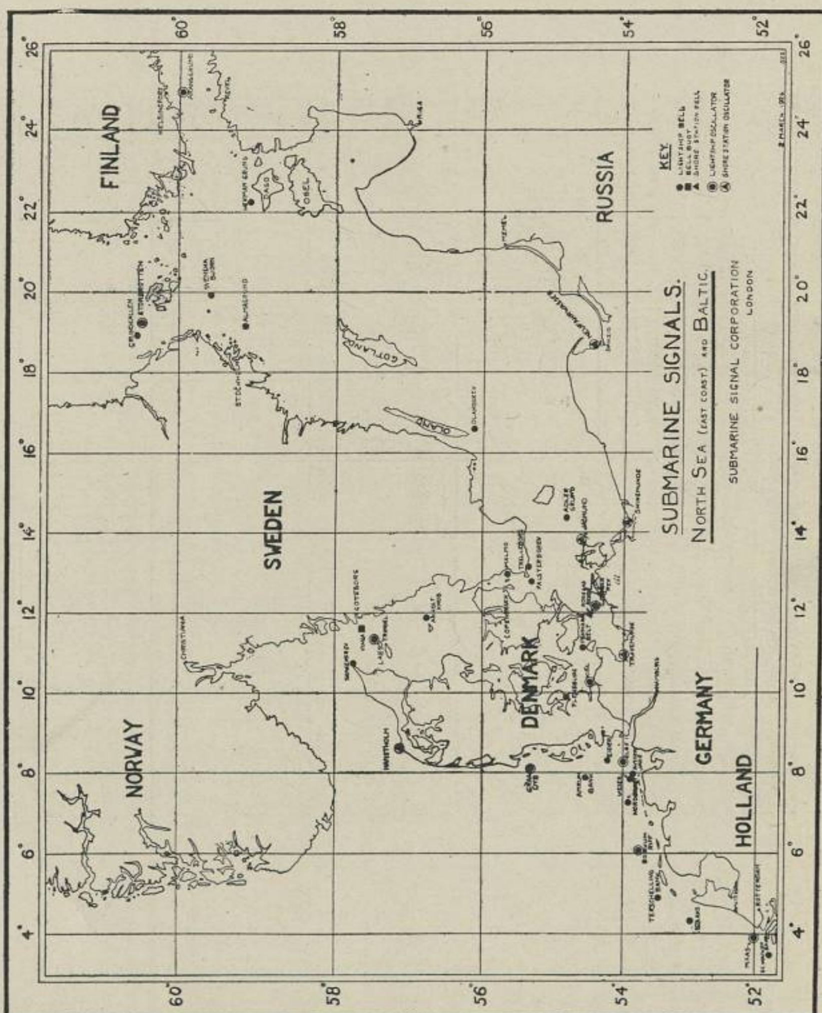
"The receiving apparatus proper is in two parts (Fig. 77C). One is a special light sensitive cell, whose electrical resistance undergoes variation with the strength of the light. This is mounted opposite the receiving lens, which gathers the beam of intermittent light, as shown in the diagram, and casts it upon the cell. The other section of the receiver is an apparatus resembling in some respects the amplifiers used in wireless. For short distances three, but usually four or five, valves are employed, and the design of the apparatus is such that failure of any of these valves, or of any of the connections, results in the fog-signals being operated.[1] Any stoppage of the light or of the interruptions of the beam has a similar effect. The valves used are of the extremely low current consumption type (0·06 amp.),

FIG. 76.—RECEIVING SUBMARINE SIGNALS.

and an accumulator battery of easily portable size suffices to operate the valves for two or three months.

"This amplifier arrangement is necessary for two reasons—the electric current from the light cell is much too weak to operate the relay directly, and the effect of fog is, in any event, not sufficient to completely extinguish the light beam. The general principle is to *restrain* the fog-signal apparatus from operating by the control of a device sensitive to light. *Dangerous* fogs exist when objects about a quarter of a mile away become indistinct in daylight.

[1] Incidentally, it gives notice to those in charge of it whenever it is in need of adjustment.


SUBMARINE SIGNALS.
NORTH SEA (EAST COAST) AND BALTIC.
SUBMARINE SIGNAL CORPORATION
LONDON
KEY
LIGHTSHIP BELL
BELL BUOY
SHORE STATION BELL
LIGHTSHIP OSCILLATOR
SHORE STATION OSCILLATOR
FINLAND
RUSSIA
SWEDEN
NORWAY
DENMARK
GERMANY
HOLLAND
GOTLAND
OLAND
60°
58°
56°
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6°
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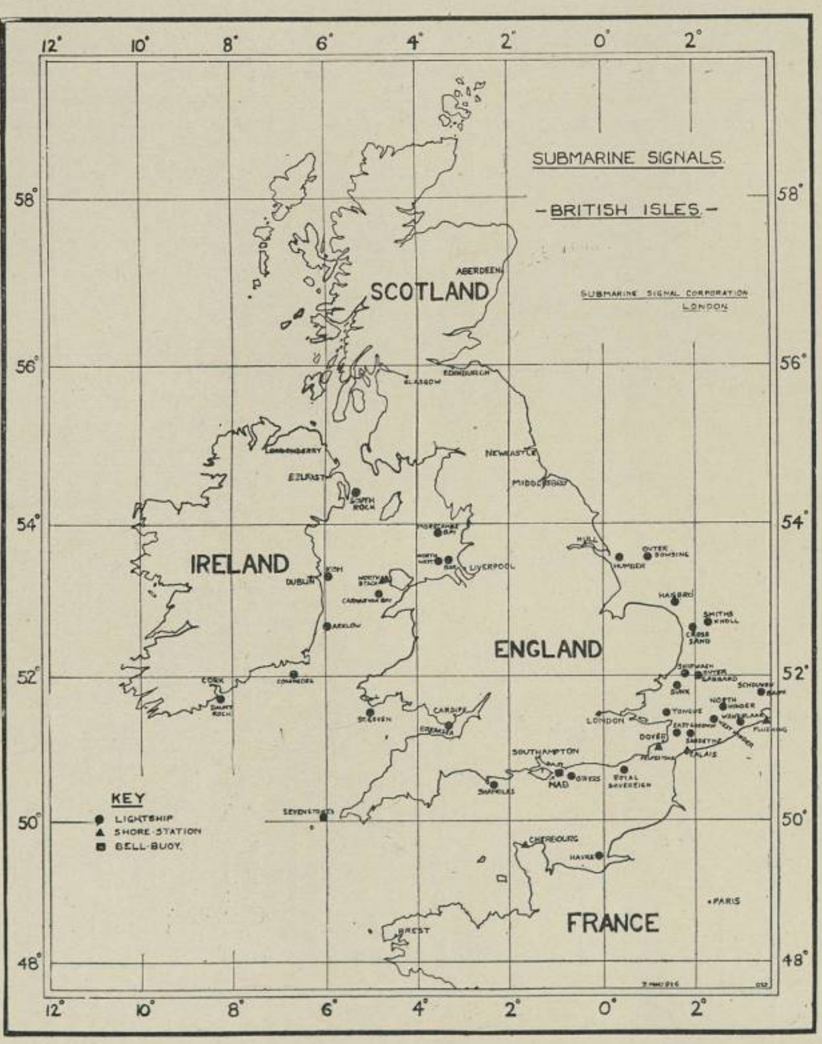
20°
22°
24°
26°


SUBMARINE SIGNALS.
-BRITISH ISLES.-
SUBMARINE SIGNAL CORPORATION
LONDON
SCOTLAND
IRELAND
ENGLAND
FRANCE
ABERDEEN
EDINBURGH
GLASGOW
NEWCASTLE
LONDONDERRY
LIVERPOOL
HULL
HUMBER
OUTER DOWSING
HASBRO
SMITHS KNOLL
CROSS SAND
DUBLIN
ARKLOW
CORK
CARDIFF
LONDON
DOVER
CALAIS
SOUTHAMPTON
ROYAL SOVEREIGN
NORTH HINDER
SCHOUWEN BANK
FLUSHING
CHERBOURG
HAVRE
PARIS
BREST
KEY
LIGHTSHIP
SHORE STATION
BELL-BUOY.
12° 10° 8° 6° 4° 2° 0° 2°
58° 56° 54° 52° 50° 48°

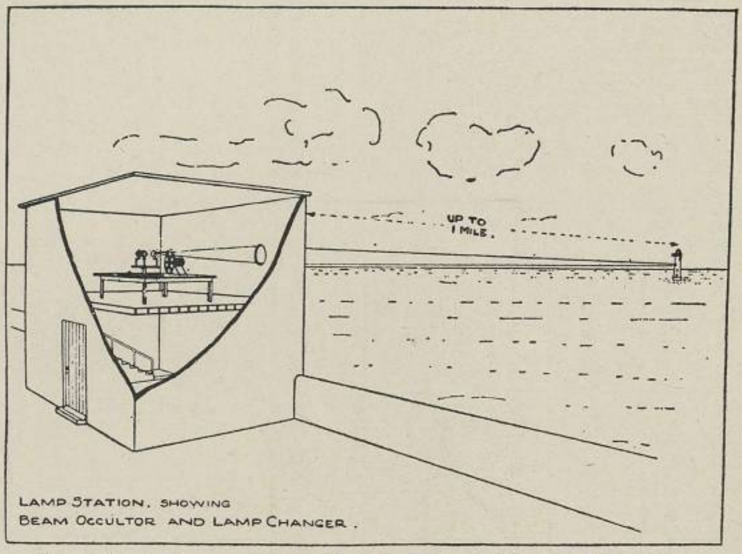


FIG. 77A.—EMISSION AND RECEPTION OF BEAM. AUTOMATIC FOG-SIGNALLING. (P. 120.)

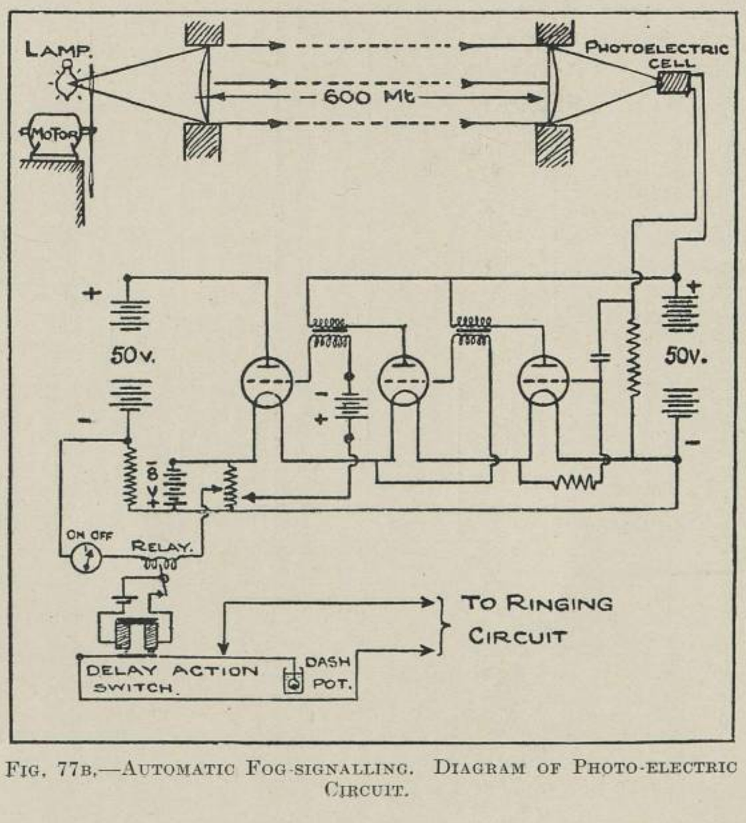


FIG. 77B.—AUTOMATIC FOG-SIGNALLING. DIAGRAM OF PHOTO-ELECTRIC CIRCUIT.

Such dangerous fogs may be quite local, perfectly clear air being found within a few hundred feet from a dense fog-bank. Fogs frequently drift up or down or across the channel, causing rapid changes in visibility.

"A *delay-action* switch is used, so that several seconds will elapse between the operation of the relay and the actual starting of the signal apparatus. This is necessary so that passing ships, birds, puffs of smoke and other transient interruptions may not cause

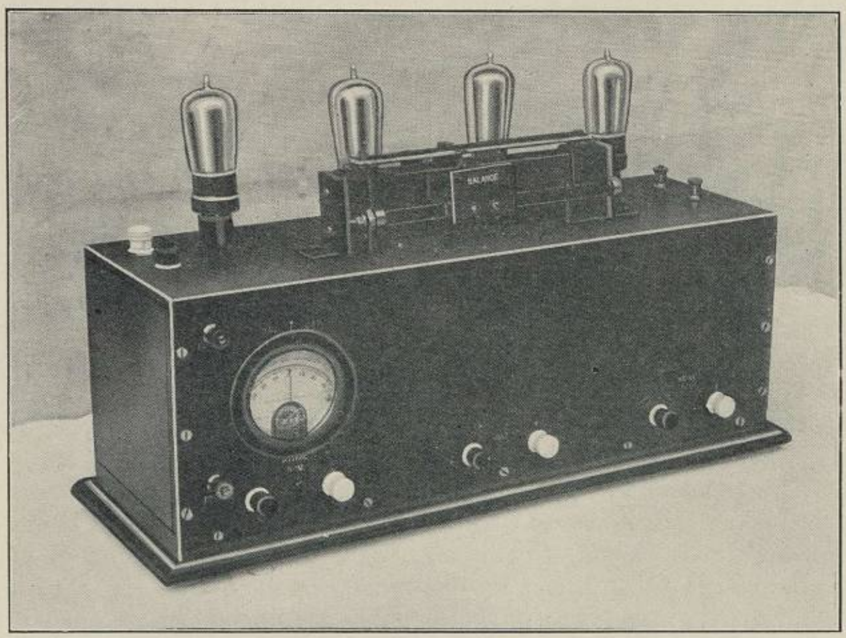


FIG. 77C.—FOG-SIGNALLING. LIGHT-RECEIVING APPARATUS. (P. 120.)

the signal to be operated unnecessarily, with consequent wear and waste of energy." [1]

It is said that the necessity for furnishing a fog-signalling service has been the main obstacle, hitherto, to the adoption of automatic lighthouses. At the end of this chapter we deal with the sun-valve, and up to this year (1926) thirty British Marine lighthouses have been fitted with the A.G.A. sun-valve, which represents a considerable annual saving rendered possible by substituting automatic for attended lights.

The mariner has always a dread of fogs. Fog-signal sounds are conveyed in a very capricious way through the atmosphere. Large areas of silence have been found in different directions, and at

[1] Institute of Civil Engineers of Ireland.

different distances from the fog-signal station, in some instances even when in close proximity to it. If closing the land in fogs, soundings must be taken, the lead is the only safe guide.

As a warning, all officers are told that if they blow their horn immediately after another horn they will not be heard. "They should wait at least half a minute before they answer a distant call, in order to allow those on board the other vessel to regain the full use of their ears."

Cable "Lead."—During the war, when ships groped about with "lights" out, at least one port was provided with an electric "leader" cable installation laid along the bottom of the channel and charged with electricity from a station ashore. A ship would "pick up" the electric current radiating from the cable, and by means of an apparatus on the bridge making sound or light signals her navigator was able to steer a safe course. This "leader" is now useful in foggy weather.

Lifeboats.—The next point to be considered—and it is ever present in our minds when we speak of "Safety at Sea"—is the ship's *lifeboats*. The construction of the ship's hull is hidden and even unknown to most passengers, but the boats are much in evidence.

"Titanic" Disaster.—Efficient means of escape must be provided for all on board a sinking ship. For quite a long time ships were badly provided with lifeboats. A new and more carefully prepared system was brought about by the *Titanic* disaster. That ship had sixteen lifeboats. The *Britannic*, a vessel not much larger and built after the *Titanic* disaster, was provided with forty-eight of the largest size lifeboats yet made, and two of these with powerful engines. Both these ships belonged to the same company, and were built at Belfast (1911 and 1914 respectively).

The *Aquitania* has eighty lifeboats. Twenty-two are of the standard class of open boat and two motor-boats. We know that, omitting the two motor-boats, the total number of persons for which boats are provided therefore is 4,584, or 382 in excess of the total complement of the vessel. All big ships built since the *Titanic* disaster have boat accommodation for some 300 souls in excess of the total complement. These boats are mostly on the boat deck, and in the *Majestic*, *Leviathan* and *Berengaria* a few are on the deck 20 ft. below. The shelter promenade deck is between, and for the convenience of passengers this is free from boat obstruction.

Sunday morning service in the saloon and boat muster are two functions looked for in British passenger ships.

Lifeboat Practice.—Boat drill or boat muster is interesting to those who see it for the first time. Suddenly a blast of the fog-horn is heard, then many strange people are seen on the run, and from below stewards, stewardesses, engineers, firemen, nurses, bakers, cooks, butchers, florists, barbers, carpenters and sailors appear and fall into two long lines for roll-call and are appointed to certain boats. This boat muster never took place on the *Titanic*.[1]

The *Aquitania* has several McLean's patent decked lifeboats in use. These are in addition to the ordinary large lifeboats. The boats are provided with food, fresh water, a lantern, and an illuminated portable compass and submarine signalling disc.

Motor-boats. Lifebelts.—The two motor-boats each take charge of half the complement of lifeboats, thus forming two squadrons. They carry wireless with a range of 200 miles, a direction-finder, and also a small searchlight (see Chapter X), medical stores, and blankets in addition to what is mentioned above. Every man of the crew has his number and position to control in any situation. Passengers also have their places, and each is provided with a patent lifebelt. A large number of automatically lighted lifebuoys, which light up upon touching the water, and rafts, are also provided.

Electricity Emergency Plant.—All large ships are provided with an emergency plant for generating supply current for electric power required on the lifeboat movements, and also for lighting the whole ship and for supply to the wireless apparatus in case the main engines fail. In the *Aquitania* it consists of a 45-b.h.p. Diesel engine on the boat deck.

On the *Aquitania* there are thirteen sets of boat davits on each side of the vessel as well as a set of the Welin double-acting quadrant type on each side of the boat deck aft, together with an inboard set of davits of the same type. The Welin double-acting davits are arranged to deal with sixteen decked lifeboats of McLean's patent right across the vessel.

Martin Transporters.—Where these boats are abreast of the ordinary boats, Martin patent boat-transporters are fitted. It consists of two track-ways, on each side of which runs a carrier fitted with chocks. Movement of boats is by turning a crank, which actuates a worm-gear. Fig. 78 shows boats stowed one above the other on R.M.S. *Olympic*. The illustration was supplied by the Welin Davit and Engineering Co., Ltd.

Davits.—With the exception of the Welin davits, the remainder of the davits on the *Aquitania* are of the ordinary round bar type, which are actuated by a worm turning-out gear. Two types of davits are found on this vessel.

To test the strength of lifeboats, davits, and all gear, bags of sand are placed in the boat equivalent in weight to its full complement of persons and equipment. The boat is then lowered to the

[1] *Titanic*, Filson Young.

water. During a test at sea on the *Berengaria*, for instance, boat after boat was lowered away at the average time of fifteen seconds. The largest boats, capable of accommodating some seventy-five persons, descended from a height of some 60 ft. under perfect control, though operated by one man only.

The *Majestic*, *Leviathan*, *Berengaria*, *Homeric*, *Paris*, *Olympic*, and *Belgenland* are fitted throughout with Welin quadrant davits, and *all* of them with electric controls. The three former are also fitted with lower-deck davits, also having electric controls. There

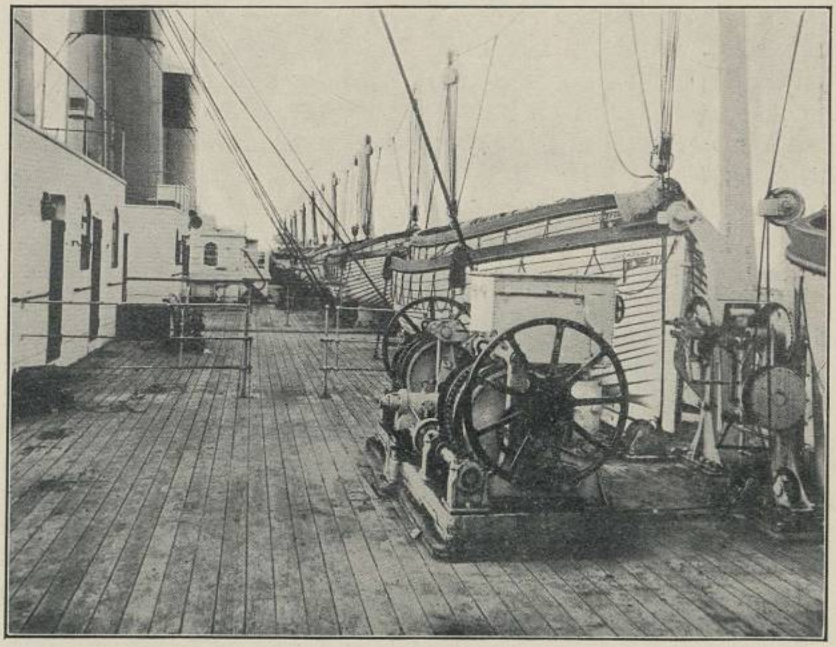


FIG. 78.—LIFEBOATS AND TURNING-OUT GEAR, "OLYMPIC" (P. 127.)

are various forms of davits. In Chapter IX the Maclachlan automatic boat davit, that carries the boats in cradles which run down a trackway and over the side of the ship, is described and illustrated.

Emergency Lifeboat.—On either side of the vessel will be found a smaller lifeboat always ready to be manned and lowered to rescue the "man overboard"—a cry so well known. These boats are ever ready equipped with oars, water breaker, baler, mast, and sails. Here is a true story : [1] "An instant after that dreaded, thrilling cry, 'Man overboard !' echoed fore and aft the ship,

[1] "Man Overboard," in *The Lifeboat* Centenary Number, by Stopford C. Douglas.

bringing on deck, as if by the waving of a magic wand, captain, officers, and every soul in the ship's company. In less time than it takes to write, our only available 'lifeboat', a 27-ft. five-oared boat, was filled with a crowd of men struggling for pride of place. As befitting the second in command of the ship, I clambered in and speedily reduced their number to the requisite five, with myself as coxswain; a moment later, in response to a few brief orders from the officer of the watch, we were being lowered almost to the water's edge, the while the whole ship quivered and shook with the vibration of the engines, now going full speed astern. For a few seconds we lay suspended above the seething, tumbling waters, awaiting an opportune moment for release. It came on the top of a huge wave, which threatened to swamp our frail craft, but which, a moment later, was hurrying us away to the rescue on its crest, as if anxious to atone for the sins of its predecessor, the cause of the accident. We left behind us a row of strained faces lining the ship's side and peering anxiously at the tiny speck which represented a human being fighting for life.

"I think I must have appeared calm, but I know my brain was working furiously the whole time, and a sort of inner voice seemed to be saying to me, 'Now, this is all your fault; if you hadn't been so keen to get the boats turned out this wouldn't have happened. If he gets drowned or taken by a shark, it will be all your fault—all your fault—all your fault'. The men seemed to be almost keeping stroke to the words. Yet all the time I heard my normal voice saying, 'Give way, men; with a will, now! All together; he's quite all right'. And how I prayed that these last words might prove true.

"I could see nothing of the man owing to the high sea that was running, and I had to content myself with following the ship's wake, with an occasional glance backward to the pointing arm of a signalman perched insecurely in the ship's mizzen rigging, his form sharply silhouetted against the grey, lowering clouds.

"Of my crew the two bow oars were youngsters, and this was, doubtless, their first experience of rescue. (I trust it was not their last; it is good training.) They were pulling with a tense, set expression on their faces and with the fear of death, or being brought face to face with it, almost written in their eyes. The man next astern of them was an Irishman, and, like many of his race, excitable. His every stroke was punctuated with 'Pull, ye divvles; pull like hell', alternating with strong seafarers' oaths as a more than usually angry sea curled inboard and sent a gallon or two of water down his back. Of the two remaining, one was a stoker who had just come off duty from the engine-room, his face so unrecognizable beneath the grime and filth of the stokehold that even to this day his identity is unknown to me; the other was a first-class petty officer. He had done this sort of thing before, and knew all too well that the man who falls overboard in the Indian Ocean has to face the possibility of other deaths than by drowning. Yet, if one excepts a few beads of perspiration on his forehead, his face betrayed no emotion whatever.

"And all the time kept running through my brain, 'All your fault; all your fault'.

"After what seemed an eternity of pulling in a boat that appeared to be making no headway whatever (though in actual fact she must have been simply flying through the water), I heard a feeble voice away to starboard. Raising myself with the utmost caution to a standing position, I at length descried the object of our search, and, thank God! he had managed to secure a lifebuoy. 'Twenty more strokes, men!' I yelled; then 'Fifteen, ten, five! Lay on your oars; well pulled all!' The bowman laid his oar inboard, leaned over the side of the boat, and hauled in the exhausted, bedraggled form, safe and sound.

"The first remark of the rescued man is worthy of note:

"''Ere, I've left my blasted cap behind,' he said.

"I promised him a new one. I felt it was the least I could do."

And this is taken from the ship's log: "8.1 a.m.—Man overboard, stopped and reversed engines, lowered boat and picked up man. 8.7 a.m.—Proceeded. Course and speed as before." This is all the news we get from our "silent Navy", and so it is that the traditions of the Service are respected.

There is an emergency lifebuoy with automatic lighting apparatus on each end of the bridge. It is held upright in a recess with a sloping board open to the sea. The buoy, which is, as everyone knows, round, like the rim of a wheel, on being released by pulling out a bolt, at once rolls down the sloping board and carries with it the lighting attachment, already alight, into the sea. This buoy is always released on the cry of "man overboard", and would float on the water near the spot where the man fell overboard.

Oil on Troubled Waters.—Pouring oil on troubled waters is not a new device. We have already shown how the lives saved from the burning *Volturno* were due to the wireless call for an oil-tanker and the arrival of the *Narragansett*, which poured oil on the sea around the vessel. Oil poured on free waves (i.e. waves in deep water) has the greatest effect. The thickest oils are most effectual. When the area to be acted on is not large the best method is hanging over the side, in such a manner as to be in the water, small canvas bags, capable of holding from one to two gallons of oil, such bags being pricked with sail needles.

Oil-separating Barges.—By the Oil in Navigable Waters Acts, 1922, it became a penal offence to discharge oil or allow oil to escape into navigable waters, either from a vessel or from any place on land. It was the practice for ships to discharge their waste oil in any sea or river, with the result that the shores of our seaside resorts and harbours were polluted and both fish and bird life destroyed. Happily, by the experimental work of Smith's Dock Co. and the Anglo-Saxon Petroleum Co., Ltd., a barge was designed with a receiving compartment into which the oily ballast water from a ship is pumped. The liquid gravitates into other compartments with means of separating the oil from the water and then filtering it. The whole of the oil is retained in the barge, and the water is discharged overboard entirely free from the slightest trace of oil. These barges are in use in such places as the Thames, Tyne, the Clyde, and at Avonmouth. An ingenious device is employed on steamers for cleaning and settling the oil; no fuel is lost through going overboard; it is used over again.[1]

Detection and Prevention of Fire.—We have seen the necessity for dividing up the ship into water-tight compartments. This is also useful for the prevention of fire. The ship is divided up into a series of fire-proof compartments; the transverse compartments are continued as diaphragms throughout the entire ship from keel to boat deck. Above the water-tight compartments the fire screen of non-flam. material is fitted with fireproof doors. In these fire-proof compartments—in which the passengers live—there are fitted up a large number of instruments—fire-detectors and alarms—which are automatic.

Fire Brigade.—In the *Aquitania*, for instance, there are electrical instruments wherein the circuit is kept open only by a metal connection which fuses at a comparatively low temperature, so that any high temperature within the compartment will make contact, with the result that a powerful electric bell is rung on the bridge and the instrument affected is indicated by a dial. Thus warning is at once given of any outbreak of fire, and the fire brigade work the system of water or steam pipes.

"Rosette" System. Fire Station.—In the *Leviathan* there is similar action in greater detail. In a network of small tubes collected in a circular pattern called a "Rosette" there is air which is sensitive to heat. A rise of 30° of heat in the column of air enclosed in copper tubes expands and closes an electrical contact, which indicates in the fire station the location of the fire. These "rosettes" are fixed in all cabins and even in every recess or cup-board or wardrobe. Fig. 79 is a view of the fire-indicator in fire control-room.

[1] *Smith's Dock Monthly*, B.E. Number, 1924.

Manual Fire Alarm.—Another system is the manual fire alarm, which consists of forty-five manual boxes from which an alarm can be turned in to the fire station. Each box is equipped with a red light, so as to make them more clearly visible from a distance. Electrical supervision is constantly maintained over both systems, which announce the instant a circuit is broken or other trouble develops. In order that either the passengers or the crew may be quickly warned of an immediate danger, alarm bells, operated from the bridge, are provided in every part of the vessel.

Smoke Indicator.—A special system is used for the *holds.*

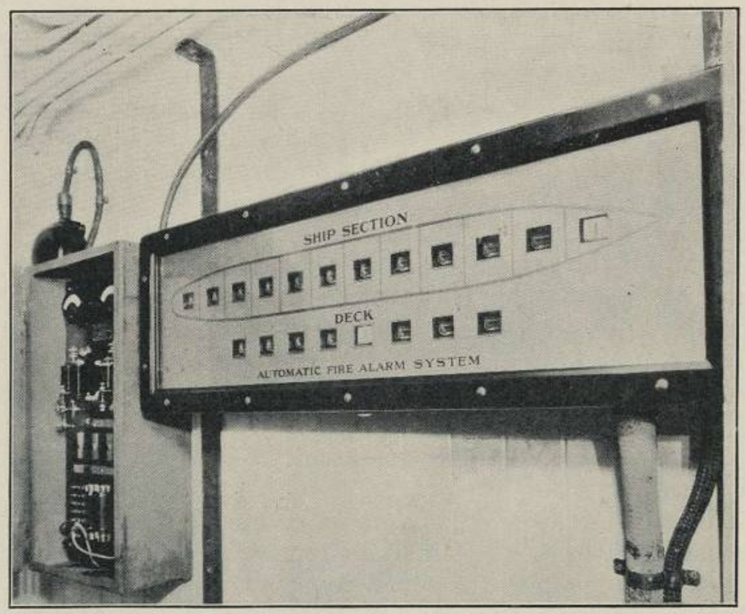


FIG. 79.—FIRE STATION AUTOMATIC ALARM INDICATOR, "LEVIATHAN".

Rich's indicator is located on the bridge. A trunk communication is made from the bridge to each separate hold, the terminal of the trunk on the bridge having over it a powerful exhaust fan, which is intermittently worked by clock mechanism, and thus any smoke generated in a hold will at once disclose itself by the condition of the air exhausted from the trunks. Alongside the indicator are fitted couplings to the steam pipes directly connected with the main steam boiler supply, so that on the first evidence of smoke issuing from any hold, steam may be injected into the hold through the trunk in order to quench the fire.

Grinnell Sprinklers.—In addition to fireproof walls and fireproof glass doors, all partitions are covered with fireproof plaster on each side. Over 400 automatic *Grinnell Sprinklers* (concealed pipes with jets carrying water round the ceilings of all the public rooms) have been installed together with carbonic acid fire extinguishers, all connected with the fire station.

Icebergs.—The giant ships leaving our shores in the spring expect to meet with icebergs, for all are engaged on the run to New York.

Icebergs met with are sometimes three scores of miles long with peaks 200 to 300 ft. high. Masses of many millions of tons of ice must chill the air and tend to influence the winds, as well as deflecting ocean currents and sometimes producing abnormal weather.

Ice Patrol-ships.—Icebergs are swept down from the north in April, and to-day ships have warning by wireless. By international agreement two ice patrol-ships are maintained. During the whole of the ice season they are on ice patrol, reporting all dangerous ice or dangerous derelict, and in the latter case warships are sent out to destroy the derelict. At all other seasons, these vessels study and observe ice conditions.

Iceberg Detector.—Dr. Copland, of Leeds University, took over 3,000 tests of the *salinity* of the water while crossing to Montreal in the *Royal Edward*. He discovered a means of getting an automatic ice alarm. His instrument was always able to detect an iceberg within 2½ miles of the ship. The instrument is an application of the form of ohmmeter, which has been used for some time for testing electrical insulation, and in particular for locating cable and telegraph faults or breakdowns.

The tests made in the *Royal Edward* is the first occasion on which it has been applied to nautical purposes. Nineteen large icebergs and five growlers were passed, and on every occasion the alarm successfully sounded. These results were independently duplicated by the officers of the ship.

As a result of the *Titanic* inquiry a still more southerly course has been arranged for Atlantic steamers.

Wireless has become international, for all civilized nations are affected by the spread of wireless and its enormous ramifications; so, in like manner, the charting of the seas of the world became international in interest, for the safety of the seas is the concern of all.

International Hydrographic Bureau.—The Admiralty announced in June 1921 that an International Hydrographic Bureau had been established. It is the outcome of the International Hydrographic Conference held in London in 1919. Its seat is at Monaco.

Already great steps have been made towards the simplification and uniformity of charts. The metric system is adopted. The

American conventional signs for wrecks have been adopted, and for the first time symbols have been agreed upon to indicate wireless stations. A new unit measure of the power of lights "The Voille", named after the French physicist, Monsieur Voille, has been adopted. *The Times* says: "The meetings between delegates of several committees, and the efforts towards standardizing practices, induce a feeling of mutual comradeship each contributing something for the common good, which cannot but be of benefit to international relationship, and the advancement of free intercourse between the nations is an asset towards maintaining the peace of the world."[1]

Chart.—As early as the fourteenth century the expression "chart"[2] became applicable to *sea maps* to distinguish them from land maps.

In 1920 the Hydrographic Department of the Navy had ten survey ships with 1,024 officers and men.

During eleven years prior to 1920, 4,746 rocks and shoals dangerous to navigation were reported. Over 3,800 charts have been published.

In 1919 there were 2,311 notices issued to mariners.

Avocet Rock.—The story of the finding of the Avocet Rock, which accounted for the sinking of three vessels in 1887 in the fair way—16 miles from the coast of Arabia—is a fine record of the valuable work of the survey ships of the Hydrographer's department of the Navy. "S.S. *Avocet* struck a rock on March 4, 1887, and signalled her position to S.S. *Oswald*. H.M.S. *Flying Fish* surveyed this position shortly after the wreck, and found over 100 fathom, and the presence of other ships showed it was the correct course. Further inquiry by the Board of Trade was made, and then S.S. *Teddington* struck a rock which was reported 5 miles N.E. of the *Avocet's* rock. The *Griffin*, whose captain sat on the Court of Inquiry at Aden, went out and sounded and dragged a chain cable over both spots, but found no sign of shallow water or rock. On her return a fisherman said he knew the rock, and so *Griffin* returned once more, taking the fisherman with them, only to find the rock was a well-known one 40 miles from the spot. A second Court of Inquiry was now held on the S.S. *Teddington* disaster; she passed 5½ miles E. of Aba Ail. S.S. *Cairo* met and took her crew off, and the captain of S.S. *Teddington* gave his position 1½ miles N. of the position given by *Avocet*. H.M.S. *Sylvia*, in Mediterranean, proceeded to survey. After a week's search, only one place gave 28–30 fathom. Then H.M.S. *Stork* was sent to make further search, and after many weeks of hard work in those hot regions, and when about to leave, the quartermaster went out in a boat to have a last try for good luck, and succeeded in finding a patch

[1] *The Times*, extracts, 1919–1920. [2] J. D. Potter.

of coral 300 yards from the spot where H.M.S. *Sylvia* was at anchor. This small coral rock, with only 15 ft. of water at low tide, is in 14.22.18 long., 42.41.32 lat.—18 miles from Jebel Zukur Island, or 16 miles from land, and its position is now marked on the chart and named the Avocet Rock." [1]

Here is an example of the work which the Navy so silently continues in all parts of the navigable globe.

Volcanic Eruptions Recorded.[2]—S.S. *Wakasa-Maru*, on passage from Hong Kong to Singapore, reported a new volcano eruption in the China Sea, March 2, 1923, some distance from land. This was reported to the Master Attendant, Singapore, who reported to Senior Naval Officer, H.M.S. *Carlisle*. That ship, passing near, saw the eruption and took notes on May 13th. Observation was carried out by H.M. survey ship *Frognois*. Then two new islands had formed, 2 miles apart; one island was 97 ft. high. The eruption was continuing. Admiralty notice to mariners No. 175 of the year 1923 was issued, and on Admiralty Chart No. 1261 these new islands are shown.

"The United States Navy Hydrographic Records show that there are 1,200 points on the globe which can be reached only by the use of British Admiralty charts." [3] These things are instructive, and go to show the importance of hydrographic survey; they are used by the mariners of all nations. Our position to-day is the product of toil amid dangers in the past that we know little about.

China Seas Survey.—"As far back as 1858 our survey ships, then working along the coast of China, were suddenly ordered to proceed to Pie-Tang-ho River and survey the entrance, where there were two forts, one on either bank, and prove if it was navigable.

"Two small gunboats, H.M.S. *Actæn* and H.M.S. *Dove*, stood out to sea 5 miles while boats proceeded across the bar into the river in the face of the two forts, and landed two groups of survey officers, who rapidly recorded the technicalities of sketching, observing, and reading the verniers of the theodolites before the Chinese in the fort, 1,200 yards off, knew what our quest was (war had been declared against China). Two Chinese men were sent to find out the nationality of the strange intruders, and they essayed to do this by scratching on the mud with a stick the outlines of the Russian flag (St. Andrew's Cross), and that of the Stars and Stripes of the United States, and pointing to the Russian and American ships in the offing, though not visible, being below the horizon. We had taken the precaution of not having the English flag hoisted in our boats or in the gunboats.

[1] *Nautical Magazine*, 1887. [2] *The Geographical Journal*, July 1923.
[3] *Daily Express*, July 14, 1921.

"Guns could be seen trained on the party. Meanwhile, the boats went on with the soundings, gradually nearing the forts. Two young officers, midshipmen J. H. Keer and John Ward, were seen to pass between the forts and disappear. The Chinamen were too dazed to do anything. The next day our fleets and transports conveying soldiers from England and France to attack the treacherous Celestials arrived." [1]

Lighthouse.—The lighthouse is both to guide and to warn navigators of danger at night. Dungeness was the first for which a toll was leviable. Before 1676 lighthouses were provided by private persons, subsequently they began to be built by a corporation known as Trinity House.

Lighthouses, lightships, and some 700 British pilots were under the control of the Elder Brethren, of Trinity House, London.

Eddystone and Bell Rock are the two most celebrated British lighthouses.

The Eddystone lighthouse, in the English Channel, was erected to mark a group of rocks lying in the fairway from the Start to the Lizard. The rocks are covered only at the flood. This is in a very lonely position at sea, sometimes difficult to approach in bad weather.

A Trinity House lighthouse official, speaking of the relief of lighthouse-keepers after the two months' continuous stormy weather in November and December 1924, said: "A continuance of gales or a bad ground swell may delay their relief far beyond their proper time. . . . No one knows how the men have fared during the recent gales. The majority of the stations have no means of communication with the shore. Men in the Service consider that the two most exposed lighthouses are the Smalls, 18 miles off the Pembroke coast, and the Wolf off Land's End. Among the hobbies followed by lighthousemen are knitting, crocheting, painting and fretwork." [2]

One is inclined to ask why wireless sets are not provided for men in all such lonely spots. Transmitting sets would soon prove of value in reporting weather conditions and other useful information.

Lightship.—The lightship *Gull*, moored between Ramsgate and the Goodwin Sands, is perhaps one of the best known by name. She is one of more than sixty light-vessels anchored around the English coast. Others are around the Scottish and Irish shores.

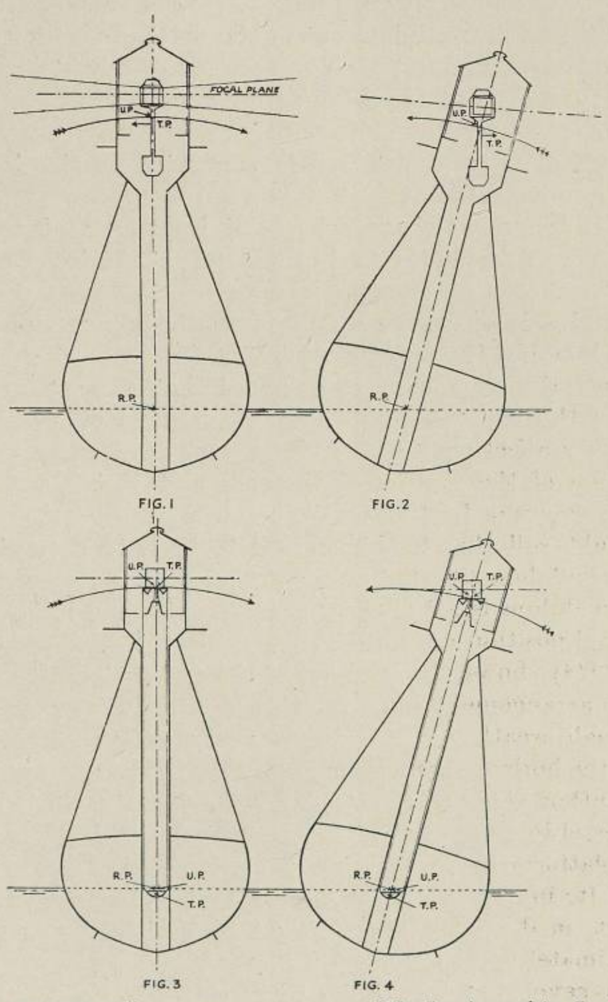
To provide food for the *Gull* lightship six seamen, master, mate, and three lamplighters, and to change the entire company once a month, a relief vessel is kept in Ramsgate; she visits four lightships. Life on board is like banishment, and so the men have only

[1] *On the Coasts of Cathay and Cipango*, by Wm. Blakeney, R.N.

[2] The *Daily Mail*, January 6, 1925.

a month at a time at sea. The same kind of relief is provided for isolated lighthouses.[1]

Lightships have revolving lights like a lighthouse, but they are hung on " gimbals " to keep them erect. There is a Marconi " wire-



By courtesy of] [*The Gas Accumulator Co.*

Fig. 80.—" A.G.A." Constant Level Light.

less " set on board as well as submarine signalling apparatus already described.

Aga Constant Level Pendulum for Light Vessels.—A light-vessel, with its flashing light apparatus located at a considerable height above the sea-level, suffers from the motion of the vessel. In order to obtain a constant level for the light, pendulum arrange-

[1] *Life on a Lightship*, by Arthur A. Cooke.

ments are at present extensively used. Fig. 80 (1) shows a cross-section through the mast of a lightship. The weak point of a pendulum arrangement, according to the old principle, lies in the presence of a turning moment which tends to bring the pendulum out of the vertical position. Fig. 80 (2) shows how the turning moment brings the pendulum out of the vertical position when the ship is rolling. Fig. 80 (3) is a cross-section of a lightship equipped with the Aga Constant Level Pendulum arrangement.

There are three main parts, namely :

The optical apparatus which is supported in the lantern by means of a universal joint.

The pendulum which is suspended by means of a universal joint and placed inside the hull of the ship at the lower end of the steel mast.

The pull-rods or wires, which form the connection between the pendulum and the optical apparatus.

The optical apparatus is so balanced that its centre of gravity coincides with the point from which it is suspended. Consequently, all the forces affecting the pendulum—namely, gravity, centrifugal force, action of the motion of the ship and inertia—will simply result in pressure or friction on the point of suspension.

The light will therefore be forced to keep to a constant level with the pendulum situated at the axis of rolling, down in the hull.

The pendulum is affected by gravity only, and remains at rest in a vertical position when the ship is rolling.

Fig. 80 (4) shows the position of the different parts of the Aga pendulum arrangement when the ship is rolling.

In rough weather the beam is never thrown entirely above or below the horizon, and consequently the light is always visible.

The author saw the Constant Level apparatus to be fitted on a light vessel in Burmese waters.

The platform to be fixed on a steel mast some 30 ft. high is about 12 ft. in diameter, the actual lantern-house in the centre being 6 ft. in diameter. The weight of the stabilizing pendulum is approximately 1,000 lb.

Flash-revolving.—In order to distinguish their various positions, lighthouses and lightships (and some buoys) lights have differences known as "Fixed", "Revolving" (gradually disappearing, it reappears again), "Occulting" (shines steadily for several seconds ; the period of eclipse is *shorter* than the period of light). There are also "Flashing" lights (one at Avonmouth, near Bristol) lasting two seconds and again showing after ten seconds' eclipse, and so on.

In a lighthouse on shore, such as the North Foreland, the point leading to the mouth of the Thames, life is not lonely.

Harbour lights often show a colour-light, but whatever it may be, it is not altered. All marine lights can be identified by their flashes with dark intervals between, and by the frequency and duration of these flashes mariners can identify them, and they are recorded on the charts.

Light Valve.—In Fig. 81 we have an illustration of the *sun* or *light* valve, and an account of it supplied by the Gas Accumulator Co. of Brentford. The *light valve* will automatically perform the duty of extinguishing the lighthouse light at sunrise and of lighting-up at the approach of darkness, independent of the hour.

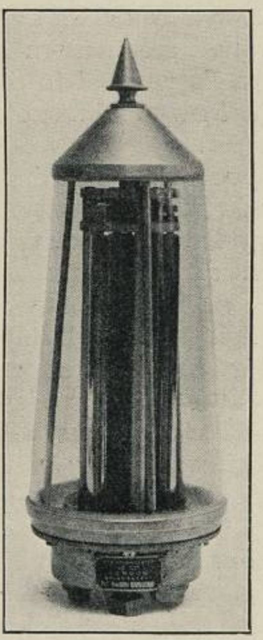


Fig. 81.—Light Valve.

These lights are equipped for a period of one year, but in isolated instances lights have run unattended for eighteen months and more. In one instance, *buoys* have been equipped for an unattended period of two years eleven months.

This light valve is actuated entirely by light, and is not influenced by changes of temperatures due to climate. Its construction is based on the well-known physical law that absorbed light is transformed into heat. It consists of a system of metal rods protected by a strong glass cylinder. The central rod is coated with lamp-black, which gives it the property of absorbing light, while the three rods surrounding it are polished, and thus reflect the light.

All four rods expand or contract in the same degree under the influence of heat or cold, but only the central rod expands under the influence of light. The additional expansion so caused is used to operate a valve which controls the passage of gas in a branch pipe between the mixer and a valve inserted in the main pipe to the burner, and controlling in its turn the gas supply to the latter. With increasing daylight the black rod expands and closes the valve; at the approach of darkness it contracts and the valve opens. The valve operates when the conditions of daylight are such as to render the use of artificial light useful. Generally speaking, the adjustments of the valve are such as to cause it to function a little before sunset and a little after sunrise during average atmospheric conditions.[1] These light valves are used on lighthouses and beacons round the coasts. There is no need to continue the employment of human beings in the lonely and monotonous life of a lightship crew or a lighthouse-keeper.

In 1914 a shipping periodical,[2] referring to the Dalen *light valve*, said: "It is this wonderful equipment which has been adopted for their supplementary lights by the principal maritime nations of the world to an extent and over a period of years which leave no room for doubt as to its entire sufficiency in every respect, whether it be in the form of light-buoy, lightship, beacon or lighthouse. In the latter application, an absolutely unique feature is a valve which puts the light out at daybreak and lights it again at nightfall."

Dalen Invention.—The advantages of Dalen's invention (Gustav Dalen, the Swedish engineer, winner of the Nobel Physics Prize in 1913) were recognized abroad long ago, and the number of Dalen lights in use in all parts of the world (for climatic conditions make no difference to its satisfactory service) is proof positive as to its reliability and efficiency. The Swedish Lighthouse Department in 1907 stated that the Dalen light was so satisfactory that it was "not necessary to undertake further trials".

The *Formby*, *Planet*, and other lightships off Bombay are all Dalen open-type units with light valves.

Aerodrome Lights.—The British aerodromes, Croydon and Lympne, have Dalen incandescent lights with light valve control and also air-route lights at Tatsfield and other places.

Not only are lightships and lighted buoys distinguished one from another by the periods of flash they give, but they are also dissimilar in their requirements. For instance, the *North-West* and *Bar* lightships are fitted with submarine bells, and all four lightships in the Liverpool Bay (viz., *North-West*, *Bar*, *Formby* and *Crosby*)

[1] Revolving lights equipped with Dalen incandescent light apparatus can be arranged for operating automatic mechanism.

[2] *The Syren and Shipping*, January 1914.

are fitted with fog horns. The *Bar* and *Formby* lightships are also fitted with wireless telephony. Several lightships are equipped with submarine signal apparatus. There are 60 lighted buoys at the Mersey entrance, 44 of which are of the Dalen open-type burners.

Mersey Lights.—Vessels approaching the Port of Liverpool first make out the *North-West* lightship and are then guided into the port by the light of the *Bar* lightship, which is at the entrance to the channels, from which point there are lighted buoys on both sides of the channel—red conical buoys on the right, or starboard hand, and black can buoys [1] on the left, or port, hand.

There are also four Bell [2] Boat Beacons to mark turns in the channel, and, in addition, the *Formby* and *Crosby* lightships are placed at important positions.

By these means vessels are guided to the entrance to the river, at which are stationed the Rock and North Wall lighthouses.

The giant ships of the world now call at the southern ports, but by far the largest number of vessels have to find their way into the Mersey.

Liverpool.—The great Mersey port deals approximately with one-third of the overseas trade of the United Kingdom, and has an export trade more than double that of any other port. For these reasons it is interesting to know how ships find their way into Liverpool.

Lightships and lighthouses do not always prevent ships from running on the rocks. Lifeboats go to the rescue.[3] The lifeboats of a ship are smaller, lighter, and less seaworthy than the lifeboats of the Lifeboat Institution. The ship's boats could not live in really bad weather. The large coast lifeboats are manned by seamen round our coasts used to small boats from childhood.

It is the life-saving work of the coast lifeboats we are going to consider in relation to " Safety at Sea ".[4]

Lifeboat Institution.—In 1924, the centenary of the Royal National Lifeboat Institution, messages of good will came from all parts of the world, and among them the Lifeboat Institutions of France, Holland, Norway and other countries. They gratefully acknowledged that the aim of the founders of their first Marine Life-Saving Society was to emulate the example of the organizers of the English National Lifeboat Institution.

The first Marine Life-Saving Society on the Continent of Europe was at Boulogne-sur-Mer. It was founded in 1825, and this was the

[1] A buoy which shows a flat top above water.
[2] Actuated by wave action.
[3] *The Lifeboat*, November 1920.
[4] Ibid., Centenary Number.

outcome of the efforts of two Englishmen, Mr. J. Larkin and the Rev. Symons. The Dominions of Australia, Canada and the rest, including India, took this opportunity of paying tribute to the noble work voluntarily carried on by the lifeboat services in the cause of humanity. The Imperial Japanese Lifeboat Institution wrote: "Your Institution is the parent of all similar organizations now existing in different parts of the world, not only saving lives in extreme danger, which would be lost without assistance, but the very nature of the work is fostering more brotherly and humane feeling among all races of the world."

The Royal National Lifeboat Institution, "The Red Cross of the Sea," has for one hundred years launched their boats in answer to the cries of shipwrecked mariners, whatever their nationality or the flag under which they were serving. This noble work of the saving of life from the sea has gone on. The example of sacrifice by these simple, brave lifeboatmen has been wonderful.

A lifeboat has been stationed at every point on our 5,000 miles of coast where it is required. There are now 47 motor lifeboats in the fleet of 228 lifeboats. The length varies from 34 ft. in the case of the smaller self-righting boats to 46 ft. 6 in. in the case of the Norfolk and Suffolk boats. The number of oars in the pulling and sailing lifeboats varies from 10 to 16. To these have to be added coxswain, 2nd coxswain, and bowman. In the case of motor-boats the crew is smaller. The usual number is 8, this being the total crew. The first lifeboat was built by a boatbuilder named Greathead. She embodied the *self-righting* principle discovered by a house-painter and teacher of singing named William Wouldhave. So Greathead's first lifeboat was named *The Original.*

The principle of self-righting has much to do with the shape of the boat, the ends of the boat sheering up about 30 in. above the gunwale amidship. Both ends are now fitted with air-boxes.

Before the end of 1803 the builder of *The Original* had executed orders for 31 boats. All were oar-propelled and without provision for sails. More than half a century after an improved self-righting lifeboat was adopted. This is practically the type of to-day, and more than half the Institution's fleet are self-righting boats. The men are always consulted as to the type of boat they would like, and they are allowed to elect representatives and send them to inspect the boats.

Self-righting Lifeboat.—First, then, we will see the value of the *self-righting lifeboat.* In December 1921 the coastguard reported a vessel in distress off Saltfleet, Lincolnshire. The *Doona Nook* self-righting lifeboat went out. There was a strong gale blowing and a tremendous sea running. When the vessel in distress was reached, 8 or 9 miles out, she was found to be a Danish motor fishing-boat, the *Koivisto*, with four men on board. Owing to engine trouble she had been drifting about the North Sea for nine days, practically helpless. The vessel herself was waterlogged and her crew were utterly exhausted. They had run short of drinking water, and had been living on fish boiled in sea-water. They were taken on board the lifeboat, but just as she was casting off a tug came in sight. The captain of the fishing-boat thereupon begged that the lifeboat should wait to see if the tug could save his vessel. The coxswain agreed, and a line was once more got from the lifeboat to the fishing-boat. The sea was not only very heavy, but very confused—the coxswain described it as a "haycock" sea—and as the lifeboat hung astern of the fishing-boat a tremendous wave struck her, throwing her completely over. Eleven of the crew and the four rescued men were flung into the sea, but two of the crew remained in the boat clinging to the thwarts. The boat righted itself at once, and the fifteen men, who fortunately had clung to the float-lines, all safely got back into her again. This was the end of a struggle lasting seven hours.[1] What would have happened if the capsized lifeboat had not righted itself ? There would have been disaster.

The first steam lifeboat was designed in 1890. She was propelled not by screws, but by a powerful pump, which drew in water through an opening in the bottom of the boat and discharged it at the sides. She could take in a ton of water in a second, and drive the boat at 9 knots an hour. It was not until the coming of the internal-combustion engine that the Institution found the form of mechanical propulsion which was really suitable to lifeboat work. The self-righting principle was set aside in favour of great buoyancy, stability, and speed. It has been calculated that two motor lifeboats are equal to five pulling and sailing lifeboats. The engine for this service had to be water-tight but not air-tight, and able to run under all conditions of night and storm without attention. It had to have controls not only simple, but easy to distinguish by touch, so that they could be worked in the dark. It had to run and to lubricate itself with certainty at any angle. At the same time, when the capsizing point was reached it had to cut itself off automatically, for if the boat were of the self-righting type, she would right herself and be carried away by her engines, leaving the crew in the water. The engine must interfere neither with the self-righting quality of the boat nor with its sailing powers. By its ability to attain a speed and to cover distances impossible for boats with oars, by its power to force its way in the face of winds and seas, and by its greater manœuvring power when close to the wreck, the motor

[1] *The Story of the Lifeboat*, p. xxv.

lifeboat can save lives which without it would be beyond the reach of human aid.[1]

Here is an illustration of the value of these motor lifeboats. On October 30, 1914, shortly after 4 a.m., the hospital S.S. *Rohilla*, of 7,400 tons burden, carrying 229 souls, was driven ashore at Saltwick Nab, near Whitby, in a storm of terrific violence. Pounded by mountainous waves, she quickly broke in half, and many of those in the after part of the ship were washed away at once and perished. At daybreak, in face of the utmost difficulty, involving the lifting of the boat over a sea-wall 8 ft. in height, the Whitby No. 2 lifeboat was hauled to the scene of the wreck. Although badly damaged, she was at once launched, and succeeded in reaching the *Rohilla*—which lay surrounded by a mass of rocks—12 men and 5 women being saved and brought ashore. The boat was then again launched, and after a fearful struggle got to the vessel and saved 18 more persons, the heavy seas filling the lifeboat time after time.

Unfortunately, the boat was, by this time, unfit for further service. Other lifeboats were therefore summoned. One of them, the Upgang boat, was lowered by means of ropes down the almost precipitous cliffs, but could not at first be launched against the tremendous seas crashing in on the shore, and when she was launched could not reach the wreck, although she tried again and again, until her crew were utterly exhausted. The Scarborough lifeboat and the Whitby No. 1 both put out, towed by steam trawlers, but found it impossible to approach the wreck, while the Teesmouth boat was damaged and forced to put back. In spite of heroic efforts, these four pulling and sailing lifeboats had failed. Nothing but a motor lifeboat could have any chance of saving the *Rohilla's* survivors. The nearest was Tynemouth, the *Henry Vernon*, and she was therefore summoned ; within a quarter-of-an-hour of the receipt of the call she was manned and under way. After a hazardous journey of 44 miles through the wild night storm, with all coast lights extinguished on account of the war, she fetched Whitby in the small hours of the Sunday morning. Four hours later the *Henry Vernon* left harbour for the wreck, taking a supply of oil to subdue the waves. When near the wreck, the oil was discharged and the lifeboat raced at full speed past the stern of the vessel. Guided with splendid skill and courage, she got under the lee of the wreck and remained alongside until, with infinite difficulty, while enormous waves swept over the wreck, all on board, fifty in number, who had survived the ordeal of forty-eight hours, were safely taken off. On her return journey the *Henry Vernon* was struck broadside on by a great wave, which theatened to throw her on her beam ends,

[1] *The Story of the Lifeboat*, p. 10.

but she gallantly withstood the shock and safely made the harbour.[1]

Motor Lifeboat.—*The Barnet* (twin-screw) motor lifeboat is 60 ft. by 15 ft. Fitted with two 75-h.p. motors, giving a speed of 10 knots and a radius of action of 100 miles. She is provided with two cabins to hold between them about 50 people. The total number able to be taken on board is 150. There is a line-throwing gun, searchlight, and life-saving net. Such a vessel will cost about £20,000. In addition to these new expenses, the Institution has recently adapted motor-caterpillar tractors to the work of launching lifeboats from flat and sandy beaches. The larger boats are being provided with a portable searchlight especially made for lifeboat work, and also a line-throwing gun which can throw a line 60 to 80 yards.[2]

The Institution now needs £250,000 a year to maintain the service efficiently—this is a small sum when compared with the cost of a single battleship. Everyone of the lifeboat men round our 5,000 miles of coasts is a volunteer. We are proud of the fact that the Institution receives no financial help whatever from the State, and that every penny of it has to be collected by appeals to the individual generosity of British men and women. Surely we cannot fail to back up those splendid volunteers of "The Red Cross of the Sea".

Coastguards.—In the accounts of shipwrecks, it is impossible to overlook the work done by coastguards. Everyone who has wandered on our coasts has come across that keen-eyed old sailor walking slowly along with his telescope or glasses, which he now and then levels at some distant ship at sea. Always observant, quite civil, but seldom given to conversation, he prefers to talk in monosyllables. On occasions of storm he keeps a fierce watch for signals of distress. He is in communication with lifeboat stations, and keeps them well informed.

It is interesting to know more of this "watch" that is kept on our coasts. Quite lately a good many changes have been made, and with no small saving of expenditure.

The coastguard of former days was intended for the defence of the coasts against sudden attack, to help in manning the Fleet in war, and to prevent smuggling. It was a Naval Reserve under the Admiralty.

The requirements under modern conditions have changed; for in war-time the coastguard would require expansion above a peace-time strength—and so far as manning the Fleet is concerned, this force would not be of much value on modern warships.

Naval Signal Stations, including those stations at which

[1] *The Story of the Lifeboat*, p. 13.
[2] *The Lifeboat*, May 1922.

the Admiralty does duty for Lloyd's [1] and certain Post-War Signal Stations, nineteen in all, are visual signal stations only.

Wireless Stations of the Admiralty are not included in the above. Normally they work only with H.M. ships.

Direction-finding Stations are at Lizard, Flamborough Head, and Goswick. A new station is to be opened at Niton, Isle of Wight (St. Catherine's Point). These are worked by the G.P.O., but in some cases they are manned by the Navy.

Coast Wireless Stations, eleven in number, are administrated and operated by the G.P.O. These stations work with vessels of the Mercantile Marine, and they deal with S.O.S. messages.

" Coast Watching Force " is now " H.M. Coastguard," the King having signified his pleasure in permitting the old title to be retained.

The Board of Trade maintain 290 stations, and the duties of the force are primarily in connection with life-saving, everything else being entirely secondary. Duties are undertaken for various bodies, such as the Admiralty, Ministry of Agriculture and Fisheries, Air Ministry, etc., but not for the Board of Customs and Excise, the Coastguard having nothing to do with the protection of Revenue except in cases of the protection of wrecked property from plunder. The Coastguards are responsible for working the rocket life-saving apparatus, in which they are assisted by some 3,000 volunteers formed into companies. The very closest co-operation is maintained with the Royal National Lifeboat Institution and other bodies connected with the preservation of life from shipwreck. The majority of the stations are now connected to the telephone systems of the country, to which many of the lifeboat coxswains are also connected, but in some isolated parts of the coast, where exchange telephone facilities have not been instituted, the coastal telephone lines instituted in 1886 are still retained. These stations are round Great Britain and Northern Ireland coasts.

The re-organization which has taken place has swept away some waste. The writer can remember when a few years ago a certain payment was made annually to a coastguard under a quaint head of " spiritual oversight ". No one could explain it, doubtless there were many other " oversights ".

Lloyd's Register.—Yes, ships are watched and cared for from the time of their inception, before any plans have been drawn right up to the very last voyage taken. How much business is done in banks, Lloyd's Registry, The British Corporation, Government, Navigation laws, Marine Insurance some men will inquire ? No one has more to do than Lloyd's surveyors. They will see the

[1] Except at the Lizard, where Lloyd's have a station quite independent of the Admiralty.

plans and watch every step in her progress, see her trials through, and grant her letters and figures on the Register and her certificate after final examination, and they will continue to examine her all through her life. Passengers ought to know the great care which so many interests bestow on the ship—all are interested in her long life.

Board of Trade.—The Board of Trade has always been the champion of the passengers' safety, though they had not seen to the required number of boats on the *Titanic*.

Lloyd's Signalling Station.—*Lloyd's*. The name recalls a diversity of undertakings—but what is of constant interest to the voyager is the sight of Lloyd's signal stations perched on a rock in full view of steamer traffic in all parts of the world. This agency is gigantic. It gives news by telegram, cablegram, and wireless. Who does not know that the movements of every ocean-going vessel are reported and registered daily ? From all parts of the world, and at all times, day and night, telegrams arrive at Lloyd's announcing such movements. To-day more than 100,000 telegrams arrive at Lloyd's annually. Some 50,000 vessels are reported from their signal stations annually in the United Kingdom alone. The daily papers give Lloyd's list of shipping and commercial intelligence.

Registration of ships by a society interested in insurance is so much to the good. Everything is tested, even anchors and cables. Vessels are classified. In one year Lloyd's Register has classified 1,300 vessels and 9,000 anchors after testing.

Engine and Boiler Tests.—Engines and boilers of steamers are required to undergo a periodical inspection at intervals of four years. Further, boilers when six years old are surveyed each year, and propeller shafts are drawn in for examination every second year.

Casualties.—There are on an average 572 serious casualties in a year to all the ocean-going British steamers, and out of these only in 46 cases was there loss of life. Take 23 years prior to the war, the serious casualties to British ships fell from 21 per cent. to 11 per cent. per annum.

Though the number of passengers carried is well over 1,100,000 a year, the average number of lives lost through accidents is not 150 a year. If the loss of the *Titanic* and one other large ship that was lost be eliminated from the figures, the annual loss for 23 years just before the war was less than 100, or 1 in 10,000 passengers carried.[1]

[1] *The Blue Peter*, August 1922.

CHAPTER VIII

COMFORT AT SEA

Comparison with fifty years ago—Refrigerating-room—Brine pumps—Aerial, wireless sets—Marconi office—Newspapers, printing shop—Marconi contract, Radiograms—The ocean letter—Broadcast by B.B.C.—Warm-air fans—Ventilation—Electricity by turbine—Shelter deck, elevators, shops—Electric track chart—Spring cleaning—Board of Trade—Kennels—Conservatory—Oil lanterns, annunciator—Storage battery—Clocks, electric light—Telephones—" Relay "—Searchlight—Gymnasium and swimming-bath, library, hospital, suites, elevators, bedsteads, culinary—Electricity in cooking—Steam cooking, kitchen ranges, scullery, confectioner's shop—One class ship—Nursery—S.S. *Berrima*.

In the description of a great modern liner the features next in interest to those relating to the ship's safety (always " safety first ") are such improvements as have been introduced for the comfort and happiness of the traveller. In every new steamer destined for public service innovations of this character are naturally anticipated, as a result of previous experience, and the increasing investigations pursued by the experts in ship construction. Competition, too, takes an active part in this. The evolution of the modern leviathan has been gradual; it has, like most things, been the result of what has gone before. The size of liners has increased most rapidly in the last quarter of a century; improvements in safety, speed, reliability and comfort have come gradually—indeed, the changes one sees each year are only remarkable because they are so continuous.

In order to appreciate the modern liner we must make comparisons between these and the ships of fifty years ago.

Comparison.—It is claimed that S.S. *Moultan* (P. &. O.) in 1860 was the first steamer to have refrigerating machinery; if so she was probably the exception for some time. The writer remembers the discomforts of a voyage through the tropics in a liner seventeen years later. There was no ice-room for meat and vegetables; consequently the deck of the ship resembled a cattle show, except that live turkeys, ducks, geese, pigeons, fowls and rabbits were not in wire cages, but kept in crates made of roughly split beech, piled up one above the other. Sheep and pigs were in pens on the open deck, and a couple of cows were carried specially for the luxury of fresh milk. They were in a glorified box or stall. In a storm all were exposed, and the unfortunate dwellers in crates were drowned.

Refrigerating-rooms.—Our ships are now well stocked with fresh milk, meat, game, poultry, eggs, vegetables, fruit and flowers, all carefully provided with special compartments in the *refrigerating-rooms* or cold store, where in the coldest compartment the temperature is below zero. Large quantities of butter and cream are also kept fresh. In the *Majestic* and other super-ships there are special hatches and powerful electric lifts travelling up to the galleys and pantries on the main deck, and the provisions are kept there in ice cases until the moment of serving.

Refrigerating Engine and Pumps.—There are special duplex refrigerating engines having a refrigerating capacity of 30 tons of ice per 24 hours, and the refrigerant used is carbonic anhydride. Three brine-circulating pumps circulate the brine in connection with the main provision chambers; a second one circulates the brine supply to the cold cupboards, bar-refrigerators, water-cooler, and auxiliary cookers. The third pump is a stand-by. All this machinery, pipes, and the chambers are insulated with granulated cork and are of the latest construction found from experience. The cubic capacity inside insulation of the cold chambers of the *Aquitania* is over 18,000 cub. ft. The temperature of the various rooms varies according to the nature of the provisions—wines, champagne and mineral waters are kept at 41°; meat, game, poultry and fish at 26°; eggs and butter are 32°. Thermometers are kept inside, and are connected so that they can be read from a long distance away outside, for the information of the engineers.

In the tropics you can have ices and iced drinks now, but in the old days of travel there was no such luxury; and often in the intense heat there was small relief only under the short swing of a saloon punka during meals, and nowhere else. The liners of to-day have powerful electric-driven fans wherever they are wanted. In cabins and state-rooms there are also portable electric fans. When in cold latitudes ships are ventilated and the fresh air warmed. Radiators, steam and electric, are provided everywhere, while coal fires are found in cosy smoking-rooms and library. After all is said, the greatest boon to a seasick passenger is a steady ship. The difference in the size of the liners of to-day compares very favourably with the vessel of fifty years ago. In January 1924 the *Aquitania*, bound for New York, encountered the worst gale experienced for many years, but she was steady enough all the time for dancing to take place in spite of waves 60 ft. high battering her.[1]

Aerials.—The wireless or Marconi officer's-room is perched on the boat deck. The *aerials* (Fig. 72, Chap. VII) of the *Olympic*, which continuously sing or whine from uncomfortable heights above the funnels, are held by the masts. From them come dangling down to the Marconi-room two wires connected up to the set which performs the wonders of "mimicry", shall we call it ? Not only does it repeat accurately in detail and tone, but it does so with a speed which for practical purposes is instantaneous, just as a looking-glass can reflect at short distances all objects in its line of light.[2] But ships use Morse ; it is more accurate.

Wireless Set.—The Marconi Company has kindly provided us with a view of the wireless instruments on the S.S. *Empress of Scotland* and this description. On the extreme left is the continuous-wave 1½-kw. valve transmitter with two rectifying and one oscillating valve. The range is approximately 1,800 miles, and the wave-length can be varied for any adjustment between 2,000 and 2,800 metres. On the right of the table is the 1½-kw. quenched spark transmitter with a range of 800 miles. A wave-changing switch on the face of the panel allows simultaneous changing of primary and secondary circuits to 300, 450, 600 or 800 metres. The spark-gap is shown mounted on the base in front of the panel. The switchboard, part of which is shown in the photograph, carries all the lamps, switches, and fuses necessary for charging and discharging accumulators and for supplying power to the main and emergency sets.

The two black fixtures over the gyro-compass are known as junction-boxes. The special cable from the direction-finding aerials is brought to these boxes and the soldered connection made to the wires leading to the instruments. The boxes are then filled with insulating compound, which prevents moisture from obtaining access to the contacts and from getting inside the lead covering of the special cable, so that no alteration of capacity is caused thereby. The wires to the instruments are then crossed as shown to neutralize any capacity effect between them. The requirements of the giant ships are, of course, on a larger scale.

The *Majestic* uses a wave-length of 2,100 c.w., and can communicate with Devizes even when 6,000 miles away ; she has a 1½-kw. valve on her big set, 1½ kw. on the spark set, and 1 kw. on her emergency set—probably the last word in marine wireless apparatus.

Close-down Periods.—Into this quiet room of mysteries

[1] *Daily Mail*, 1924.

[2] Some day we may make wireless reflect objects as well as sound.

come distress calls or some great business transactions with an office, it may be, 1,000 miles away. In some waterways considerable jamming is experienced—it seems as if all the ships for hundreds of miles round were sending messages at once on the same wave-length! To enable S.O.S. messages to be picked up, operators have to close down for three-minute periods, at the quarter and the three-quarters. The world's news comes in at night, and this is in due course handed on to the printing-office; or sometimes messages are to be passed on elsewhere, relayed messages, or an ocean letter handed in for dispatch by wireless to a friend on shore. Whatever messages come or go, all have to be recorded most carefully by the Marconi officer. Ships talk of cargo and the weather all day long.

Press News. Newspaper.—The wireless stations used to broadcast Press news to North Atlantic ships—British: Rugby and Leafield; American: Marion, Mass and East Moriches; Canada: Lewisburg, N.S.; French: Eiffel Tower; and German: Nauen. The vast majority are without a printing-press, but all the large liners enjoy a newspaper, and some print several editions a day. The Atlantic *Daily Mail* was inaugurated in the Cunard liner *Berengaria*, which left Southampton for New York on February 10, 1923, fully equipped.[1]

Printing Office.—Fig. 82 shows a corner of the printing shop with one of the newly installed linotype machines on board. Up to July 1924 ten Cunarders and the first four big Anchor liners were supplying passengers with the *Daily Mail*, Atlantic edition. Order forms are placed in the cabins to enable passengers to obtain the *Daily Mail* throughout the passage, or they can buy the newspaper on the way to their breakfast-table. Contents bills, as seen in railway-station bookstalls, will also be displayed in the larger ships in mid-Atlantic.

This takes the place of the *Cunard Daily Bulletin*, which was well known before the war. Almost all long-distance passenger ships now carry a printing-press.

"The Magnificent Trio" of the White Star also publish a newspaper which is printed on board. S.S. *Paris* (France) publishes *Journal de l'Atlantique*, and S.S. *Belgenland* also print its own newspaper on board.

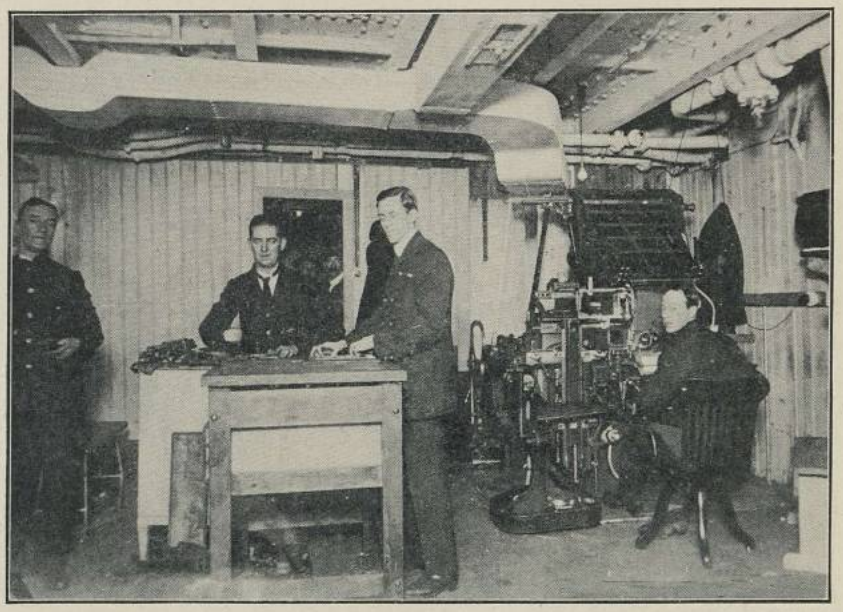
The Marconi Contract.—The vast majority of ships are equipped with apparatus operated and maintained by the Marconi International Marine Communication Company, Ltd., who install the gear and provide the trained operators to work it, the operator

[1] The *Daily Mail*, Atlantic edition, is printed on board the following steamers of the Cunard Line: *Berengaria, Aquitania, Mauretania, Carmania, Franconia, Samaria, Laconia, Scythia, Carona, Corinthia* and *Lancastria*.

while on articles being the servant of the shipowners. The company undertakes all clerical and accounting work in connection with the wireless traffic.

Passengers at sea or friends ashore wishing to send a wireless message need not trouble about how the message is sent. There is a "Central Routing Bureau" in London whence messages are dispatched in accordance with the position of the vessel to which they are addressed.

Radiograms.—*Radio telegrams* [1] to ships at sea are accepted at any postal telegraph office. Every message must be prepaid.



By courtesy of] [*London "Daily Mail."*

FIG. 82.—ATLANTIC "DAILY MAIL" PRESS on "BERENGARIA". (P. 151.)

Wireless messages can also be flashed from mid-ocean to the uttermost parts of the world. All communications must be prepaid.

Radio telegrams from ships at sea have precedence over other classes of messages; they are accepted at any hour.

Poste radio telegrams are special rate messages—by wireless to the most suitable vessel for forwarding by post from a chosen port of call. It catches the mail ship on the high seas.

The Ocean Letter.—Say your vessel is 200 miles from land when you file an *ocean letter*; it is sent by wireless to another ship, passing in the opposite direction, for mailing by registered post on arrival of the connecting ship at the first port of call. Charge

[1] *Wireless Guide for Passengers.*

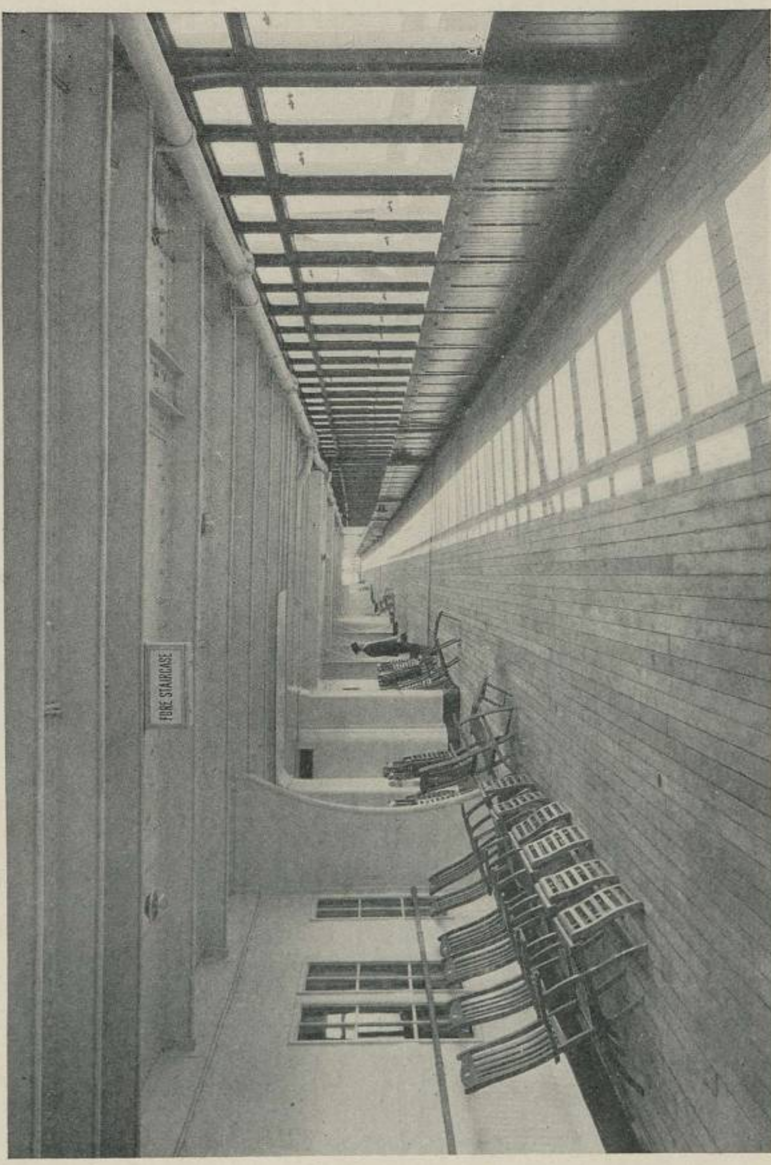


Fig. 83.—Shelter Deck, "Berengaria". (P. 156.)

is 5s. for a message of 20 words up to a limit of 100 words. *Ocean letters* must bear full address.

Broadcast by B.B.C.—When we listen-in and hear 2LO and 5XX calling the British Isles it must be remembered that the call reaches many hundreds of miles beyond our coasts ; not only can all ships within range get our programme, but also all neighbouring countries, or even distant lands like India, provided they have wireless receiving sets sufficiently powerful ; they can enjoy our concerts and news without making any contribution. They do not take out a licence, and they do not necessarily purchase their wireless sets from the B.B.C. (a part of the profits is obtained by a surcharge on wireless parts or sets).[1]

Here is what a wireless expert sailing along the North Sea says : " 5XX being more powerful than 2LO is generally used when listening-in to B.B.C. programmes on board. At lunch-time Radio Paris was picked up ; their midday concert came through well. In the evening Newcastle had become the ' big noise ', and its strains entertained the passengers until closing-down time came." [2]

Ship Broadcast.—Some ship stations have broadcast their own concerts. The *Leviathan's* concert was heard in England from Dorset to Chester when she was 700 miles west of Cherbourg on wave-lengths varying from 320 to 350 metres. This is believed to be the first full concert broadcast from a ship.[3]

We have seen how the ship is kept warm in cold climates and cool when in the tropics. In this process it comes about that there is a great ventilating system by means of fans and enormous air-shafts up and down the ship.

In the *Olympic*, for instance, there are twelve " Sirocco " fans, fitted with powerful electric motors (Fig. 54.).

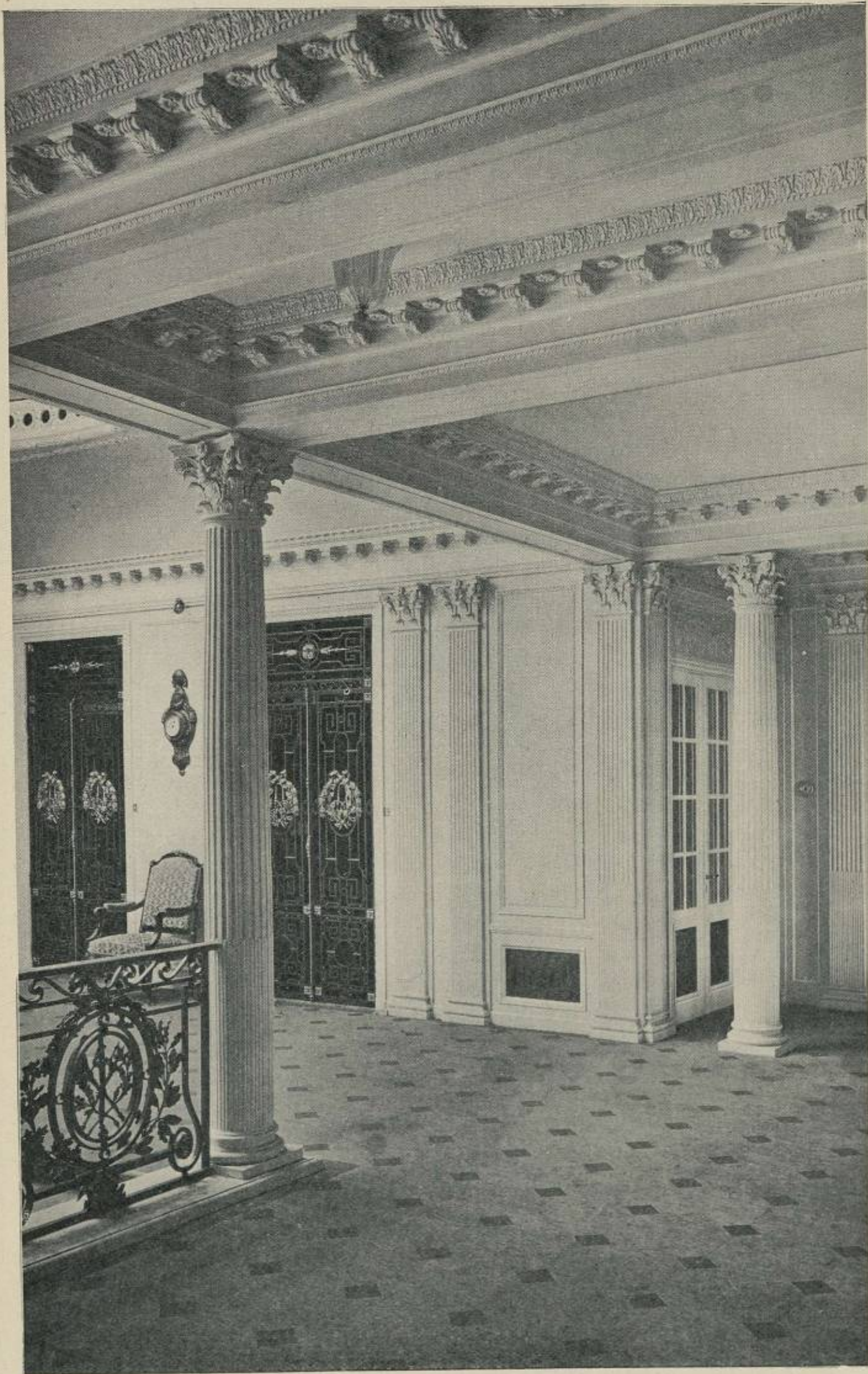
The fans are placed on the middle deck level and draw in air through ventilating shafts from the boat deck through trunks led down to the furnaces. Eight of them are 55 in. in diameter and two are 50 in. and two 40 in. Heating with warmed air is by

[1] B.B.C. letter, November 18, 1924.

[2] *Amateur Wireless*, September 20, 1924.

[3] The Marconi Marine V-4 broadcast receiver has been fitted on steamships and steam yachts.

The wireless operator on the yacht *Naz-Perwer* reports that whilst at Rotterdam, Holland, London was easily readable in daylight. At night he found both Bournemouth and Newcastle much stronger than 2LO. Up to a distance of 200 miles north of Bergen, in Norwegian fjords, Chelmsford came in continuously in daylight. It was in August, when it never gets dark in those latitudes, so other stations could not be heard, but the Savoy bands broadcast by 5XX at 10.45 at night were received in Fromao, a place which is well inside the fjords and absolutely land-locked. These are interesting items.



By courtesy of] [*Cunard Co.*

FIG. 84.—MAIN ENTRANCE, "AQUITANIA".

means of electrically-driven fans, the air being driven in all directions through insulated trunks. In addition to the hot and warm air delivery fans, there are a large number of suction fans for taking foul air from the lavatories, galleys, pantries, and other quarters, so that not only is fresh air brought into the ship from the top deck, but all vitiated air is removed. There are no less than sixty-four fans, of large type, and all are provided with both hand- and automatic-control for the variation of speed required. There is no need for the numerous cowls which formerly encumbered the decks of liners ; and besides, it must be remembered that these are only of service while the ship is moving.

Shelter Deck.—On the shelter deck no boats are seen. The deck above is the boat deck, and on the deck below there are boats in bays—so-called—with a unique arrangement, which has, so far, only been applied to three vessels of exceptionally large tonnage. Shelter decks or covered promenade decks are to protect passengers from wind, rain and dirty weather. Patent self-balancing frameless deck lights have been fitted on all the largest vessels, as in the illustration of the *Berengaria* (Fig. 83), $\frac{1}{2}$-in. plate-glass running in brass channel bar. A window lift working on lazy tongs in conjunction with two twin powerful springs adjusted so as to balance 100 lb. weight of glass window in any desired position, and can be locked in that position.[1]

Elevators.—For the convenience of passengers, there are electric elevators running down five decks from the boat deck downward (Fig. 84). There are also lifts for baggage on nearly all large liners. Fig. 85 shows one of the large double water-tight gangway doors through the shell-plating of the ship.[2]

Shops.—A ship which has a town population has certain shops. The most recently installed are confectioners' and florist shops. The butcher, baker, and barbers' shops are found on all liners. There has always been a printer of menus and notices for the everlasting procession of meals. The barber of a liner is not merely a hairdresser : he has a general store. He can provide string, sweets, photographs, books or a fancy dress. There are banks and agency offices on all large liners. For instance, the Farmers' Loan and Trust Company Banking Office of New York, London and Paris is on the *Leviathan.*

For those interested in the run the ship performs daily, or the speed at any moment, the direction by compass and so on, there

[1] Messrs. W. S. Laycock, Ltd., Victoria Works, Sheffield.

[2] The illustration of the gangway entrance to the main deck of the *Berengaria* is from a photograph taken by the author on the day she made her first visit to England in 1913.

are dials and repeater instruments usually in places where passengers can see them.

Electric Track Chart.—On the *Belgenland* there is an *Electric Track Chart* hung up like a map in a glazed frame. A miniature ship moves along the sea track across the Atlantic, showing each day exactly how far the ship has gone. On this chart both America and the West of Europe are shown. There is a track chart on the *Majestic* which is set by hand daily.

Oil Lanterns.—If we could step on board a passenger ship of fifty years ago—say after dark—several strange sights would give us food for thought. On deck you would see great dark sails

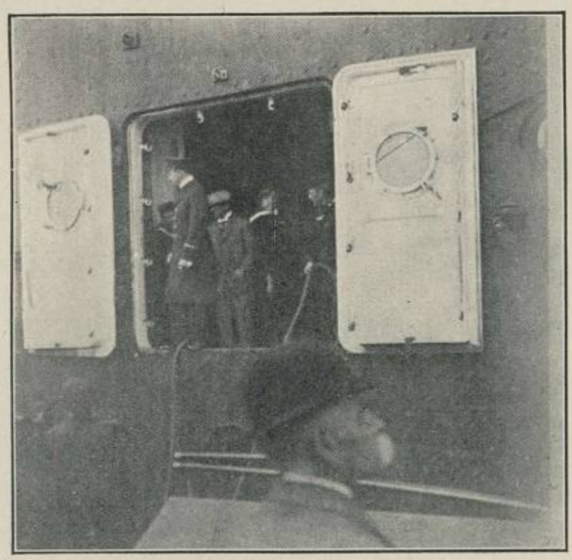


FIG. 85.—DOUBLE WATER-TIGHT GANGWAY DOORS, "BERENGARIA"

—in the darkness greatly exaggerated in size. Steamers sometimes used sails when the wind was favourable. The deck, being illuminated with a few dismal-looking *oil lanterns*, was the only light vouchsafed. The passage-ways, saloons and cabins used oil lamps swinging in gimbals. These, too, gave trouble and very little light; similarly, such navigating instruments as the compass, chronometer and barometer were illuminated by oil lights. There was no electric bell.

Annunciator.—To-day there is the more modern *annunciator system* in which the push-buttons for steward and stewardess service operate a lamp signal in the passage-way, indicating the room number and class of service desired. This signal is visible from a great distance, and remains set until the attendant reaches the door of the room from which the call was sent. At this point the attendant operates the reset button which releases the signal and restores the system to its original condition. A checking annunciator in the chief steward's office indicates the rapidity with which the calls are being answered. In this system there are as many as 1,700 (electric) lamps and 4,500 push-buttons ; separate systems are installed for the smoking-room, swimming-pool, dressing-rooms and bridge-deck officers' quarters. On the good old ship you had to shout for the steward. If he was unpopular amongst the clan someone would be sure to draw his attention to the call.

Clocks.—In place of the few ordinary eight-day clocks of former days, hung up in the public rooms, and all requiring alteration almost daily according to the difference in time due to the ship's position at sea, electric clocks are now provided in the public rooms, in many first-class state-rooms and suites, as well as in other parts of the modern vessel. These clocks are controlled from a master clock which is installed in duplicate on the bridge deck. They are electric-controlled clocks and are capable of being set backwards or forward, as required, when the vessel proceeds either eastward or westward.

Let us see how the lighting of a vessel of the size of the *Leviathan* is done.

Electric Light.—For controlling the electric current in the multitude of circuits 9,000 switches of various types and sizes are used, the largest being capable of handling 6,000 ampères. In order to light some 4,000 rooms of the vessel, nearly 15,000 lamps are required. In the social hall, the winter garden, swimming-pool, restaurant and dining-saloon the lights are artistic, and for the most part lamps are concealed in cornices or behind the great glass skylights as in the social hall.

Stage.—At one end of this hall is located a small stage, where the footlights and overhead lights have been arranged so that any degree of illumination and almost any colour effects required on a stage can be obtained. Owing to the unequal competition brought about by the United States Prohibition Laws, the U.S. Shipping Boards have, it is stated, arranged to stage, nightly, lavish entertainments on board the liner *Leviathan*, a " dry " ship, in order to attract passengers. The services of the manager of the Hippodrome, New York, were engaged. Similar entertainments are installed on board one of the Sud-Atlantique liners plying between France and South America.[1] The centre dome of the dining saloon, some 30 ft. above the tables which are dotted about—seating two, four, or six persons at each—presents one uniform glowing surface, the light apparently coming from nowhere.

[1] The *Daily Mail*, April 3, 1923.

There is an excellent photograph of a saloon illuminated (Fig. 98, Chap. IX). The lighting in the other *giants* is almost the same. It is important that the lighting of the ship should never fail.

Storage Battery.—A storage battery which would run all lights for three hours is installed, and in addition engines operated by oil are on the boat deck for emergency, as already stated. These emergency engines are run for awhile every day to insure their condition.

Telephones.—In Chapter V loud-speaking telephones and also the ship's ordinary service telephone system were mentioned. All liners now possess telephones. In the *Leviathan*, for instance, there are over 600 telephones connected to the switchboard, which requires the services of two operators and is the same as installed in small towns.

"Relay."—In this connection it is interesting to hear of the telephone systems of liners provided with the "Relay"—the first automatic telephone to go to sea, where it has proved as thoroughly efficient afloat as ashore. It is an automatic exchange which effects connections between any parts of the vessel in less than four seconds, and is as alert at midnight as at midday. There are no operators to be paid and no operators' accommodation to be provided.

The S.S. *Conte Rosso*, built on the Clyde, is installed with automatic 'phones fitted in such places as the navigating offices, captain's-room, chief engineer's-room, pantries, Marconi officer's-room and numerous other places. The owners of this vessel are fitting a similar system in the *Conte Verde*, a new ship.

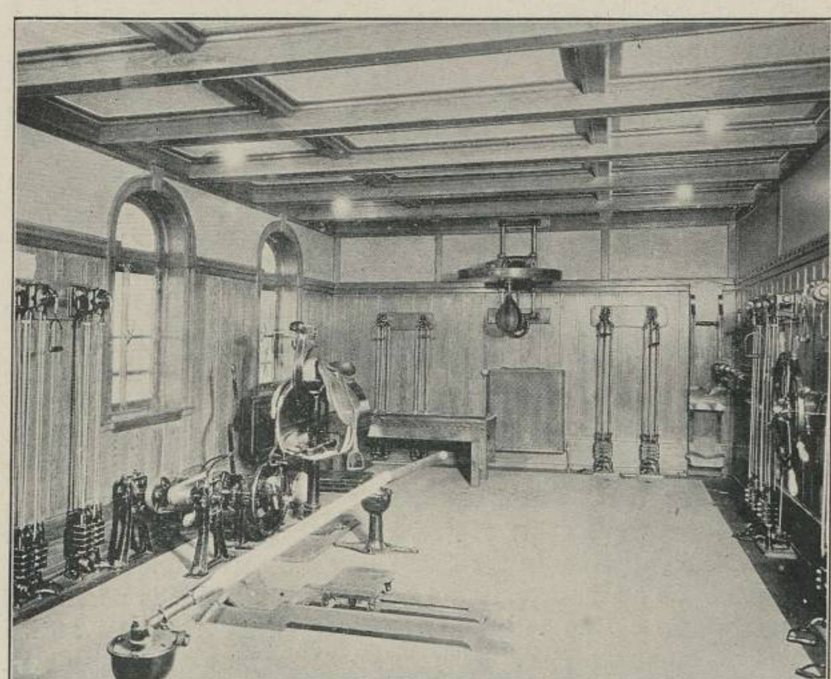
There is no mechanism to get out of order, and it is unaffected by movements of the vessel and is immune from defects arising from climatic fluctuations. There is no waiting, no wrong numbers. Transmission is clear and *secret*, and a conference can be held with a number of persons whilst they remain at their desks, just as if they were all in the same room. This is another Marconi triumph!

Gymnasium (Fig. 86) **and Swimming-bath.**—Amusements of the usual kind can be found on deck—games of deck-quoits, sets for shuffle-board and others. There is a gymnasium, with such forms of exercise as rowing and riding and cycling, mechanically aided. The swimming-bath, with its fresh tepid sea-water, is a most popular resort (Fig. 100).

Library and Hospital.—There is also an excellent library and reading-room. Big liners also carry two or three doctors, assisted by trained nurses, masseur, masseuses and attendants for medical baths. There is quite a large hospital with over sixty beds, and in case of need an operating theatre.

Suites.—There are flat suites opening into each other so that large families can be provided with private accommodation, and separate dining-rooms, sitting-rooms, and bathrooms, and even private deck accommodation. Hot and cold water is laid on in each bedroom. Fig. 87 gives a view of the lobby and stairway on the *Leviathan*.

Bedsteads.—Formerly berths were placed one above the other; these have been entirely eliminated in the first-class, bed-



By courtesy of] [*United States Lines.*

FIG. 86.—GYMNASIUM, "LEVIATHAN". (P. 159.) 100.000 PK 1914. 23 km norm (27 max)

steads being used in their place (Fig. 88). Here is a bedroom for a private suite of the *Leviathan*.

Culinary.—The culinary department of the *Aquitania* might be taken as an up-to-date example of the requirements of a big liner. The entire kitchen, bakery and pantry outfits on all the English-built ships of importance have been carried out by the engineers and coppersmith specialists, Cornhill Works, Liverpool. The kitchen is the most important section making for the passengers' comfort, and the success of the *chef's* work depends on ample and efficient cooking plant.

Electricity in Cooking.—Electricity and steam are largely used in the kitchen, and it is said that the time is not far distant when electricity may be the chief source of cooking energy on board ship. At present it is, of course, in regular use for motive

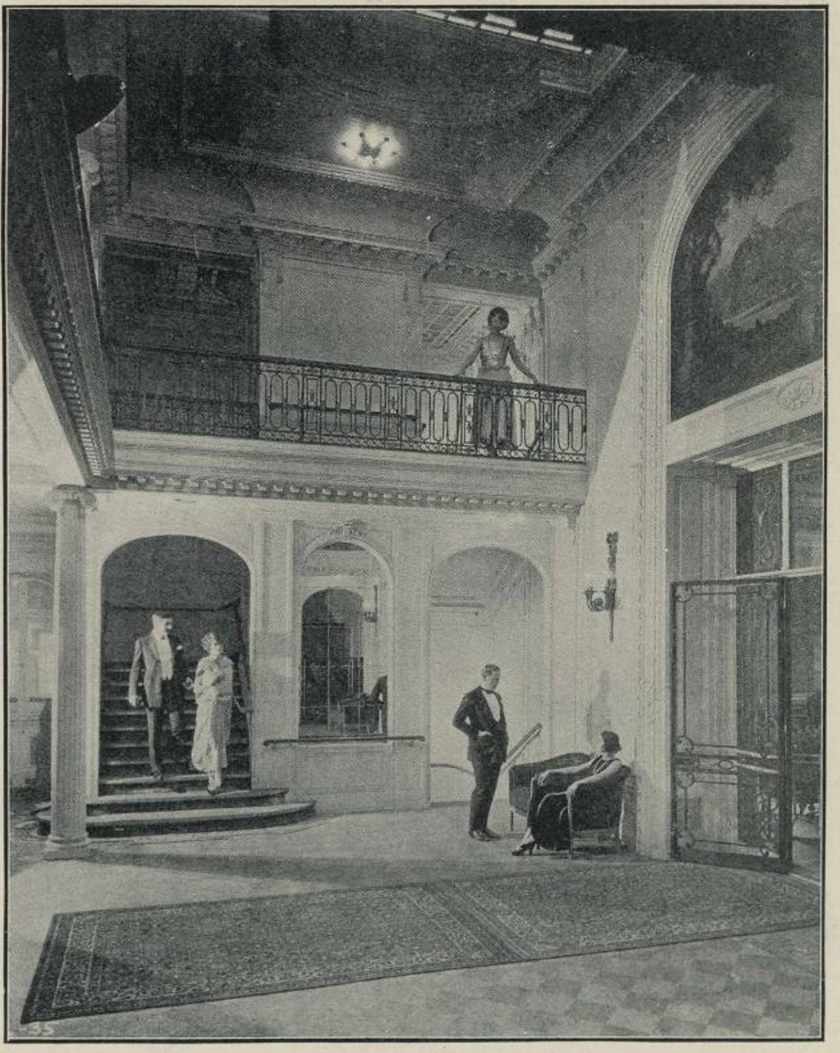


Fig. 87.—The Lobby and Stairway, "Leviathan".

power, potato-peelers, dish-washers, choppers, slicers and dough-mixer, being examples of this use. It is also used as a heating agent in grills, toasters, bakers' ovens, griddle plates, etc.

Steam Cooking.—Steam is used for the stockpots ; there are a pair of large tilting steam-jacketted pans, and have each a capacity of some 60 gallons. There are four other boilers, which are of similar construction, but do not tilt, and four smaller boilers fitted for the purpose of cooking vegetables. These latter have a capacity of 40 gallons each. Steam is used for hot presses, *bain-maries*, etc., hot shelves, egg-boilers, coffee apparatus, and so forth.[1]

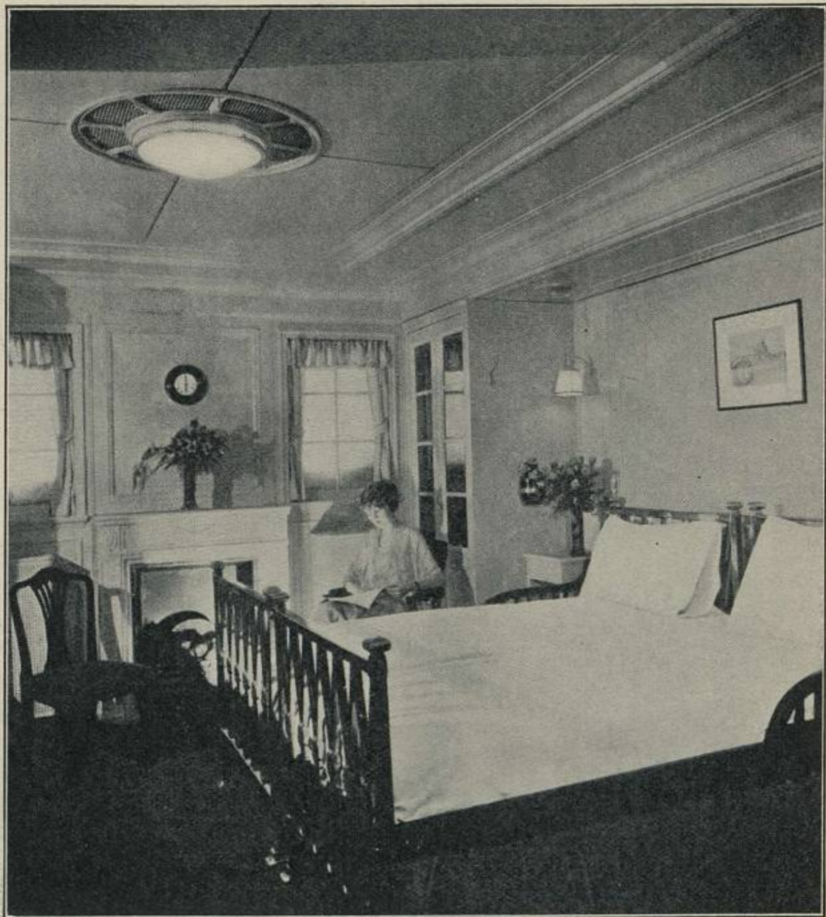


FIG. 88.—BEDROOM WITH A FIREPLACE, "LEVIATHAN'S" PRIVATE SUITES.

Kitchen Ranges.—The kitchen ranges are equipped with down-draught flues. This leaves the range-top clear, and obviates unnecessary heating of the kitchen atmosphere (Fig. 89). The illustration shows a corner of the kitchen of the *Leviathan*.

Sculleries.—Attached to the kitchen proper are the sculleries,

[1] *Shipbuilder*, *Aquitania* souvenir.

vegetable-preparing room, butcher's shop, and like appendages. The electric potato-peeler can deal with over 40 lb. of potatoes per minute. The pantry is full of time-saving machines.

Confectioner's Shop.—The confectioner's shop is provided with ice-cream machines, rotary cake-mixers, electric griddle plates, range, and similar apparatus.

Ocean travel eastward as well as westward has been much improved of late. Some companies have built "one-class" liners. These vessels offer better accommodation for cabin passengers, and as there are no first-class passengers carried, the entire steamer

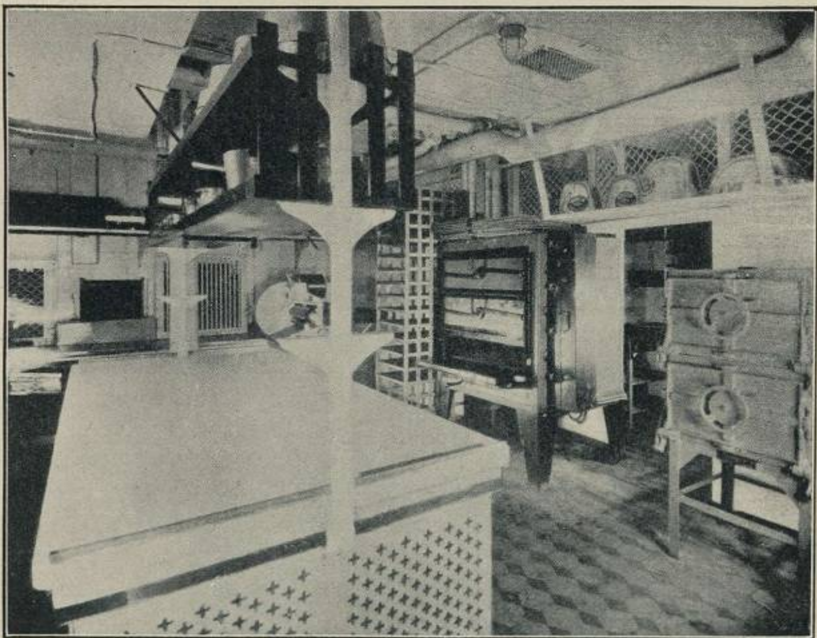


FIG. 89.—A CORNER OF THE KITCHEN, "LEVIATHAN".

is at their disposal. Moreover, they will have a chance of enjoying cabins in the best positions in the ship. The public rooms may not be so luxurious as in the first-class, but they are more homely.

One-Class Ships.—There are nine one-class liners of the P. & O. Branch Service, London to Australia via the Cape. They are all twin-screw steamers. The journey from London to Australia occupies slightly longer than via Suez Canal; the route affords an equable temperature and freedom from the heat of the Red Sea.

As the course is almost directly north and south, the steamers are in the tropics a few days only. This is of importance when children are travelling.

"Cabin" Class.—The Cunard steamships run a cabin and third-class line between Liverpool, Belfast and Canada. In this case it is a "cabin class" and the rate of passage money is equivalent to second-class fares. "In the Cunard liner *Albania* all class distinctions have been abolished, only cabin passengers being carried, thus creating a democratic type of vessel."[1] Undoubtedly these changes have met the popular spirit of our time—cheaper ocean travel and no invidious distinction. Three vessels are engaged in the Canadian service to Montreal and Quebec from London, Southampton and Cherbourg, and in the winter to New York after calling at Halifax, N.S. Other routes are Southampton and New York, Quebec and Montreal in summer, Halifax in winter.

These ships burn oil fuel and are driven by turbines of the latest double-reduction geared type.

The Nursery.—Passengers travelling with children will appreciate the cheerful nursery; a continuous frieze illustrates the principal incidents from popular nursery rhymes, and the windows are glazed in old-fashioned "bull's-eye" panes so fascinating to children. Miniature furniture, toys and playthings of every description are provided.

Log of "Berrima."—Some idea of the popularity of these one-class steamers may be gathered from a few scraps taken from a copy of *The Log of the S.S. "Berrima"*, kindly supplied by the P. & O. Company. It is just a pamphlet of three dozen pages written on the voyage of this ship, April 19th to June 19th, 1922, Sydney to London—and, mark you, "unofficial"—"being a souvenir of the voyage", written and illustrated rather after the style of "Spy" in *Vanity Fair*, doubtless by some of the passengers. In "Table Talk" we find this: "We have read so many 'Don'ts' on the S.S. *Berrima* that we are put in mind of the Melbourne cable tram. We would suggest some 'Do's':

"(1) Do empty the whole of the contents of the vegetable-dish on to your own plate. It saves the stewards trouble.

"(2) Do carry along five buns in each hand from the afternoon tea-table. It makes you very popular.

"(4) Do move the bandage round your eyes when sports are in progress. It is positively expected of you.

"(5) Do say 'I protest', whatever the umpire's decision. It tends to promote peace and concord.

"(7) Do place your deck-chair between those of the newly-wed. They love it."

Other headings in this brochure are "Ruminations", "Wails from the Cabin", "A New Game" (registered) runs like this: "Farinaceous Food Hustle":

[1] *The Times.*

Rules.—1. Game to be played by any number of adults and children—the more the merrier.

2. Hours for play—2 p.m. to 3.10 p.m. every day of voyage.

3. Competitors will assemble in the port alley-way, on the main deck, and at the head of the saloon stairway.

4. On assembling, competitors to make as much noise as possible with a view to waking up the afternoon sleepers. First competitor sworn at scores three points. Any competitor hit by the awakened ten points.

5. On the bell ringing at three punctually, the competitors will stampede into the dining-saloon and grab the buns. The winner to be the one who grabs most buns and prevents the corresponding number of competitors getting any at all.

6. One point additional will be awarded for every bun successfully concealed. Low-necked blouses *not* allowed.

7. This game is deservedly popular, more especially amongst afternoon sleepers. Any competitor receiving injuries will be treated by the ship's chiropodist.

This is characteristic of the fun in a ship full of the spirit of friendship in a one-class ship.

CHAPTER IX

SPECIAL FEATURES

Gross tonnage and net tonnage—Dues—Displacement—Freeboard sheer—Table—Funnel feature—"Sea dogs"—Wireless—Lifeboat on lower deck—Workshop—Tudor room—Ballroom—Lounge—Offices—Flats—Berths—Roman bath—Fire-screen—Racket court—Telephone system—Altar—Tennis court—Lost day—Motor-ship *Aorangi*—Wireless telephone to shore—Laundry—"Sal" log, Forbes' ship log—Doctors and hospital—*Asturias*—Dead-beat compass.

Is the largest ship to be judged by her gross tonnage ? For business purposes—yes. It is doubtful whether the ordinary landsman ever thinks of a ship's cubic capacity.

For many years past we have heard of ships being built the dimensions of which are kept secret from the public. One day she is advertised to be launched, and there is a great deal of rejoicing and self-satisfaction on the part of the builders when they are able to say that the new vessel is "the largest ship in the world". This fact is largely advertised, and rightly so. In course of time another ship takes the water under similar conditions, and she is then claimed by her owners to be the largest vessel.

When speaking of the largest ship, the man in the street would think of the size of a vessel, by eye standards, but most people will agree that the size of these great ships is not so impressive ; the eye requires in reality a great contrast with another vessel floating alongside. It is the registered gross tonnage of a ship that settles the question.

Gross Tonnage.—In the *Manual of Seamanship* it is written : "The gross tonnage under British rules represents the total inside capacity of the ship with all deck-houses or erections which are permanently closed in. The water-ballast tanks and double-bottom compartments are not included." Each "ton" is taken as 100 cub. ft. of space. Even gross tonnage is not calculated in the same way in all countries, for we have different rules for measurement in the Suez Canal and elsewhere.

If we take the length of a vessel over-all as a guide, there will only be one measurement, no deductions and no rules, and on this standard of comparison we know that the *Majestic* is the longest ship afloat. No subsequent alterations in a vessel of less length can alter it. In the table below, a comparison of dimensions of the nine largest vessels is given, and they are placed in order according to their length. The vessels now being launched mark no increase in size. Those of pre-war days, ending with the launch of the *Majestic* (*Bismarck*), are not likely to be surpassed in size or speed for some time to come. This is the opinion of both builders and owners.

The new German liner *Albert Ballin* (22,000 tons, 1924), of the Hamburg-America Line, is in all essential features similar to the United American liners *Resolute* and *Reliance*, and she bears out the above statement.

The unsettled state of the world's trade due to the war cannot last indefinitely; better times will come, when better efforts will be made in two directions, (1) speed, (2) size. The 30-knot passenger ship between Europe and America will surely come. The present period of halt in size of vessels on the Atlantic may give the development of internal-combustion engines a better chance in the future. We may see this class of engine large enough to deal with the requirements of giant ships. Who knows ? There are some who even dream of one day seeing wireless power available for ship-propulsion. Why not ? We once enjoyed the stories of the French romancer, Jules Verne, but now everyday progress reads like romance.

Net Tonnage is reckoned by deducting from the gross tonnage the space occupied by engines and boilers, coal, water-ballast, the accommodation for the officers and crew, and other spaces entirely necessitated by the working of the ship and of no use for stowing cargo.

Dues.—Dues are paid on the net tonnage.[1]

The Turret Ship.—The turret ship provides a high deck without unduly increasing the tonnage.[2] The narrow deck is called the " harbour deck ".

Displacement tonnage is the weight of the water displaced by the ship when loaded. In all naval vessels this includes all guns, armour, etc. The displacement of an oil-tanker is sometimes greater than that of a *Dreadnought*. When we say a vessel like the *Majestic* is 64,000 tons displacement, we mean that her weight, including everything on board, is equal to that amount.

The distance from the water-line to the gunwale is usually larger on a passenger cargo boat than on a cargo tramp.

[1] *Steamship*, by Fletcher.

[2] *The Design and Construction of Ships*, 1908, by Professor F. Havard Biles.

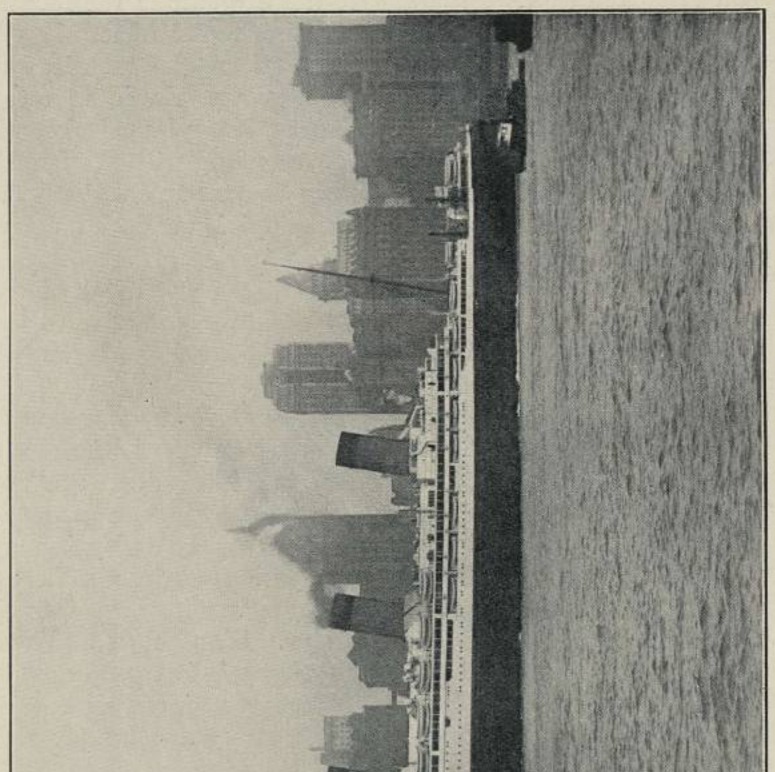


FIG. 90.—"MAJESTIC" IN NEW YORK.

Freeboard. Sheer.—Freeboard is defined to be the height of the side of a ship above the water-line at the middle of her length, measured from the top of the deck at the side, or in cases where a waterway is fitted, from the curve line of the top of the deck continued through to the side. The limit to which vessels can load is fixed by regulations incorporated in the Load Line Act of 1885. Increased freeboard is called sheer.

In considering the construction of these super-ships, we can see that the requirements of Atlantic liners are much the same in build. While they all have turbines, some are "all" turbines, while others have a combination. They all use a system of tele-

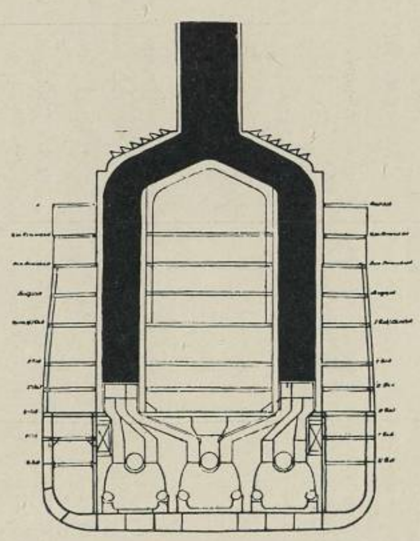


FIG. 91.—GRID-SMOKE UPTAKE ON "LEVIATHAN" AND "MAJESTIC".

graph communication between the bridge and the engine-rooms, but these are of different types and patents. Again, in davits for lifeboats, more than one design is found even in the same ship.

Now the "special features" claimed for each ship will be brought to notice. In Table I the super-ships are found in order of their length. It is proposed to take them in this order—the longest vessel first.

Funnel Feature (Fig. 90).—The *Majestic* has three funnels, and the special feature is the arrangement for her funnels, which do not pass directly through the centre of the decks. Each of her two great amidship funnels divides at a point beneath the lowest passenger deck, and join again in a single tube which rises considerably above her boat deck. (The third funnel is not a smoke-

TABLE I.

	MAJESTIC	LEVIATHAN	BERENGARIA	AQUITANIA	BRITANNIC	OLYMPIC
Year of completion	1922	1914	1913	1914	1914	1911
Builders	Blohm & Voss	Blohm & Voss	Vulcan Werke	John Brown & Co.	Harland & Wolff	Harland & Wolff
Owners	White Star Line	United States Lines	Cunard Steamship Company	Cunard Steamship Company	White Star Line	White Star Line
Length over-all	956·7	950·7	919	901·6	900	882·9
Breadth	100	100	98	97	94	92·6
Depth moulded	63	—	63	64·6	64·3	64·3
Gross tonnage	56,551	59,956·65	52,117	45,646	50,000	45,000
Load displacement	64,000	60,000	57,000	53,000	53,000	60,000
Load draught	—	37	35·6	36	34·6	34·6
Type of machinery	Parson's turbines in series	Parson's turbines in series	Parson's turbines in series	Parson's turbines in series	Combined reciprocating and turbine	Combined reciprocating and turbine
Number of propellers	4	4	4	4	3	3
Horse-power	100,000	100,000	62,000	60,000	50,000	46,000
Speed on service	23 knots	23 knots	22½ knots	23½ knots	21 knots	21 knots

TABLE I—*continued.*

	LUSITANIA (sunk)	MAURETANIA	HOMERIC	PARIS	BELGENLAND
Year of completion	1907	1907	1922 (Reg.)	1921	1923
Builders	John Brown & Co.	Swan, Hunter & Wigham Richardson	F. Schietran, Hamburg	Atelier et Chantier de St. Nazaire	Harland & Wolff
Owners	Cunard Steamship Company	Cunard Steamship Company	White Star Line	Compagnie Générale Transatlantique	International Navigation Co. (White Star and Red Star)
Length over-all	790	790	776·9	768	696·5
Breadth	88	88	83·5	85·4	78·4
Depth moulded	60	60·6	54	—	49·6
Gross tonnage	30,822	31,938	34,356	34,500	27,132
Load displacement	44,660	44,640	43,258	36,700	39,935
Load draught	36	36·2½	35·3½	31·2	36·3½
Type of machinery	Parson's turbines	Parson's turbines	Reciprocating 4-cylinder	Parson's turbines	Combination
Number of propellers	4	4	2	4	3
Horse-power	70,000	70,000	28,000	46,000	12,000
Speed on service	25·5 knots	26 knots	20 knots	22·5 knots	20 knots

stack.) The space occupied by the ordinary funnels passing through the middle of the deck is thus left clear, and the public rooms occupy the deck without obstruction (Fig. 91). There are three alley-ways running fore and aft, which serve to supply her with abundant light and fresh air, and gives to the ship an effect of great roominess. Fig. 92 shows lounge and ballroom, 100 ft. wide. Like the *Aquitania*, the *Majestic* has Frahm's anti-rolling tank

By courtesy of] [*Bedford, Lemere & Co., for White Star Line.*

FIG. 92.—LOUNGE AND BALLROOM, "MAJESTIC."

system, and was built without the usual bilge keels, but bilge keels have now been fitted on both vessels.[1] From the keel to the boat deck this vessel is 102 ft. deep. The cables and five anchors together weigh 230 tons.

The *Majestic's* swimming-bath (Fig. 100) is almost a replica of the Pompeiian Roman bath described in the *Berengaria*. This bath can be filled with 120 tons of warm water in twenty-five minutes.

[1] See Chapter II, p. 38.

FIG. 92B.—BREAKWATER LIGHTHOUSE, DUBLIN.
(Showing small white window for entry of a beam of light. See p. 120.)

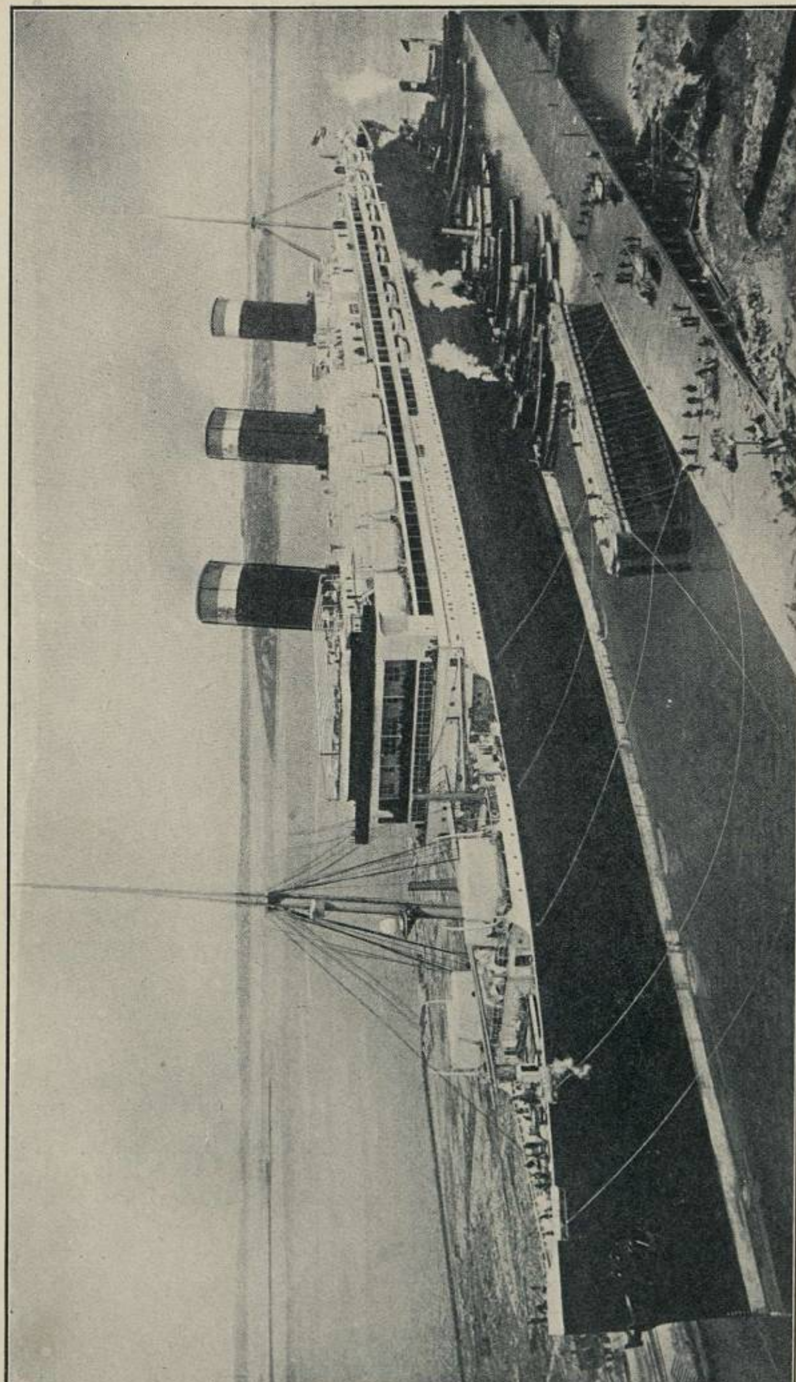


FIG. 93.—"LEVIATHAN" IN GRAVING DOCK, BOSTON.

The *Leviathan*, completed in 1914, made only three voyages across the Atlantic before the war broke out. She was the German *Vaterland*, and remained interned in New York. In 1917, when

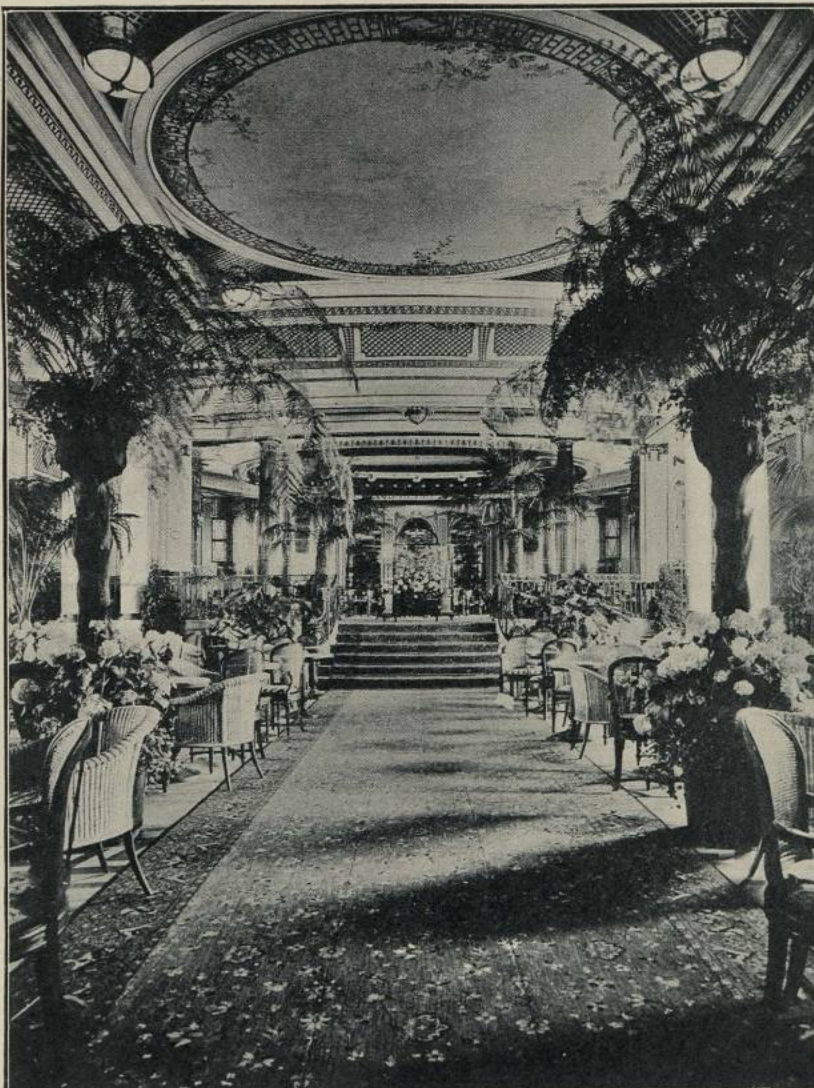


FIG. 94.—THE WINTER GARDEN, "LEVIATHAN".

the United States entered the war, she was seized and used as a troopship. In ten trips she carried 110,591 United States troops across the Atlantic, on one trip carrying 11,470 soldiers, breaking the world's troop transportation record. This was in addition to officers and crew, numbering 2,078, making a total of 13,548 souls on board, the greatest number ever carried across any ocean in one ship. As a result of this effective service, the *Leviathan* has become endeared to many thousands of Americans. She was nicknamed "Levi", "Levi-Nathan", and also "Big Train". Here she is in Boston naval graving dock (Fig. 93).

FIG. 95.*

Once, when twelve tugs assisted in getting her under way and every man was at his station, the situation was acute, when suddenly a hail from one of the tugs broke the spell: "Where in 'ell can I make a line fast to that hotel?" The "hotel" had eight 6-in. guns! The *Leviathan* (ex-*Vaterland*) is the first vessel ever built with funnels which do not pass directly through the centre of the decks (as described, the smoke passes up the sides). In this respect as in many others she is like the *Majestic*. It is said that a clear vista of 112 yards through the saloons unobstructed by funnels is obtained. Fig. 94 shows the Winter Garden.

The latest type of Sperry gyro-compasses are installed in duplicate, with repeaters located at important positions.[1] A recorder is also installed in the chart-house for making a permanent record of all courses taken while under way.

In the engine-room are a number of special electrical signalling or recording systems all indicating at one central point. In this way even the salinity of the feed-water and temperature of the fuel oil are indicated. The Sperry 36-in. high-intensity searchlight was described on page 103.

"Sea Dogs."—On the main deck is a large library and a painting of President Harding. The four corner pictures of the "Sea Dogs" (Fig. 95), carved in solid wood,

FIG. 95.*

[1] All repeaters can be thrown from one to the other master without interrupting the service.

* Four Sea Dogs. Silent "Salts" who keep vigil over the *Leviathan's* smoking-room.

each 18 in. high, form part of the decorations of the smoking-room. The ship carries 9,500 tons of fuel oil for the engines and 8,500 tons of fresh water for the passengers. Incidentally she carries several thousand tons more liquid weight than an average tanker, with six evaporators, each of which can transform 24 tons of sea-water into fresh water every twenty-four hours. Here is the large bell on deck (Fig. 96).

Fig. 95.*

Wireless.—Duplex watches are maintained at all times in the radio-room to ensure the reception and transmission of traffic without delay. The installation provides additional receiving equipment for tuning-in stations on long and short waves simultaneously, combined with the ability to transmit and receive messages on different wave-lengths at the same time. "Five antennæ are used : three for transmission and two for reception. A staff of eight operators, none of whom have had less than ten years' experience, and two messengers are included in the personnel necessary for the handling of the ship's wireless apparatus. It is understood to be the largest radio personnel on any ocean-going liner."[1] The ship is provided with the Sperry gyro-pilot, known as "Iron Mike", which has been installed on the steering-gear, as described in Chapter VI.

The *Leviathan* is also equipped with a radio telephone of the duplex type which permits two-way conversations.[2] This telephone transmitter is often heard at ranges up to 3,000 miles.

In order to facilitate the transmission of broadcast programmes from the ship, special microphones have been installed near the orchestra stations. Incoming broadcast programmes can easily be handled by the method of grouping loud-speakers, which are temporarily installed in the dining-room when desired. When atmospheric conditions and

Fig. 95.*

[1] *Electrician*, May 16, 1924.

[2] *Communications and Radio Department, U.S. Shipping Board, Emergency Fleet Corporation*, November 25, 1924.

* Four Sea Dogs. Silent "Salts" who keep vigil over the *Leviathan's* smoking-room.

interference permit there has been no difficulty in receiving 2LO (London) up to 1,000 miles and 5XX (Daventry) up to 2,000 miles.

A very interesting feature of the equipment aboard this vessel is the system of antennæ which allows the operators to handle spark- and continuous-wave apparatus when working simultaneously. The telephone transmitter and receiver can also be used with another antennæ while the continuous-wave and spark-transmitters

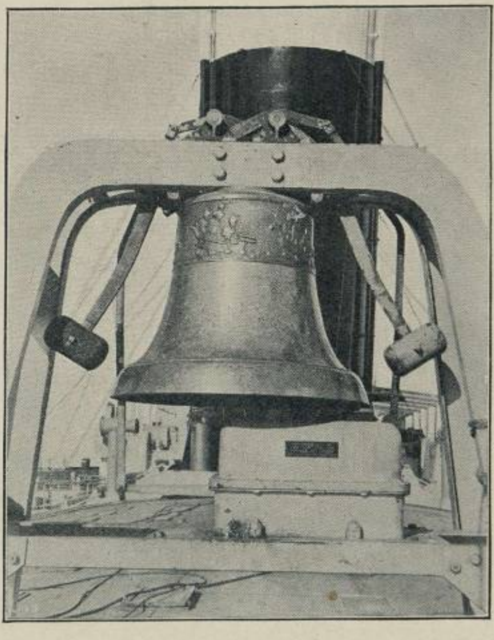


FIG. 96.—SHIP'S BELL THAT STRIKES THE HOURS ON "LEVIATHAN".

are in operation. The radio receiving apparatus has a range of 3,000 miles on all lengths up to 30,000 metres.

The "Berengaria" (Fig. 97), of the Cunard Line, appeared in Southampton Water for the first time in June 1913 as S.S. *Imperator*, of the Hamburg-American Line. She was the first of the three German large liners.

Lifeboats on Lower Deck.—A feature which even to the uninitiated will at once appear as a most striking innovation is the removal of a large number of lifeboats from the top deck to a lower promenade deck, 20 ft. below. Repeated observations have proved that the last-mentioned deck is seldom used by passengers. The deck below the boat deck (the shelter deck) is free from boat obstruction, and the boat deck aft is also free to

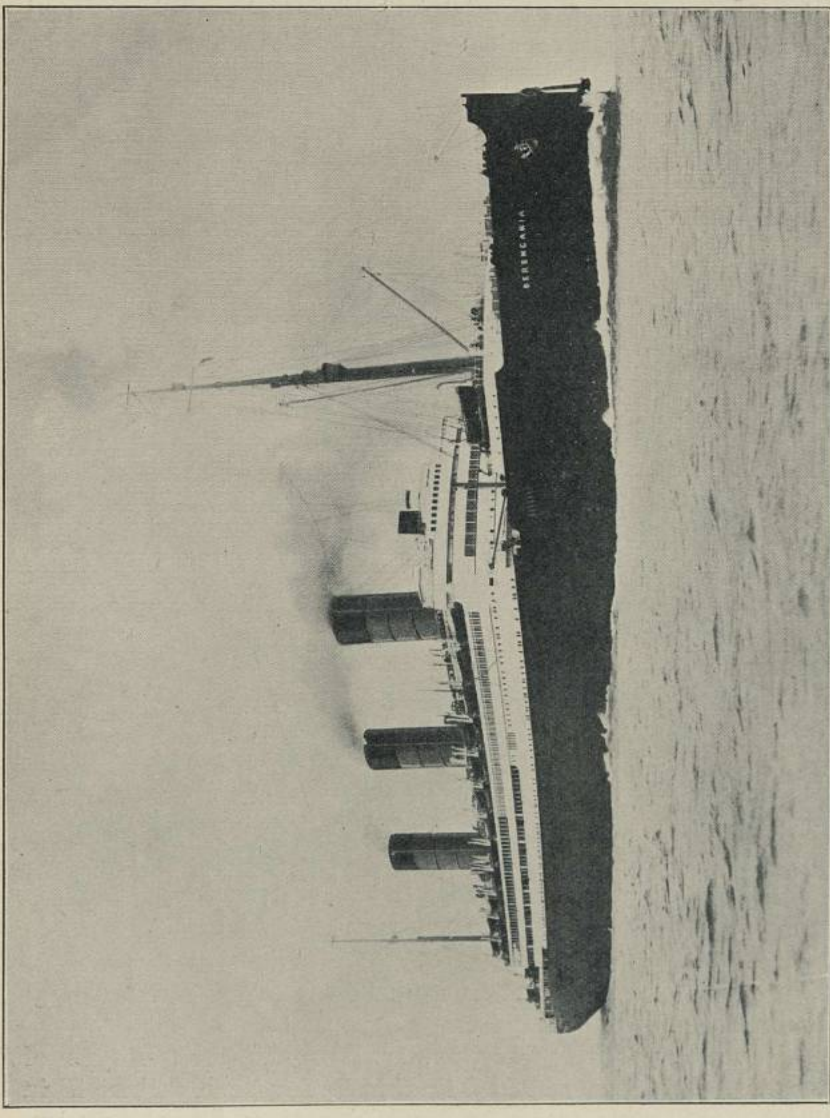


FIG. 97.—"BERENGARIA" AT SEA.

passengers for open air and exercise. A shelter deck is seen in Fig. 83, p. 153.

Workshop.—It may be mentioned that a completely fitted machine-shop is situated in the forward engine-room, containing all the latest and most powerful machines, including lathes and drills, planers and tools, capable of dealing with repairs of all kinds.

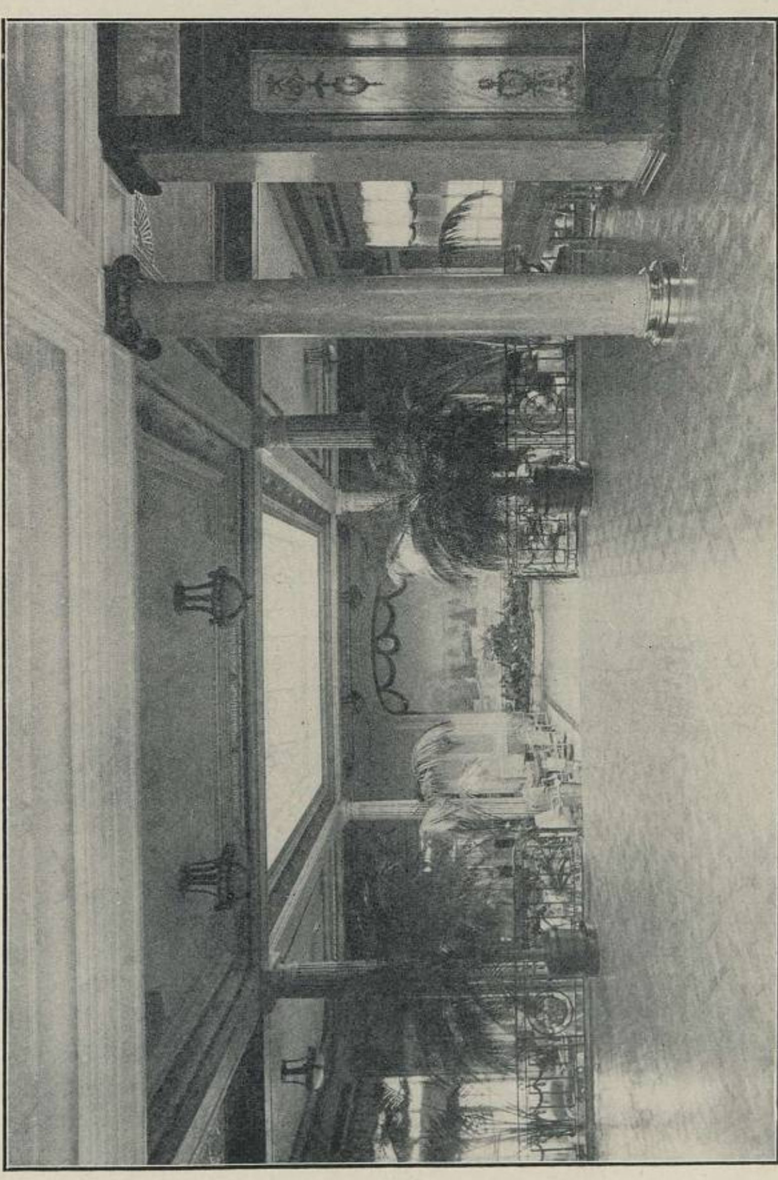
By courtesy] [*By Brown & Dawson, Stamford, Conn.*

FIG. 98.—DINING SALOON ILLUMINATED, "BERENGARIA".

Similar repair and construction workshops are found on all large liners.

This vessel was the first to start the Ritz-Carlton type of restaurant. Meals are served *à la carte* at any hour. There is, in addition, a grill-room, tea-room, verandah café, and a palm-garden. The first-class main dining-room is 98 ft. wide and 25 ft. high. This fine picture is by Brown & Dawson, Stamford, Conn. (Fig. 98).

Tudor Room.—The smoking-room is a truly English feature—a Tudor room with a large open fireplace, the red brickwork over which (as in other parts of the room) realistically reproduces that



By courtesy of] [*Cunard Steamship Co.*

FIG. 99.—BALLROOM, 'BERENGARIA.'

of the sixteenth century. The bricks in question came from a Buckinghamshire cottage of the Tudor period which was demolished for the purpose. The work was carried out by a London firm.

Ballroom.—The ballroom now occupies the saloon formerly used as the Ritz-Carlton (Fig. 99). The old grill-room has given place to a verandah café, and the private dining saloon has been re-arranged and refurnished to serve as a reception-room for the ballroom.

Lounge.—The lounge was formerly used as a ballroom ; it is the most beautiful room in the ship, and it has been constructed without any pillars visibly supporting the roof, which is 18 ft. above the floor. There are windows 10 ft. high on either side.

The entrance-hall is 98 ft. wide and 69 ft. long.

Offices.—The three main staircases in the first saloon are 57 ft. high. On the various entrance-halls are situated the offices of the chief steward, purser, baggage-master, doctor's consulting and waiting-room, chemist shop, book-store and florist shop. Passengers' elevators convey passengers from the second deck to the boat deck, running through five floors.

Flats.—Besides the usual cabins and state-rooms, the ship has two complete self-contained flats comprising drawing-room and verandah with large windows opening out over the sea, dining-room, two bedrooms, two bathrooms, dressing-room, boxroom and pantry.

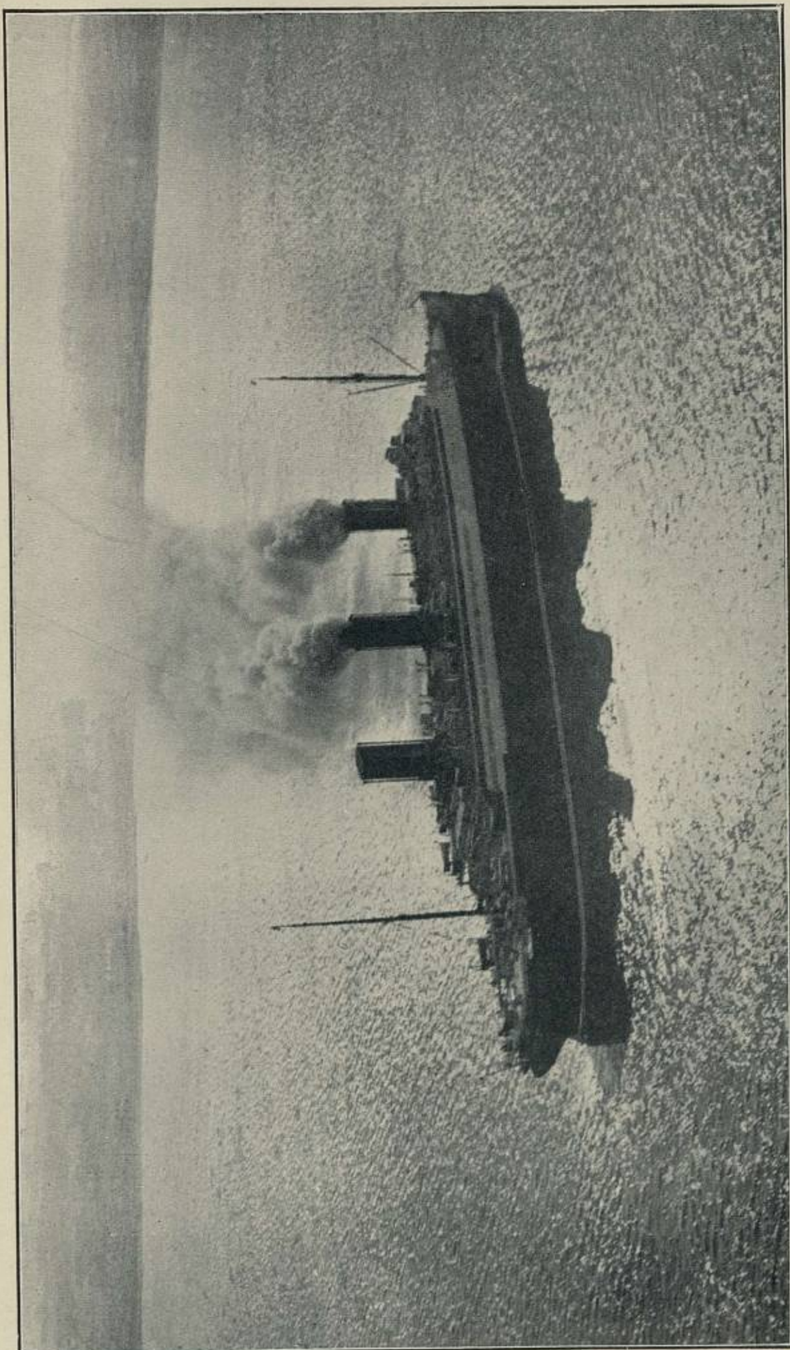
Berths.—Bedsteads of ample proportions are used in place of berths. The folding washstand is replaced by a commodious marble washstand with hot and cold water. All rooms are provided with steam heating systems, electric heaters, electric light, etc., as already stated.

Roman Bath.—The swimming-pool, built after the designs of the ancient Romans, was first introduced in this ship (Fig. 100). There are eighteen decorative Pompeiian pillars of marble and an ornamental cascade of running water, also a gallery for visitors.

The *Aquitania* (Fig. 101) is the longest of the British-built liners ; she is a Cunarder with four funnels.

One of the principal features in connection with passenger accommodation is the unique method of construction of the " B " deck. In order to admit light and ventilation to the inner rooms of the deck below, this deck has been raised in the centre to the height of 18 in., affording a terrace for deck-chairs and an uninterrupted view of the sea. The ceilings throughout the first-class cabins are of plaster, each fitted with suitable cornice. The windows are made with teak frames as found in houses.

Fire-screen Doors.—All openings in the fire-screen bulkheads throughout the superstructure of the ship have been closed by



By courtesy of] [*"P. and A. Photo."*

Fig. 99b.—"Berengaria" from the Air.

"Roneo" steel doors of hollow construction. These doors passed through a two-hours' test, during which there was a maximum temperature of 1,560° F. They have been panelled and grained in imitation of mahogany so perfectly that it would be very difficult for an expert to distinguish them from wood.

This vessel was used as a hospital ship during the war, and

By courtesy of] [*Bedford Lemere & Co., for White Star Line.*

FIG. 100.—SWIMMING-BATH, "MAJESTIC". (P. 172.)
(This Pompeiian pillar Roman bath was first introduced in the *Berengaria*.)

after the loss of the *Britannic*[1] in the Ægean Sea in November 1916, when the White Star sacrificed the most splendidly equipped of her liners, the *Aquitania* was kept out of such danger-zones and smaller vessels brought the wounded to her.

The *Olympic* (Fig. 102) has four funnels. She belongs to the White Star Line. Perhaps the most noticeable features of the *Olympic* are the special state-rooms situated on "B" and "C" decks amidships between the two grand staircases. The internal

[1] 48,150 tons. Built by Messrs. Harland & Wolff, Belfast.

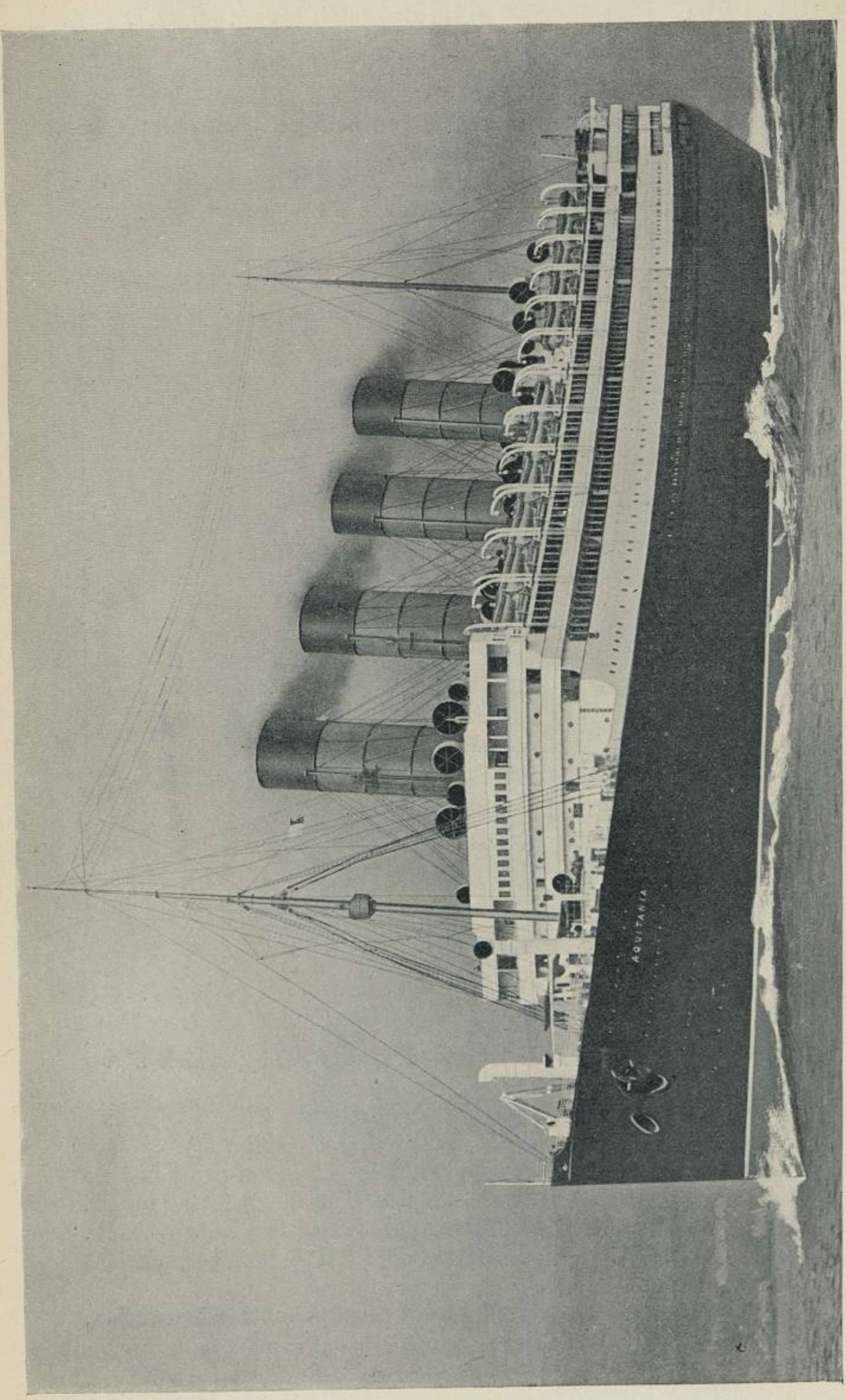


FIG. 101.—"AQUITANIA" AT SEA.

decorations of the various rooms include Louis Quatorze, Georgian, Regency, Queen Anne, Modern Dutch and Old Dutch. The parlour suites consist of one sitting-room, two bedrooms, two wardrobe-rooms and private bath and lavatory.

In the second-class-forward there is a staircase which is one of the features of the ship, as it extends through seven decks and

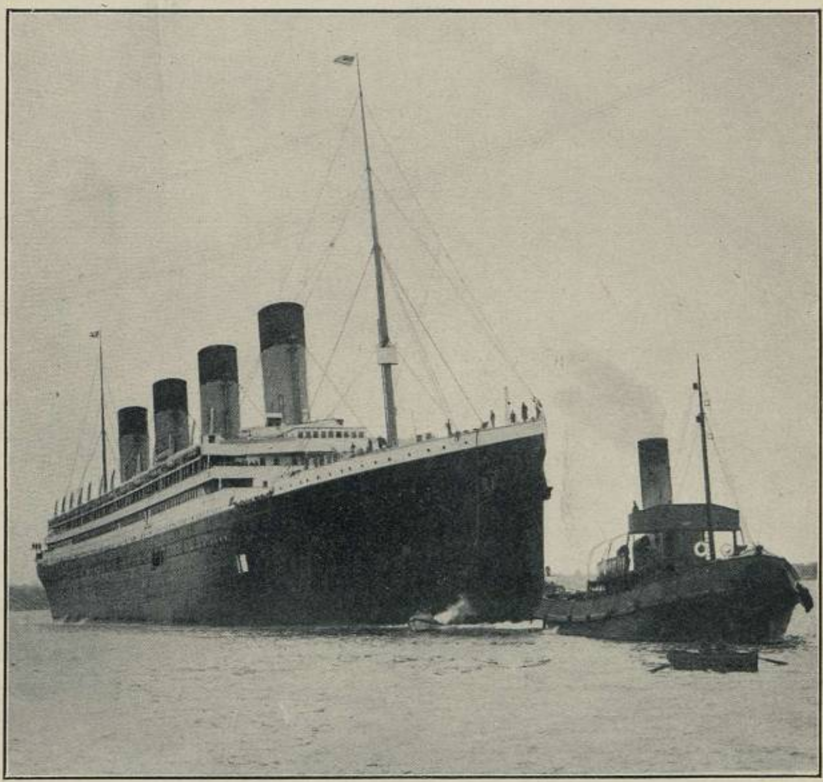


FIG. 102.—"OLYMPIC" AND TUG.

has an electric elevator incorporated in the centre which serves six decks.

The beautiful decoration of the smoking-room (Fig. 103), which is 65 ft. long and 63 ft. broad, is in early Georgian style. The walls are panelled in mahogany, inlaid in mother-of-pearl instead of the usual carving. Over the fireplace is a fine painting by Mr. Norman Wilkinson entitled "The Approach of the New World". On the stained-glass windows are depicted landscapes, ancient ships, and other subjects.

Racket Court.—The squash racket court is another innovation.

It is situated on the lower deck at the centre of the ship, and extends two decks high for a length of 30 ft. and a width of 20 ft. A gallery for spectators is placed at the after end of the court at the middle deck level. This vessel possesses the largest low-pressure turbine in the world.

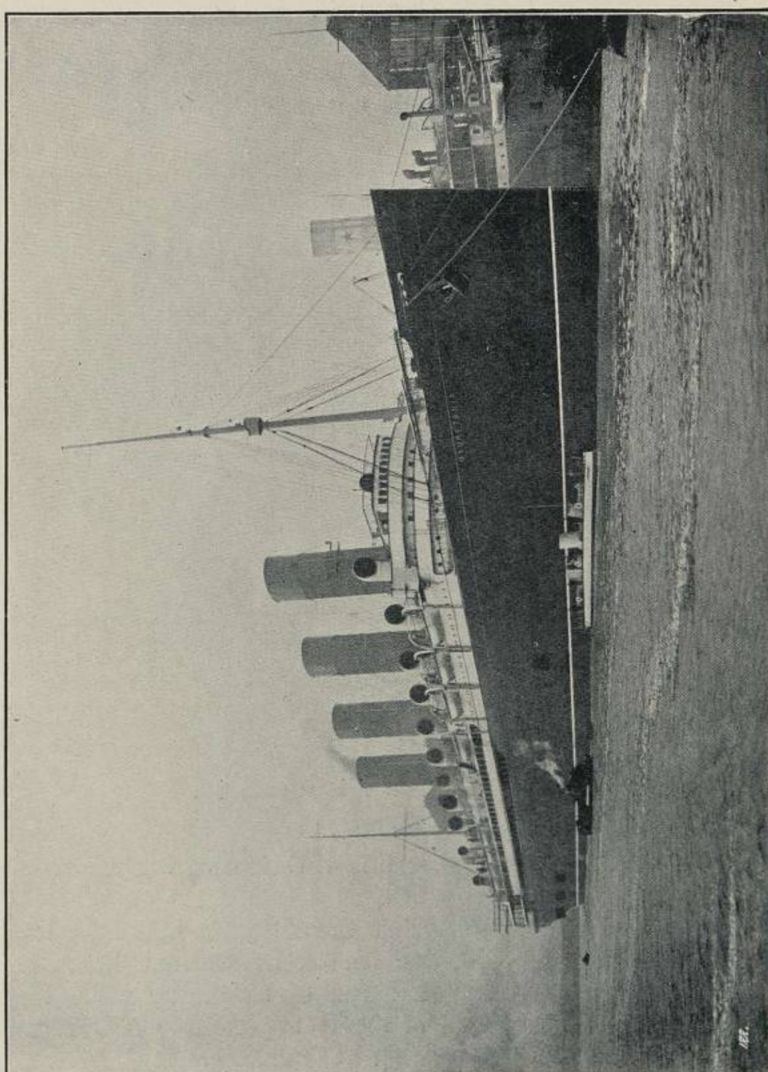
This is an interesting picture (Fig. 104). It shows the *Turbinia* alongside the *Mauretania*.

The *Mauretania*, also a four-funnel Cunarder, is in a class by herself. As a rule vessels are built on the fruits of experience.

FIG. 103.—SMOKING-ROOM ON THE "OLYMPIC".

Each firm carefully watches the results of their own workmanship with a view to improvements.

Up to 1898 British lines crossing the Atlantic had held the record for speed. This record was beaten by German liners in competition. Their vessels had a speed of 23 knots, while the fastest English liner had a speed of barely 22½ knots. A Government Commission was set up to examine the matter. It discovered that the enormous fuel consumption for fast boats was a commercial impossibility. If the German authorities were helping the German lines, it was indispensable that the British Government should give financial assistance to the British. To enable the companies to run boats of 25 knots, the British Government lent aid to the Cunard Company. The company further received an



By courtesy of] [*The Parsons Marine Steam Turbine Co., Wallsend.*
[*Photo., W. Parry & Son.*

FIG. 104.—"MAURETANIA" WITH "TURBINIA" ALONGSIDE.

annual subsidy. Something approaching a departure from the old methods was needed.

When a liner is required with some new departure, such as the *Lusitania* and *Mauretania*, built for speed, elaborate preparation, research, and investigation are necessary; models are built and trials are made. The planning of every special type of vessel requires many varied factors. Stability, speed, economy, steadiness, behaviour in rough weather, must all be considered. The engines and the size and shape of the propellers, the effect of wind upon the ship—items which could not be seen in experimental tank tests—had to be settled. In 1903 a model launch was designed to one-sixteenth of the dimensions of the full-sized vessel. Trials took place in the Northumberland Docks of the Tyne, over a ¼-mile length.[1]

The craft was electrically propelled by means of an accumulator battery strong enough to keep up full speed for about three hours. Each of the four propeller shafts was driven by an independent motor coupled by means of a self-recording torque dynamometer designed for the purpose. Arrangements were made for measuring the thrust, the number of revolutions of the shafts, the speed of the launch running over a measured distance and taking the time. The velocity of the wind was measured by an anemometer during each run. The experiments extended over two years. While comparatively little was known concerning triple screws, never before had quadruple screws been fitted on a ship. In these circumstances the *Lusitania* and *Mauretania* were laid down. Since their appearance the blue ribbon has been held by Britain.

The bilge keels of the *Mauretania* are 36 in. deep and only about 200 ft. long, whereas the *Olympic* is fitted with bilge keels 300 ft. long and 25 in. deep.

Telephone System.—The *Mauretania* was fitted with a telephone service and a switchboard capacity for 200 stations. The equipment was first designed to be connected with Liverpool and New York Exchanges, when the ship is in port. The *Mauretania* with other big liners calls at Southampton now, and the postmaster of that port was asked if this arrangement still worked. His reply was that " telephone facilities are not provided for either Government use or for the general use of the public ". The arrangement at Liverpool was made by the National Telephone Company of the good old days.

Already vessels are provided with ship-to-shore telephony,[2] as on the M.S. *Aorangi*, but the P.M.G. does not permit its use freely at present.

[1] *Steamship Conquest of the World*, F. A. Talbot.

[2] See p. 196, M.S. *Aorangi*.

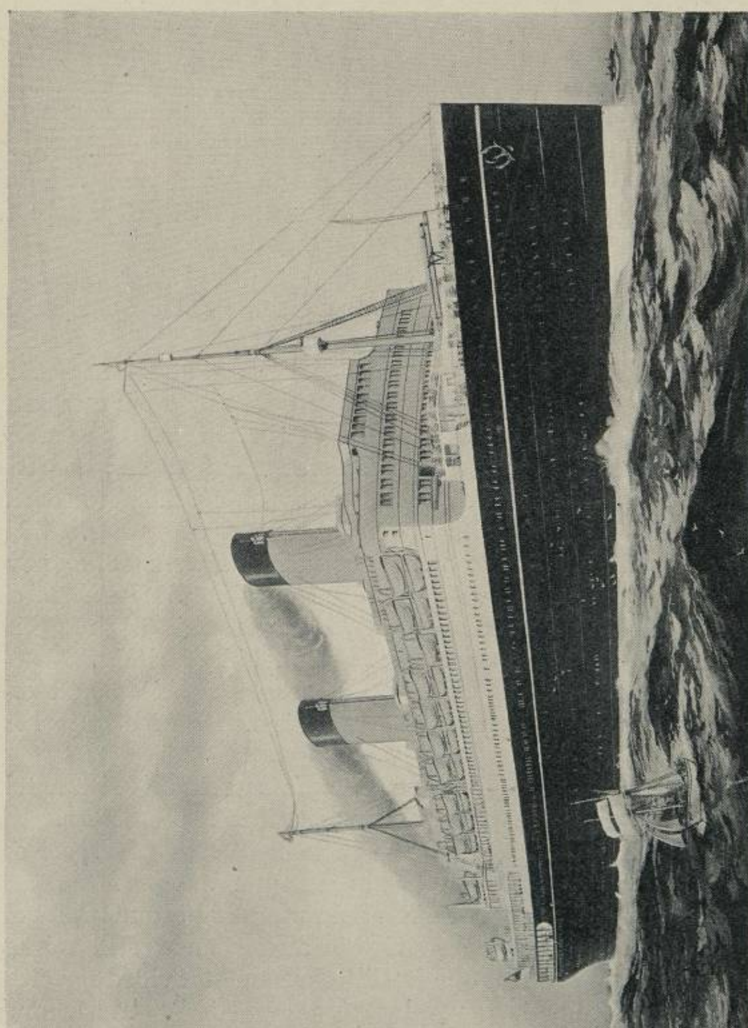


FIG. 105.—"HOMERIC", WHITE STAR.

R.M.S. *Homeric* (Fig. 105) (34,356 tons), comes after the *Mauretania* and is the sixth longest liner. She has two funnels, and claims to be the largest twin-screw steamer in the world. Engines are four-cylinder triple reciprocating. She has a great lounge on the upper deck, with a roof of champagne-coloured glass. This lounge and ballroom is 20 ft. high. On either side there is a colonnade of pillars intermingled with tall windows.

She has not been fitted with Frahm's anti-rolling tanks ; no doubt this is an instance of the lessons learnt from the previous experience of large vessels like the *Aquitania* and *Majestic*, which had to be fitted with bilge keels.

The smoking-room has on either side bay windows 18 ft. high, beside each of which is a high-backed chair in red morocco. The beautiful marble fireplace brings one's thoughts home.

When burning coal the *Homeric* had an engine-room crew of

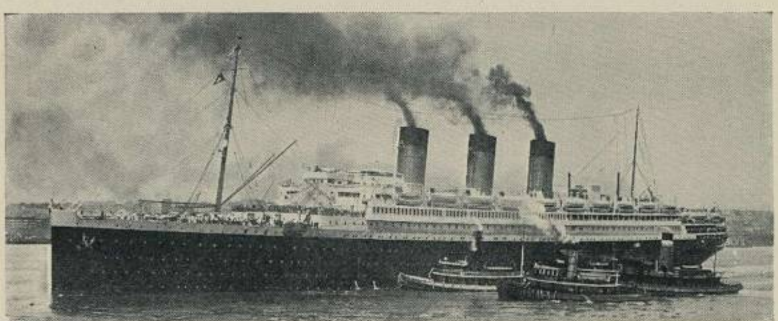


FIG. 106.—S.S. "PARIS" AND TUGS.

239 men ; now she uses oil fuel there is a reduction of 123 hands, or more than half.

S.S. *Paris* (Fig. 106), the three-funnel French liner, was built at Penhoët shipyard for the Compagnie Transatlantique. She made her maiden voyage on June 15, 1921, and stands for France as the *Aquitania* stands for Great Britain, the largest ship of her country. She is a luxuriously decorated "palace hotel" and also a museum of contemporary French decorative art, and is the eighth longest of the world's mercantile ships. Out of nine decks, five are continuous. As regards fire prevention and detection, the means adopted for safety are of the usual kind already described. She has twenty-two seamless steel lifeboats, twenty-seven Maclean's boats, and a motor-boat fitted with wireless and intended to tow the fleet of lifeboats. All are launched by means of Welin davits. Wireless installation is the same as for other ships, but of French make. The ship also carries a receiving station for Press messages, enabling it to receive news from Lyons throughout the passage to New York for the *Journal de l'Atlantique*, which is published every day on board.

The main turbines are arranged on four shafts with four propellers distributed in three compartments, two lateral, one central. The high-pressure turbine is on the port side, the medium-pressure turbine on the starboard, and the two low-pressure turbines in parallel in the centre. This arrangement, which offers great advantages from the point of view of steam consumption on account of the great expansion it is possible to get, first appeared on the

FIG. 107.—DINING-ROOM, S.S. "PARIS".

liner *France*. It has been adopted on the *Berengaria*, *Aquitania* and *Leviathan*.

The *Paris* is arranged to carry 3,903 souls (including the crew). The usual gymnasium is found, and a very wonderful nursery playroom for the children. When the writer paid a visit to this, one of the ship's nurses just took up a weeping infant in her arms, and, pushing aside some curtains, showed the child a beautiful aquarium full of lively fish and water-weeds, like a bit of fairyland. It had a magic effect on the infant's mind. Shortly after this an English lady passenger, who was a guest in the captain's-room during tea, said that some mothers even complained that the children showed too great an attachment to the nurses and cried when taken from the nursery!

Altar.—In the rear of the drawing-room, on a small dais, there is an altar for the celebration of Divine service.

Announcement was recently made of a unique innovation on board the White Star-Dominion Line steamers in connection with religious services held at sea.

The usual custom followed at sea is for the purser or doctor to conduct a service according to the rites of the Church of England, but without the usual formalities.

Arrangements have been made to supply all ships with the necessary equipment in the way of altars, chalices, etc., whereby priests of the Church of England who may be travelling will be enabled to celebrate Holy Communion in the formal manner.

The necessary equipment is also carried on all White Star-

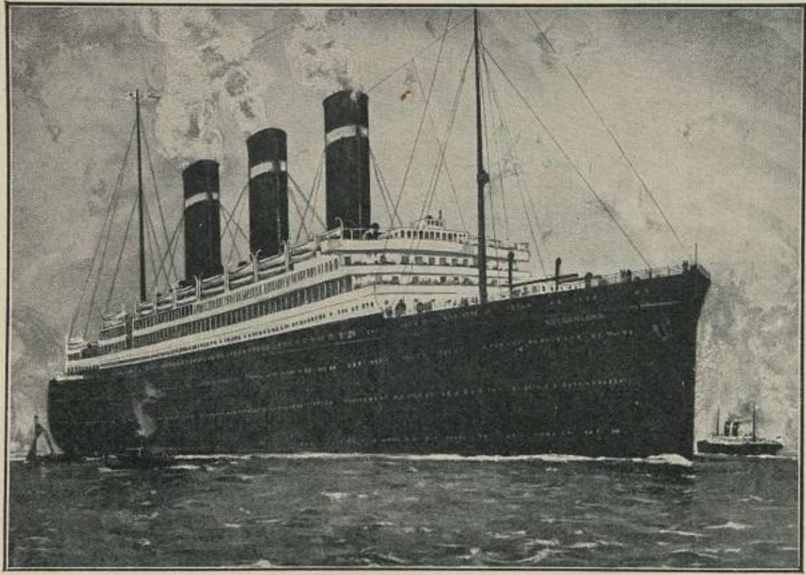


FIG. 108.—"BELGENLAND", RED STAR.

Dominion Line steamers for the celebration of Mass by priests of the Roman Catholic Church.

The smoking-room is in two stories, one on deck "B" and the other on deck "A", connected by an interior spiral staircase.

The first-class dining-room and its dome (Fig. 107) occupies in all the height of three decks. The bent iron decorations here are very effective. Remember, that every item on this vessel represents the very highest art and the best workmanship of France, be it on the floor, on the walls, or her engines. The writer was specially struck with the smart appearance of the engine-rooms.

R.M.S. *Belgenland* (Fig. 108), of Belgium, has three funnels, 27,200 tons (gross) and was built at Belfast and launched from

Messrs. Harland & Wolff's yard on the last day of 1914. Employed as a cargo vessel during the war, she returned to Belfast to be completed as a passenger vessel in March 1922, then proceeded on her trial trip in March 1923. She is the latest of the big ships, and has the distinction of being the largest steamship to enter the River Scheldt, but, most unfortunately for Antwerp, her owners decided not to allow her to do so in future because of the danger to navigation caused by the shifting sands in the Scheldt. So far, the *Belgenland* is the largest vessel to enter the Thames and King George V dock. The Port of London improvements may enable larger vessels to enter in about three years. Oddly enough the ship looks larger than the figures of her tonnage and length indicate.

Tennis Court.—She has public rooms, state-rooms, and other attractions, such as gymnasiums, swimming-pool and even a deck tennis court. The restaurant service is exclusively *à la carte*. There is no old-time *table d'hôte*. The staterooms are inter-communicating, offering various combinations of suites with private sitting-room and dining-room, and there are no less than thirty-two private bathrooms. On approaching the vessel some of the ports on her freeboard are noticeably of oval shape ; these are outside the main dining saloon. They admit of better ventilation and light. The *Electric Track Chart*, mentioned on p. 157, was found on this ship and was made to particulars and designs furnished by Messrs. Harland & Wolff, of Belfast.

This vessel has the distinction of having been officially blessed by the late Cardinal Mercier, Primate of Belgium, before leaving Antwerp. Sailing west from New York, she returned there in about 132 days,[1] save the "lost day". By international agreement the 180th meridian is where the day begins.

Lost Day.—Sailing westward clocks are retarded every day in proportion to the speed of the ship. The total gain made circling the earth westward is twenty-four hours. This adjustment is made at the 180th meridian, where a day is dropped. At this point there is no to-morrow, but only the day after to-morrow. If the meridian is reached on Monday, the next day will be Wednesday—Tuesday is lost ; every day is lost in turn. There is no need to worry, for when we are on the other side of the line we can get even by sending a wireless home, which, according to the calendar, will arrive before it was sent !

This subject, like "summer-time", will be likely to produce considerable arguments ; some people are always "at sea", while others may be "sick of it" ! If you wish to keep your friends, avoid trying to explain it.

[1] The duration of her second world cruise was 133½ days. The third cruise commences in December 1926.

The *Belgenland* (Fig 109) is the largest vessel which can claim to have passed through the Suez Canal (March 21, 1925) and the Panama Canal (December 4, 1925), and the largest ship to girdle the globe.

The Motor-ship and the internal-combustion engine are growing in popularity, and the application of internal-combustion engines for ships was predicted long ago. The late Lord Fisher was a great believer in its future. He was known as "an oil maniac", and he knew it. In 1919 he wrote to *The Times*: "I was dubbed 'an oil maniac' when I was at the Admiralty in 1885."[1] Again he wrote in *The Times*: "Mind you, when all these articles are read people will say, 'Here's a lunatic'. Now I will tell you a story about a lunatic. A friend of mine went to see a lunatic

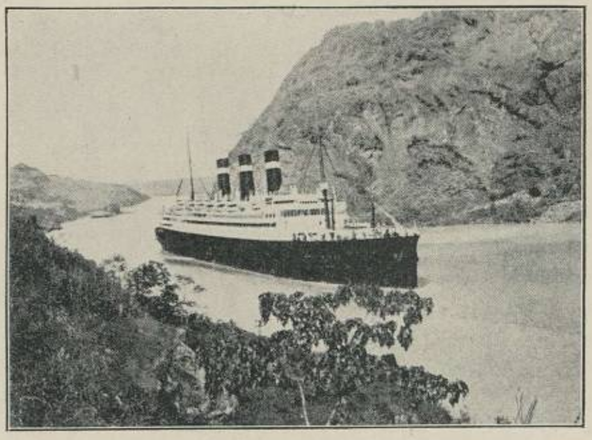


FIG. 109.—"BELGENLAND" PASSING THROUGH THE PANAMA CANAL.

asylum, where the patients were being treated on a new principle of giving them the utmost latitude to indulge in their tastes. The day he went, bricklayers were putting up in the spacious grounds some little out-buildings. A bevy of patients had asked for wheel-barrows to trundle about the grounds. They were given them, and my friend met one of them wheeling his barrow upside down. He said to the lunatic: 'Ain't you making a mistake? Your barrow ought to be the other way up.' The lunatic stopped wheeling his barrow and said to him: 'Well, you know, I thought myself I was making a mistake, but when I turned it over the other way they kept filling it full of bricks!' He was the only sane man among the lunatics. The others were wheeling barrow-loads of bricks for the bricklayers. He used his barrow for his own intended purpose." We know the whole Navy now uses oil,

[1] Lord Fisher on the Navy, *The Times*, September 1919.

and may thank Lord Fisher for it. Internal-combustion engines have come, too.

Motor-Liner.—In the last days of 1921 the first passenger-carrying motor-liner *Domala,* equipped with internal-combustion engines, left London on her maiden voyage to India. She was built for the British India Steam Navigating Company, and can travel at 13½ knots on less than 20 tons of oil daily and carry sufficient fuel oil for a round trip from England to the East and back, whereas a steamer of the same size and speed must take on coal at various ports—a very disagreeable process from the passengers' point of view.

M.S. "Aorangi" (Fig. 110).—In the last days of 1924 a new motor-ship (*Aorangi,* 18,500 tons gross), carrying two funnels, built by the Fairfield Shipbuilding and Engineering Company[1] for the Union Steamship Company of New Zealand, was on her trial trip prior to leaving for Southampton, where the writer saw her arrive on January 1, 1925, and went on board. She was the largest motor-ship afloat, and is equipped with four Sulzer-Diesel engines totalling 13,500 h.p.

The name *Aorangi* is taken from the Maori name of Mount Cook—the name of the historic navigator—it is the highest mountain in New Zealand (12,500 ft.). The ship is a quadruple-screw of 22,000 tons displacement, and is the first motor ocean-going ship to be propelled by Diesel engines on *four* shafts, and, strange to say, some of her marine engines were supplied by Switzerland!

The *Aorangi's* bunkers contain sufficient oil-fuel to carry her over the round voyage from Vancouver, Canada, to Sydney, New South Wales, and back, a total distance of 15,000 nautical miles. There are four distinct sets of six-cylinder engines having cylinder diameters 27½ in. by 39 in. Stroke designed to give the ship a sea speed of about 18 knots, one pair of engines is easily accessible for the control of one man.

The rudder is of the underhung spade type, and has an area of 225 sq. ft.[2] The lifeboats are stowed about 7 ft. above the deck, giving clear space under and a clear ship's side rail. Sixteen sets of Maclachlan Automatic Boat Davit Company's patent gravity davits form a most attractive feature on the boat deck (Fig. 111).[3] The lifeboats are stowed on cradles mounted on rollers, which move over parallel trackways laid at right angles to the ship's side and carried down to the embarkation deck, thereby forming ship's side deck supports.

[1] There have been other workers in the Diesel field—the B. & I. Elder Dempster, the I.S.N. Co. and the Bibby Line.

[2] *Syren,* January 1925.

[3] The Maclachlan Automatic Boat Davit Company, Ltd.

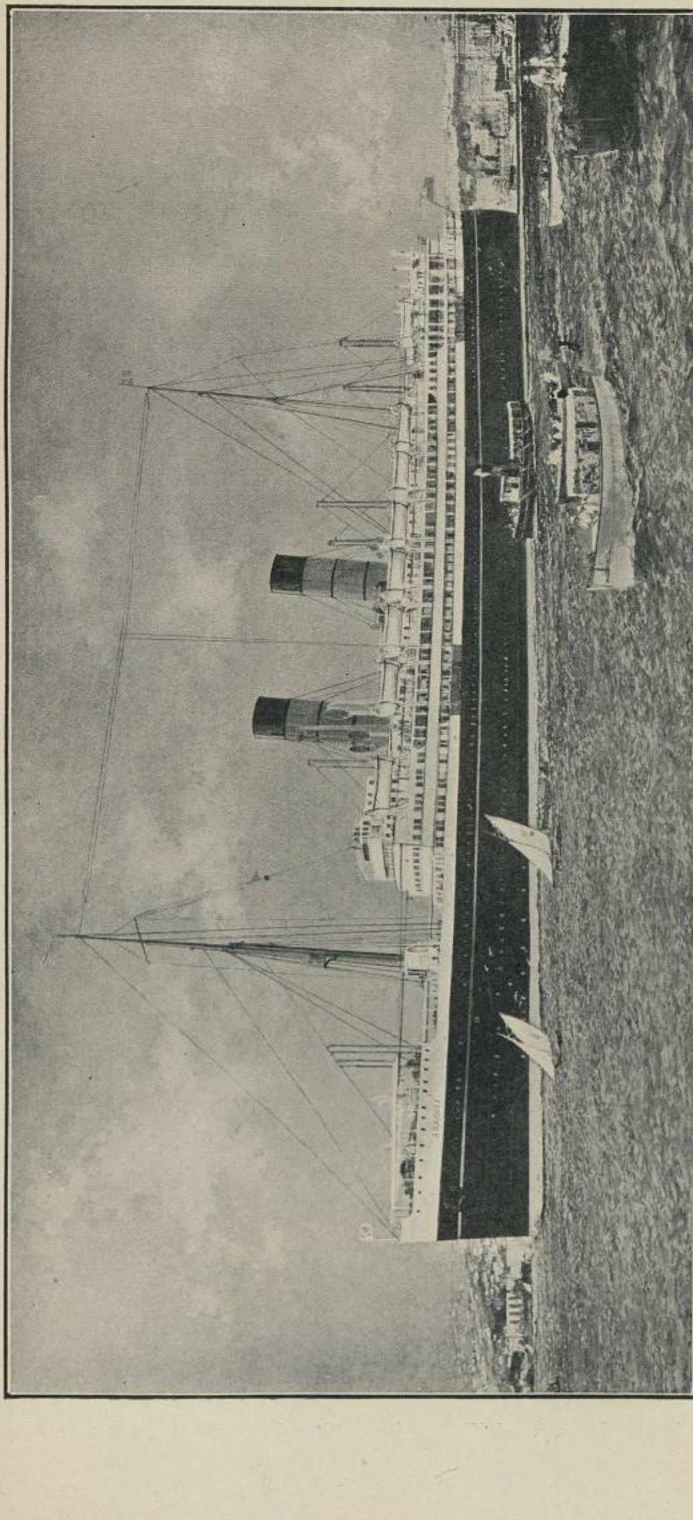


Fig. 110.—Motor-ship, "Aorangi", Union Steam Ship Co. of New Zealand.
(The first quadruple-screw mail and passenger motor-ship.)

By the simple operation of lifting a brake lever on the davit winch, the lifeboat and cradles move, under the force of gravity, down the trackways and over the ship's side until the cradles come to rest on the stopper pins. The lifeboat comes automatically alongside the embarkation deck irrespective of list. After the passengers have embarked, the brake lever is again lifted and the boat continues to the water. The whole operation of releasing

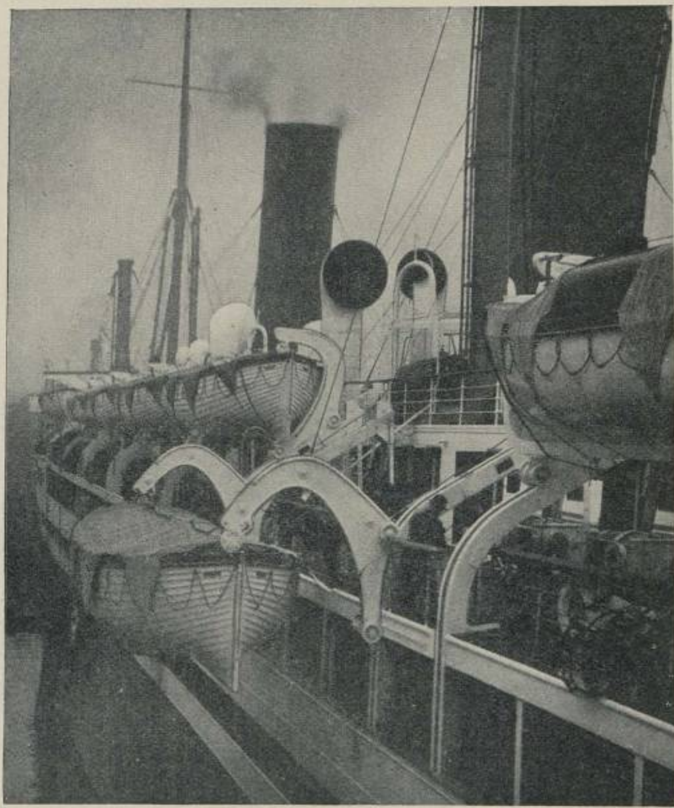


FIG. 111.—M.S. "AORANGI", SHOWING THE NEW ARRANGEMENT FOR WORKING THE LIFEBOATS.

and lowering the largest lifeboat may be carried out by one man in twenty-four seconds. The boats can be hoisted by hand or electric power back into their stowed position.

The trackways, which extend inboard over the deck, are given a declivity of 30°, so that the boats are able to be launched against any list up to that angle under the force of gravity.

Wireless Telephony to Shore.—Two pole masts serve for signalling and to carry wireless aerials. Wireless equipment is of the latest, including direction-finder and apparatus for broadcast reception and transmission on a separate aerial, and seventeen loud-speakers have been installed. There is also provision for wireless telephony for ship-to-shore communication up to 50 miles.

Laundry.—On the promenade deck aft is a large deck-house for the laundry and laundry attendants—the best equipped ever fitted on board a ship. Electrically-driven washing and extracting plant, dryers, ironing machines, clothes presses, etc.

A Sperry master gyro-compass of the latest type, steering and bearing repeaters, a Sperry continuous-course recorder, and a Sperry gyro-pilot for automatic steering have been installed.[1]

" Sal " Log.—The automatic hydro-electric " Sal " log, a combined speed indicator and distance-recorder is installed. In appearance it is not unlike the Forbes' ship's log and speed indicator, in which a 15-in. tube, having a propeller in it which generates current by a magneto generator at a pressure proportional to the speed of the ship. The tube containing the propeller and gearing protrudes through the ship's bottom. The current is led to one or more voltmeters, having a scale marked in knots—the speed indicator. On another dial is the distance-recorder. The ship's speed can be watched in the same way as on a motor-car. The " Sal " log, however, is different; it utilizes the principle of the pitot-tube, which indicates the dynamic pressure exerted by water due to its velocity—the pressure of the water due to the ship's ahead motion controls the diaphragm and mechanism by means of which the speed is indicated. This is a Swedish invention, and over 200 of these logs have been fitted on vessels of the Japanese Navy and others, but this is the first log of the type to be fitted in a British-built ship. There is a modern plant to deal with the ship's printing.

There are two electric passenger elevators and additional service lifts for the staff, and the writer was taken down to the bottom of the engine-rooms in a rapid-moving electric lift. There is almost extravagance in space and light in the engine-rooms. Two Diesel engines are worked by one man, and a noteworthy fact in connection with the crew is the elimination of firemen and trimmers owing to the adoption of oil engines.

Doctors and Hospital.—Two doctors are carried, and facilities provided comprise a consulting-room, dispensary and four well-equipped hospitals, so that both infectious and non-infectious cases can be properly treated.

The vessel is up to the standard of high-class liners travelling on deep-sea voyages. The dining-room is designed after the period of Louis XVI; near this is an attractive auxiliary dining-room for

[1] *The Shipbuilder*, January 1925.

private parties, or children's dining-room. Eight suites, cabines-de-luxe, each with marble-lined bathrooms attached, are furnished in different periods styles like the suites on the *Olympic*.

Messrs. Harland & Wolff are building two passenger liners for the Royal Mail Steam Packet Co. They will be motor-ships of 22,000 tons gross. Twin-screw Diesel machinery totalling about 20,000 h.p. will be installed in each ship, and a similar vessel for the Union Castle Line.[1]

The main machinery will consist of two sets of Messrs. Harland & Wolff's eight-cylinder double-acting four-stroke Diesel engines

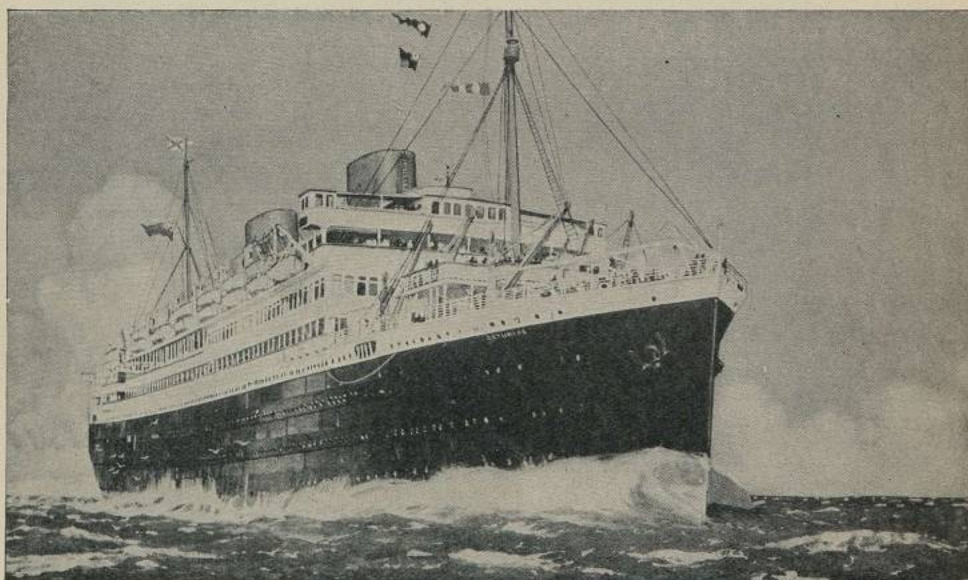


FIG. 112.—M.V. "ASTURIAS", ROYAL MAIL STEAM PACKET CO.

of the Bumiester and Wain type. Already 800,000 gross tons of shipping have been equipped with this type.

M.V. "Asturias."—The first of these vessels the *Asturias*, sailed from Southampton on her maiden voyage on February 26, 1926—a fine motor vessel of 22,500 tons (Fig. 112).

Her two funnels are very short—less than half the height of an ordinary liner. Strictly speaking, there are no funnel casings on this vessel, and if desired the funnels could be dispensed with altogether. There are, however, two machinery or motor-room casings, one over the main engines and one over the main auxiliary motors, both of which are carried up through all decks to the boat deck.

[1] *The Motor-Ship.*

These casings are on the centre line of the ship, as is usual with engine casings. The after funnel houses the main and auxiliary motor silencers, but the forward funnel is fitted with a view to symmetry. The inside is fitted up as a store-room or locker.

The funnels are equipped with compressed-air whistles, there being no steam for this purpose, and the Sperry "visible" smoke unit, which makes a visible signal at the same time and for the same duration as the sound signal made by compressed air.

The number of transverse water-tight bulkheads is in excess of the Board of Trade requirements, and are so spaced that the vessel will float with two and a half compartments flooded.

The social hall, a noble and lofty apartment of Georgian character, is two decks high. The Moorish lounge on the top deck of all is gay and sunny. The swimming-bath, with its Pompeiian red-colour columns and a broad balcony and dressing-rooms, is beautifully lighted by day as well as by night. The wireless equipment is of the latest. Direction-finding equipment has aerials mounted in an open teak framework 8½ ft. in height, which is fixed rigidly to the deck. This new method gives bearings with the highest standard of accuracy, and dispenses with the large aerial system hitherto employed.

Dead-beat Compass.—The ship is fitted with the dead-beat form of compass—not a gyro-compass. "The magnetic control of the earth on the compass depends on the local strength of the horizontal part of the earth's magnetic field and on the total magnetic moment of the needles; and this needle-strength should be made as large as is reasonably possible in comparison with the weight of the card system. Only with strong needles can the bad effects of pivot-friction and mechanical disturbances, due to rolling and pitching and yawing and turning of the ship, be kept within tolerable limits. Further, the large magnetic moment should be obtained as far as possible by highly magnetic material and not by long needles; for long needles by their action on spheres and flinder's bar render it impossible for the compass-adjuster to produce a clean deviation table.

"But a strong needle system needs to have associated with it a high degree of damping. In its return to rest after disturbance the card then 'gets off the mark' promptly in virtue of the strong magnetic moment, and 'pulls up' promptly on nearing the resting position by reason of the powerful damping." [1]

The outstanding feature of this ship lies in the propelling machinery, which consists of two sets of eight-cylinder, four-cycle double-acting Diesel engines of the Harland B. and W. type, the largest

[1] By Dr. Bennett, F.R.S.

marine Diesel units hitherto constructed, developing an aggregate of 20,000 h.p. These double-acting engines are a development of all the successful features so well known in the single-acting type built for many years past by Harland & Wolff. The manœuvring controls are at floor-level at the centre of the engines, and each engine can easily be controlled by one man.

The crank cases are totally enclosed, and forced lubrication is used. In fact, from the top of the columns downwards the engines are practically indistinguishable from the single-acting engines of the same type. The same can be said of the top cylinder covers with their push rods and valve gear. The pistons are oil-cooled, and the cylinder jackets and covers are cooled by means of fresh water. The valve gear for the top and bottom cylinder covers is worked from a single camshaft, in conjunction with two weigh shafts for manœuvring. Each engine drives its own twin blast air-compressor off the forward end of the crankshaft. Flywheels and electrical turning gears are fitted aft. Thrust blocks are of the Mitchell type.

The auxiliary machinery in the wings of the ship for the use of the main engines consists of electrically-driven pumps for salt water, fresh water, lubricating oil, and fuel oil ; also coolers for fresh water and lubricating oil and sets of filters. Six manœuvring air reservoirs are fitted. Four auxiliary Diesel generator sets of 400-kw. capacity each are arranged in a room forward of the main engine-room. Each set consists of a four-cylinder trunk-type Diesel engine coupled to D.O. dynamo, mounted on a common baseplate. A separate jacket cooling system is arranged for the auxiliary engines. Electrical elevators are installed, and other electrical service includes laundry, printing, galley and cooking gear, while there are about 5,000 electric lamps up to units of 1,000 c.p. All the engine-room auxiliaries are electrically operated. Electric power will also be available for fans, heating, etc.

The new Union Castle M.V. *Carnarvon Castle* (20,063 tons) left Southampton on her maiden voyage to South Africa on the 16th July, 1926.

CHAPTER X

ODDS AND ENDS

The tramp ship, the *Savanah*—Teaching ships to speak—Captain's powers —Rats—Derelict—Dredging—Sea phosphoresence—Flying fish—Expansion joint—Whales—The ticket—Private enterprise—Law of storms, cyclone—Marconi officer's duties—Direction-finding station—Echo sea-sounding—Dazzle painting—Fathometer, determining a ship's course—Open lifeboats, direction-finder—Conclusion.

Tramp.—" The tramp ship has no recognized route like the passenger steamers and larger freight-carriers ; they go about from place to place according to the requirements of the charterers. The cargoes are very mixed—railway material, bones, hides, or whatever is to be moved." [1]

The real cargo steamer carries no passengers, but they carry the great staple commodities on which so much depends—homogeneous cargoes, grain, coal, oil and timber.

The late Sir Douglas Owen once observed that " the term tramp seemed to convey a sort of stigma or discourtesy ; it was formerly considered better taste to refer to them as ' seekers ' ".

" Tramps have increased since the advent of wireless telegraphy, because the latter enables an owner to have such easy control over his fleet." [2] These vessels did splendid service during the war, and in times of peace they will help to reduce the cost of living.

The " Savanah ".—The first experiments in steamships may be of interest. The *Savanah* of 1819, the American sailing vessel, was made famous on account of her having used auxiliary steam-engine power to cross the Atlantic, but as the vessel sailed nearly the whole way, and carried neither passengers nor cargo, she had only the honour of being the first sailing ship to carry a steam engine.

The voyage occupied twenty-nine days, but the engines were run for a total of only eighty hours, for there was insufficient fuel. Even this performance in those far-off days was the cause of some alarm, for she was pursued by the Revenue cruiser *Kite* under the impression that she was on fire.

[1] *Ship Construction and Calculation*, Geo. Nicol.
[2] *Merchant Ship Types*, A. C. Hardy, 1924.

The Cape Clear telegraph station had reported a ship on fire! The humorous side of the coming of steam!

The *Savanah* was, however, a sailing vessel, built to be one, and on her return to America the machinery was taken out of her, and she resumed her place as a sailer.

Teaching Ships to Speak.—Teaching ships to "speak" correctly in the many-tongued language of the sea is part of a British warship's duty. She does this by rehearsing them in different methods of inter-ships "talking". "I wish to exercise you in signals," says the warship to the mercantile vessel as they meet. The latter intimates that she is ready, and the lesson begins. Wireless has not yet edged out the older methods of communication. Long distances apart, two big flags and a "drum" beneath them hoisted at the mast-head will enable two vessels to indulge in quite a lengthy and vivacious gossip. "Flag-wagging", semaphoring, and operating flash-lamps are other systems of visual signalling in which a warship tests the skill of the "pupils" whom she picks up trudging along the sea lanes.[1]

Captain's Powers.—The captain of a ship has greater powers at sea than any civilian on shore. He is known as "the old man", but he is lord paramount. His word is law through the ship. In a warship he is the most lonely man afloat. His orders are repeated to the men through his officers. In case of offences, he is the judge and jury. Every decision must be recorded in the "log". Sometimes he may find it necessary to sell the cargo or the ship. He performs the offices of a clergyman. He may perform a marriage ceremony as well as reading the Burial Service over one who dies at sea.

Some of his powers have been really judicial, as the following anecdote will show. H.M.S. *Tribune* (1860) paid a visit to Chincha Islands, off the Peruvian coast, 100 miles south of Callao, and found 160 ships, "a forest of masts" of different nationalities, all taking guano from a hill, nearly 100 ft. high above its rocky floor, the dried deposits of sea birds. As may well be imagined, there was much quarrelling and fighting over it. The American Minister of Lima furnished Captain Edgell with plenary powers to deal with American ships. The short description of the use of these powers is as follows: "Several couples were 'spliced' by the chaplain under licence from Captain C. Harry Edgell, R.N., and many difficulties and complaints adjusted, mutinies investigated and judicially settled by quarter-deck under the pennant".[2]

[1] The *Daily Mail*, March 3, 1922, "Teaching Ships to Speak", by "Jackstaff".

[2] *Martello Tower in China and the Pacific*, by F. M. Norman, R.N.

The captain has no watch—he comes and goes as he pleases—but in stress of weather, or accident, he has an awful time. The captain of the *Aquitania* had five days' continuous vigil not long ago. This was on account of bad weather.

Rats.—In the photograph of the side of the *Majestic* (Fig. 113), on one of the large ropes used for holding the ship close in, there is a disc fastened on the part over the water. This is specially

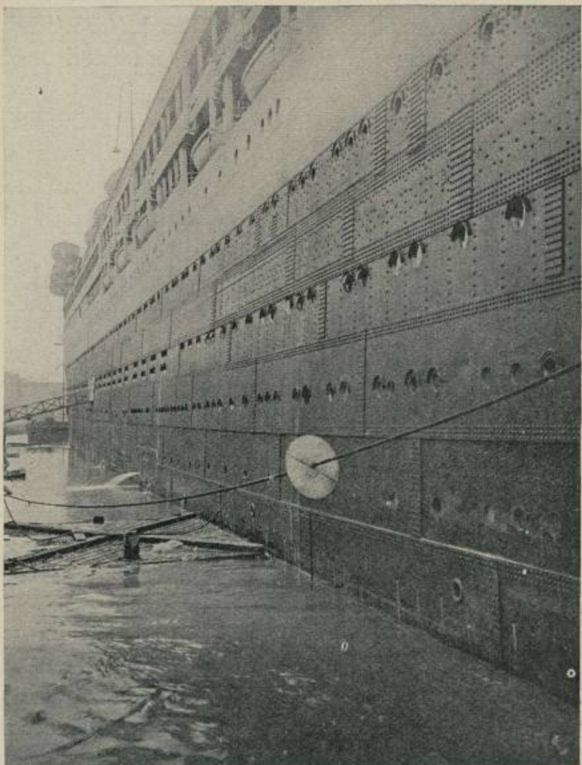


FIG. 113.—SIDE OF SHIP, "MAJESTIC", SHOWING A RAT GUARD ON A ROPE.

fitted as a protection against rats. As everyone knows, rats carry plague, and transfer the disease from one to another and to human beings. The rats die (and so do human beings), but the fleas leave the cold body for another feeding-ground and a living body. The Panama Canal authorities have stringent rules for the fumigation of ships and killing of rats. Ships in dock have been required to use rat guards on their hawsers, and to breast off from the structures. There is a large laboratory at Panama where ov e a thousand rats are examined every month for signs of plague infection.

Dr. W. M. Willoughby, M.O., of the Port of London, says: "Rats breed up to their food supply and can therefore be starved out. Accordingly concrete flooring, iron wall sheeting, and the like are used in food stores. To deal with visiting rats from ships, cats, traps and chemical poisons are used; and to prevent rats from leaving ships, rope guards are employed and gangways whitened, rats avoiding gangways when so treated. By fumigation of a ship the largest bag ever taken was 1,400 rats." [1]

Derelict.—In Chapter VII, p. 133, it was stated that by International agreement ice patrol-ships on the Atlantic, one of the world's busiest waterways, are required to report all dangerous derelicts, and warships would be sent out to destroy the derelict.

During the war a sailing vessel which had been the victim of a submarine continued, without a soul on board, to progress through the sea. It was the three-master *Ainsdale*, of Liverpool.

After she had been bombarded and broken, and the crew had taken to the boats, she was sighted by the *Basuta*, of Glasgow, going in whatever direction the wind and waves took her, and rolling heavily. Thinking that she might be a decoy, the *Basuta* approached with caution. Volunteers were called for, and the Chief Officer Macdonald and a crew of eight boarded her with difficulty.

The only living things they found on board were a cat, a parrot and a monkey. The steering-wheel had gone and the compass was smashed. A jury wheel was rigged, and as they could not take her in tow, the chief and his crew of eight took charge.

Only one was skilled in navigation, and three had never been in sail before. There was no chronometer or compass; in spite of this, Macdonald found, after eight days of terrors, that he was only five miles out of his reckoning. On the eleventh day they ran short of provisions and only a few biscuits remained. Finally the derelict was taken in tow by a tug—a splendid record of the courage and resource of British merchant seamen.

A derelict is very dangerous to fast Atlantic liners. In these days of wireless they are reported and quickly destroyed.

Dredging.—In connection with the ever-increasing size of steamships, the word dredging will occur. The two great sea canals, Panama and Suez, use great floating girder-built machinery for the purpose. There are many kinds built specially to meet local requirements. Dredging is necessary at the mouth of rivers or in the river channel and at the entrance of, and inside, harbours.

"In the harbour of Bombay there is a quantity of low-lying

[1] The *Daily Mail*, November 5, 1924.

land, some of which (about a square mile) is being reclaimed, in order to provide a site for railway sidings. This is being done by depositing material upon it obtained from the bottom of the harbour itself, and two special dredgers have been built for the purpose. They work by suction, a rotary cutter—a sort of gigantic auger—fixed at the mouth of the suction-pipe. This cuts up the material, some of which is heavy clay, and renders it capable of being drawn through the pipe. So powerful is the suction that lumps of stone of 400 lb. weight have been sucked up. Having dug up and raised the clay, the dredger then drives it along a line of pipes, 4,500 ft. long, the end of which is on the land to be raised. One of these dredgers has delivered as much as 2,700 cub. yards an hour, and between them they are able to do in an hour as much work as 5,000 carts and an army of men could do in a day." [1]

Those who have passed through the Suez Canal will have seen many such dredgers and the long line of pipes for discharging.

Sea Phosphorescence.—Among the strange sights at sea the phosphorescence at night is most interesting. "Suppose the ship is at rest on the sea. On a dark night, if we tip over the bulwarks a bucketful of water, instantly a blaze of green flame splashes far and wide, and every droplet of water shooting out from the impact raises an incandescent patch where it falls. To starboard begins a faint reverberating roar of a distant machinery, which waxes and wanes after the fashion of far-off sounds on a still night. The great passenger boat rises on the night horizon as a constellation of ever-widening lights, and as she draws near we have the impression that her port-holes near the water's edge must be illuminated with green lamps; for a suffused halo of green light, low down, can be discerned, miles away though we are, and by the time the fast vessel has approached close enough for us to hear the swish of the torn waters, the emerald blaze is resplendent from stern to stern.

"This phosphorescence in the sea is due to the microscopic animalculæ whose myriads light up the surface of the water—called Noctiluca (the night light)—and has a profound significance in Nature. It must be borne in mind that there is nothing in the life of the ocean comparable to the production and reception of sound utterances among its inhabitants.

"Land-living creatures communicate with each other, express their emotions, warn enemies, court the opposite sex, largely to the accompaniment of cries and vocal sounds. But marine organisms lead silent lives. They are devoid of anything corresponding to ears, therefore Nature has endowed them with the power of producing light, where, and for the same purpose that, terrestrial

[1] *Steamship*, by R. A. Fletcher.

creatures utter sounds." [1] This phosphorescence is very noticeable in tropical waters.

Flying Fish.—During a voyage through tropical seas, after the sun has done its worst and set in a beautifully painted sky, passengers may be seen on deck in twos and threes taking a constitutional in the cool of the evening. The sea is a wonderful dark blue colour ruffled by a breeze sufficient to create the pure white-crested waves so evenly distributed over its vast surface. Flying fish rise from the water in flocks, or shoals, of hundreds at a time, when disturbed by the passing ship or pursued by their inveterate foe, the dolphin. At great speed they dart into the air, all moving in one direction for a true glide ; using the unseen forces of the wind to prolong their flight, they will cover distances of 200 yards in half a minute, then skimming the surface of the sea looking like swallows, suddenly they find a friendly wave and disappear. So much for Nature.

Expansion Joint.—While out for a constitutional up and down the deck one passes over a broad and continuous strip of brass plate which crosses the deck at right angles. It is not beautiful, but what is it ? It is crossed and re-crossed times without number. Few passengers even give it thought, because they are unobservant. It is known as the *expansion joint.* It is found on the promenade decks of all large passenger vessels. The brass plate covers a 2-in. wide opening right across the deck, and the separation continues down the sides of the ship. It is space to allow the upper works of the vessel to expand or contract with the hogging and sagging caused by the waves of the sea. The brass plate is screwed down to the deck on one side only, the other side being left free to work with the ship. The gap is made water-tight, and the brass plate is to protect the passengers from being injured by the opening. To prevent creaking, the joints and rubbing surfaces are well bedded in flannel.

Whales.—The story of all that took place on *Titanic* is well told in Filson Young's book. First the impact and then the stopping of the engines causes alarm. Not long ago it was reported by wireless [2] that the R.M.S. *Berengaria* ran into a school of whales frolicking in the calm blue sea. The ship hit one more than 30 ft. long. The impact shook the great 52,000-ton liner so that seamen in the fo'c'sle ran on deck to see what had happened. The whale's great bulk stuck into the bow until it fell away in two parts. For a time it endangered the propellers.[3]

"It takes a mighty storm greatly to reduce the speed of an

[1] *Why the Sea Lights Up*, by Professor George Sleggs.

[2] The *Daily Mail*, September 18, 1924 (wireless).

[3] *Notable Shipwrecks.*

ocean liner, and few wrecks are traced to such a cause," so says a book on " Notable Shipwrecks ".

The Ticket.—It is extraordinary how we always have faith in the power of a ticket for a journey. Even when we find ourselves in a train passing places with unfamiliar names we still trust the company's servants who answer our questions.

A woman was once heard demanding : " Say, porter, is this direct for Wembley ? " " Yes," she was told ; but even if misinformed she would trust in the correctness of the reply.

Purchasing an article from a person is not the same as buying a ticket from a company. Sometimes there is a want of faith in the individual. Of course, the company has more to gain by correct behaviour, and sometimes the stranger suffers from misplaced trust in the individual. In the former case we have learnt to trust even those we do not see. A story is told of two men who were discussing matters in a train, and one of them said, " It is never safe to trust a man farther than you can see him ". The reply was brief : " Can you see the man who is driving this train ? "

We may purchase a ticket that will not only carry us through many continents round the world, but which will even provide for our amusements on journeys by steamer, train, motor, and aircraft, providing for hotels on land and even guides to show the wonders within our reach. This is what was provided for the passengers who made the trip around the world in the Red Star liner de luxe *Belgenland* in 1924–1925.

Private Enterprise.—The shipping industry of Great Britain has been built up by private enterprise, and it is well it should be so ; even docks and harbours are guided in the same way. Public authority, largely represented by the payers of dues, manage our ports. This cannot be said to be State ownership or control of British shipping ; most people will agree with Gladstone that " the business of a Government is to govern, not to trade ".

Law of Storms.—All revolving storms, such as cyclones of the South Indian Ocean and Bay of Bengal, hurricanes of the West Indies, typhoons of the China Sea, appear to come about in the same way. " The wind revolves in a spiral curve round and towards an axis with great rapidity, in a direction *against* the hands of a watch in the northern, and *with* the hands of a watch in the southern hemisphere ; the nearer the centre or vortex the more violent is the wind, while in the centre itself is calm." [1] The diameter of this whirl is sometimes 1,000 miles.

These storms travel bodily along at a speed of about 200 miles a day, but it has sometimes approached 1,000 miles a day.

Cyclone.—The writer was in the neighbourhood of Madras in

[1] *Glossary of Navigation*, Rev. J. B. Harbord, M.A., R.N.

October 1888 when a cyclone travelling down from northern ports was reported by telegrams. Towards evening the wind was near to maximum force, and the noise was so great that it was very difficult to hear ordinary speech indoors, while outside all traffic was suspended. As darkness came on the closed doors and windows began to give way to the pressure from outside, and made the night terrible. In the morning most of the roads were found to be blocked by fallen and twisted trees, some of which were many feet in girth. Military stables had collapsed, and twenty-two horses were destroyed. At sea there was even greater disaster. Eleven ships had been blown out of the harbour. The breakwater—a mile long, constructed with 10-ton blocks of cement—was broken up, and a Titan crane on rails at the end of the breakwater weighing many hundred tons had disappeared into deep water.

Two hours after this storm had swept by two large steamers came in. The passengers and crew were much surprised to see the fearful wreckage. The fact was, they had been in the calm centre of the cyclone, and thus escaped its force. The calm centre is the point of interest. In those days there were no wireless warnings to be picked up. We have given an account of wireless warnings which saved eight big steamers from running into a cyclone in the Bay of Bengal in 1922 (see Chapter VII, p. 113).

Marconi Officer's Duties.—"The Marconi officer's duties on a liner are described as a cross between a continental cable and telegraph office and a branch of the navigation department, enjoying an existence which would be amply justified by its work in either capacity alone.

"When the ship is out of sight of land passengers make their way to the Marconi office and send one or more Marconigrams to their friends. In this way an avalanche of messages reaches the desks of the telegraph staff to be routed, charged for, and transmitted to addresses in all parts of the world.

"There are friends ashore who do not forget to send a word of good cheer, so that a similar though smaller flood of inward telegrams must be received, recorded, and handed to their various addresses.

"Again, as the ship approaches the opposite shore passengers will want to book rooms, announce their arrival to friends, and otherwise make arrangements prior to landing, whilst at any stage of the journey they may wish to keep in telegraphic touch with their business interests. So there is always plenty of inward and outward 'traffic' (as telegraphists term telegrams in bulk), the 'peak load' occurring during the last two days of the voyage.

"Besides these radio-telegrams, a certain number of messages will pass between the ship and her owners, and warnings in regard to navigation will be received by which the great vessel will be shepherded on her way. Several times a day reports on meteorological conditions are transmitted to the Air Ministry in England and to the Hydrographic Bureau at Washington, U.S.A., and are of great assistance to the authorities in compiling their weather forecasts.

"The ship is in touch with the world news. Every day, then, the Marconi man must receive news bulletins giving items to suit every taste, not to mention latest market prices and exchange rates. The *Majestic* is fitted with high-speed automatic transmitting and receiving apparatus capable of handling traffic at

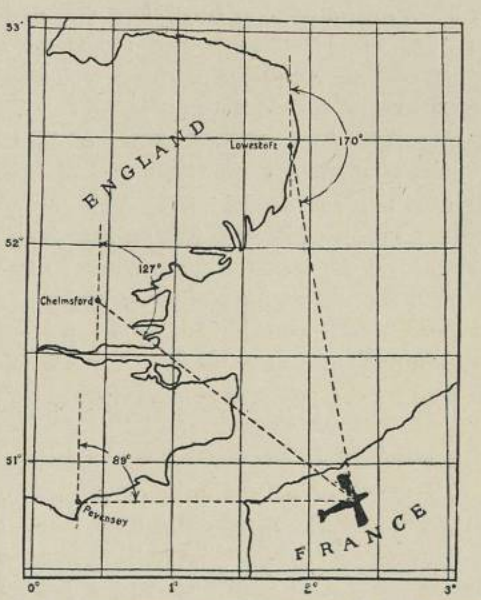


FIG. 114.—AIRCRAFT AND WIRELESS D.F. STATIONS.

100 words a minute or more, high-speed working taking place between ship and shore at ranges as great as 1,800 miles. The *Olympic* is now similarly fitted, and before long other ships will follow suit." [1]

One of the ways the safety of the ship is assured is by signals sent out from Coast D.F. stations, which the Marconi direction-finder fixes. There are sensitive receivers which, in addition to being able to pick up signals from stations at a considerable distance, will, when required so to do, indicate the direction from which the signals have arrived, and perform this task with remarkable accuracy. The position of a ship fitted with a Marconi

[1] *White Star Magazine*, November 1923, by Sidney H. Nayler.

direction-finder can, however, be readily found from the bearings of two or more coastal wireless stations, with a very small margin of error, often less than a quarter of one degree of arc, which may be less than a mile. Correct "fixes" have been obtained at a distance of over 700 miles from land. It is not usual to require a "fix" more than 50 miles from land. Fig. 114 shows this system in use for aircraft. "D.F." wireless is of greatest value when vessels have to grope their way along in a fog. Wireless can be trusted not to play tricks in the way sound will do, as already described (p. 125); not only this, but the direction-finder unhesitatingly gives the bearing and relative course of other vessels using wireless long before they come near enough to be dangerous. We have already mentioned the fact that the ordinary telephone can be used as if connected with the shore at distances up to 50 miles. Think of the joy of hearing a well-known voice hours before the passenger can set foot upon land.

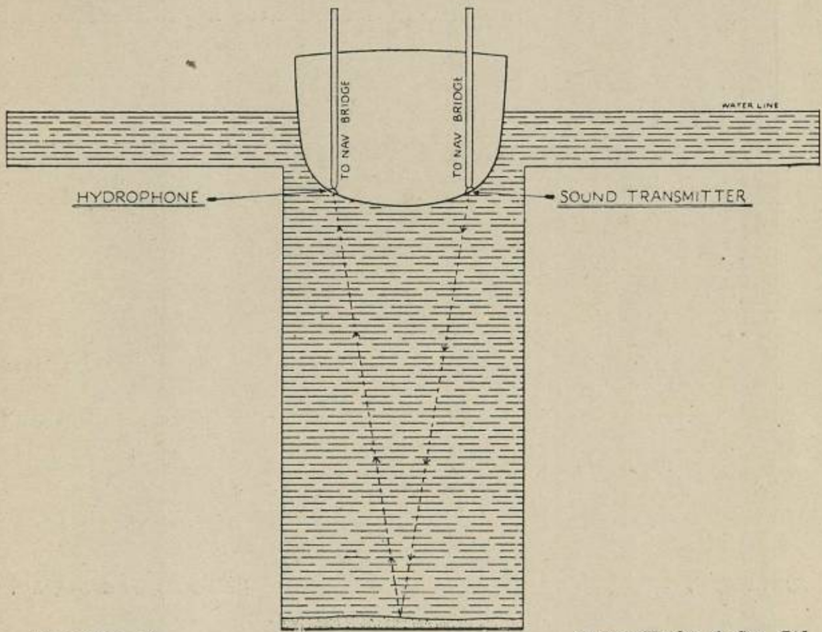
Direction-finding Station.—About 41,000 readings are summarized in the first report on the work of the ten directional radio receiving stations set up in the British Isles in 1921.

Observing stations on the coast taking readings of the apparent bearings of ships whose positions were known, it was found that up to 100 miles the observations showed only a slight variation. Wave-lengths between 2,000 and 9,000 metres over distances of 100 to 1,500 miles were used. When the same waves travelled considerable distances overland they showed much greater variations.

Echo Sea-sounding.—We have heard of the echo method of estimating the distance of an iceberg, or a cliff, or a hillside by the simple expedient of shouting at it and using a stop-watch to determine the time of the echo. There is now an apparatus which can accurately measure the depth of water beneath a ship, even when the vessel is proceeding on its course. "The method of sounding by lead is probably as old as the art of navigation, and so old that history can help little in discovering its origin. Herodotus (*circa* 450 B.C.) not only refers to sounding by the lead, but he also mentions arming the lead with grease for obtaining samples of the sea bed, and so we may say with certainty that for more than 2,000 years—that is, until the invention of the Kelvin wire sounding machine—this ancient method remained an unimproved and an unchallenged guide to navigation.

"The system known as the *echo* method of depth-sounding (Fig. 115) depends on the measurement of the time interval—i.e. the time taken by the sound to travel from the *transmitter* on one side of the ship to the sea bottom, and the echo to the *receiver* on the other side of the ship—both being fixed below the line of water-level—a distance which is approximately double the depth of the water.[1]

"The source of sound is a steel diaphragm, about 5 in. in diameter, fixed to the hull of the ship. This is set in vibration at regular intervals by a spring hammer, which is withdrawn from the diaphragm by a solenoid, the circuit of the latter being broken automatically every half-second. The note emitted by this transmitter has a frequency of 1,250 per second, and when immersed in water the diaphragm is heavily damped, so that the energy com-



By courtesy of] [*Henry Hughes & Son, Ltd.*

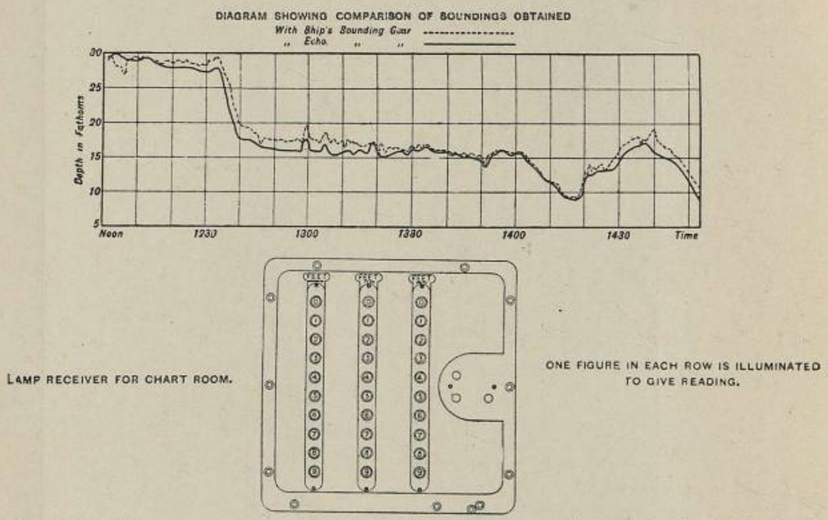
FIG. 115.—ECHO DEPTH-SOUNDING, BRITISH ADMIRALTY SYSTEM.

municated to it by the hammer is quickly transferred to the water. The *receiving* hydrophone is a simple microphone enclosed in a rubber body immersed in water. Both the *transmitter* and *receiver* act quickly and do not confuse the original sound and the echo. An electric motor which drives two switches through a reduction gear is so arranged that the instrument is graduated to read in fathoms directly instead of time. Thus, soundings can be taken when the ship is proceeding on its course, and it is stated that hundreds of sea-soundings can be taken in the time occupied by one with the old 'lead'. Depths of over 4,000 metres have been

[1] Speed of sound travelling through water is 4,700 ft. per second, but through air it is about 1,100 ft. per second.

reported, and it is confidently expected that echoes will be obtained in depths far greater than this. The diagram shows comparison of soundings obtained " (Fig. 116).[1] While the Admiralty Research Department continue experiments, the German "Behm Echo Depth-sounder" is being handled in Great Britain, the Dominions and Colonies by a co-operation arrangement with Messrs. Kelvin, Bottomley & Baird, Ltd., Glasgow and London.

The impulse is provided by a cartridge. On pressing a firing key, a small cartridge is discharged from a firing head attached to an upper deck rail. The cartridge on entering the sea detonates at a few feet below the surface and originates a powerful sound-



By courtesy of] [*Henry Hughes & Son, Ltd.*

FIG. 116.—THE INDICATOR.

wave which first affects by direct action a microphone on the ship's side (fixed internally); and secondly, after reflection from the bottom of the sea, affects a second microphone similarly fixed on the other side of the ship. This instrument has been made automatic and self-indicating, and it is now being supplied to Mercantile Marine.

Of the many novel scientific devices which appeared during the war, the hydrophone is in some ways the most remarkable, especially when we recall the part it played in detecting the propeller sounds coming from the German submarine.

Fathometer.—The Submarine Signal Corporation's "Fathometer" depth-indicating apparatus (Fig. 117) (by kind per-

[1] *Use of the Acoustic Method of Depth-sounding for Navigational Purposes*, H.M.S.O.

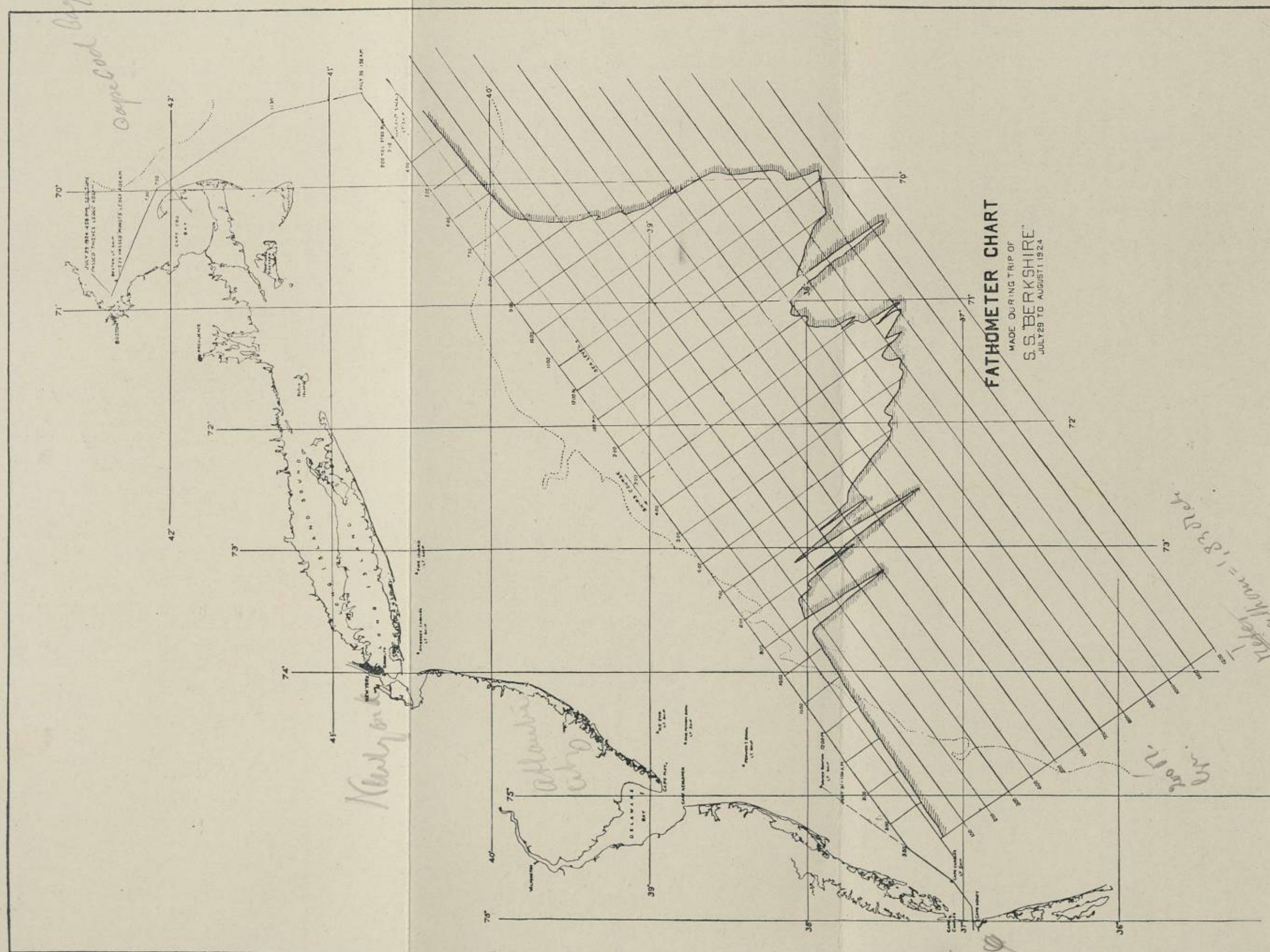


FIG. 118.—FATHOMETER CHART.

[To face page 215

mission) is claimed to be superior to either of the foregoing. It consists, essentially, in the production at periodic intervals of a powerful sound—of short duration—in water, near the surface, and the time elapsing before the echo is returned from the sea bottom. For depths not exceeding 100 fathom it is automatic, but for deeper soundings it becomes necessary for the observer to listen through a telephone receiver for the return of the signal. On a glass dial are two circular scales, the inner scale being graduated

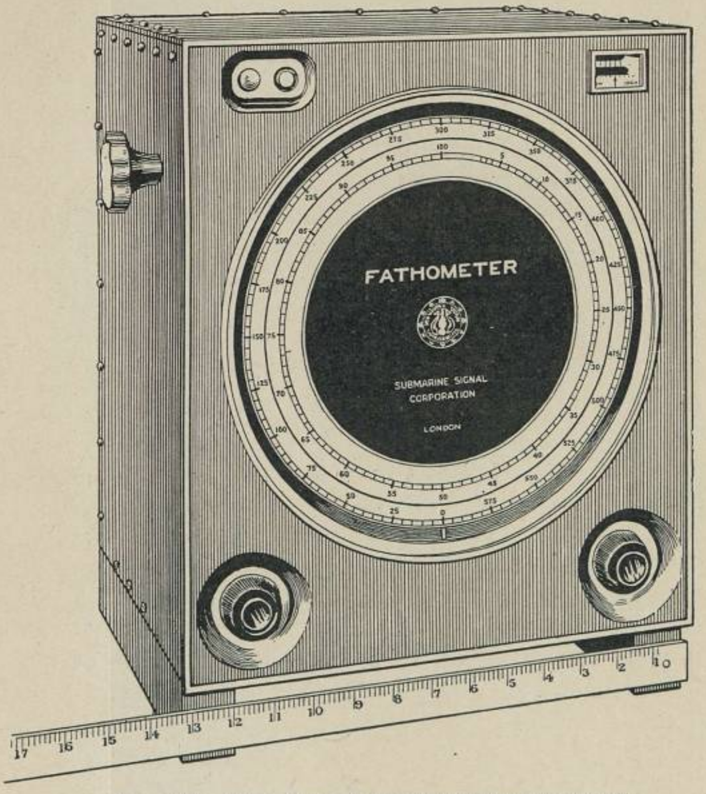


Fig. 117.—The Echo Sounding "Fathometer".

from 0 to 100 fathom and the outer scale from 0 to 600 fathom, the zero-point of the two scales being on opposite sides of the dial. The chart shows a record (Fig. 118).

This apparatus has been installed on the *Mauretania*, and it is being used in America on certain Government and cable-laying vessels. The Royal Mail Steam Packet Company's new ship, M.V. *Asturias* (22,500 tons), now the largest motor vessel in the world, has the Admiralty system of echo depth-sounding fitted on her.

Dazzle-painting.—Another very wonderful development during the war was the adoption of dazzle-painting as opposed to painting a ship with a view to achieving invisibility. In the words of Commander Norman Wilkinson, who invented it: "Dazzle-painting is a method of producing an effect (by paint) in such a way that all accepted forms of a ship are broken up by masses of strongly contrasted colour, consequently making it a matter of difficulty for a submarine to decide on the exact course of the vessel to be attacked."[1]

Determining a Ship's Course.—"The accurate determination of a vessel's course is the prime factor required by a submarine commander to ensure successful attack." "He who hesitates is lost," so we come to realize the extreme importance—even in times of peace—of a knowledge of the appearance of vessels at sea under all conditions in order to be sure of the speed and direction it is taking, apart from any signals. Long experience has taught the mariner these things.

Lifeboat's Direction-finder.—In Chapter VII ships' lifeboats were dealt with, but we must move with the times.[2] The new Mercantile Shipping (Life-saving Appliances) Rules, dealing with the subject of wireless appliances for ships' lifeboats, came into force in 1925. The Marconi International Marine Communication Company have a special wireless set to be fitted to the normal 26-ft. lifeboat. The transmitting range is from 60 to 70 miles if the rescuing ship is fitted with a crystal receiver, and double this range if there is a valve reception. The receiving range of the lifeboat set is 80 miles. A direction-finding system is incorporated with the instrument. This will enable the lifeboat to direct the course towards the rescuing vessel. The direction-finding works on vanishing point instead of, as is usual, the position of maximum signal strength, since, whereas complete silence is easily detected, gradations of strength are difficult to appreciate. For open boats the whole set is housed in a waterproof container.

"It is gratifying testimony to the increasing degree of safety under which sea transport is carried on that during the past year (1925) only ten vessels were posted as 'missing'. The number of such disappearances in 1924 was seventeen, and for each of the two preceding years twenty-one. These diminishing casualties are at once a tribute to the classification societies, shipowners, shipbuilders, and last, but not least, to wireless telegraphy. With regard to this last-named factor, it is of interest to note that only

[1] *The Dazzle-painting of Ships*, by Lieut.-Commander Norman Wilkinson, R.N.V.R.

[2] *The Times*, December 16, 1924.

one of the ten vessels which disappeared without trace was equipped with this adjunct to safety."[1]

Consider what the ship means to us. Apart from the carrying of food and materials, who can estimate the enormous benefit to humanity which these ships bring? Think of the visits of children to the old folks at home, the ever-interesting first sight of new places and in more remote times those wonderful ships which did all the exploration and search for us; think, too, of to-day how rapid travel and the wonderful wireless are shortening the distance between nations, and causing them to mingle together. Surely this must bring about universal brotherhood.[2]

[1] *Syren*, January 6, 1926.

[2] *Engineering of To-day.*

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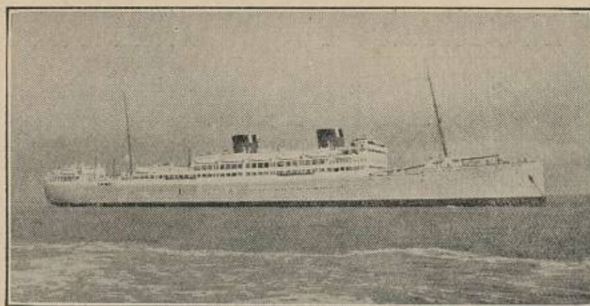

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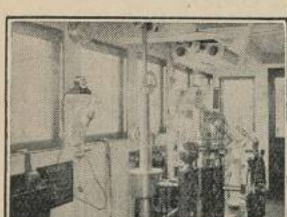

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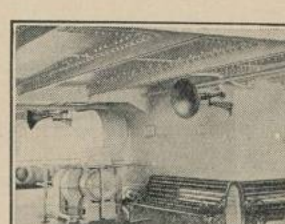

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