ALL ABOUT SHIPS

All About Ships

By

Lieut. TAPRELL DORLING, R.N.

With Four Colour Plates and a large number of Drawings and Photographs

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PREFACE

THOUGH the literature of the sea is wellnigh inexhaustible, there is, I venture to think, no work at a popular price dealing with sea subjects as a whole, and in compiling this volume it is my hope that it may be of interest and use to all boys, and particularly those who one day will serve their country either in the Royal Navy or the equally important Mercantile Marine.

The book is not intended to run in competition with more elaborate and comprehensive volumes already upon the market, each of which deals with its own particular nautical subject, nor for the perusal of the professional seaman; but, of course, it goes without saying that I shall be much gratified if there is anything in this work which arouses his interest.

I have included a certain amount of historical information, and have touched upon certain matters not frequently discussed outside the covers of technical works. It must be remembered, however, that in endeavouring in many cases to compress into one short chapter information to which a whole volume might well be devoted, I have been forced to cut down to the greatest possible extent, and though I have used every effort to prevent anything of importance from being left out, I cannot hope that there are not blemishes and flaws which will be apparent to the practised critic.

In the preparation of the work I have necessarily consulted many works in search of information. With the idea of keeping the book within sizeable limits, too, only British maritime affairs have been discussed, and in regard to these the greatest pains have been taken to ensure accuracy. Every date, tonnage, speed, etc., has, where possible, been verified from more than one source, but in spite of extreme care inaccuracies may be present, and for these I must apologise.

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; the Secretary of the Royal National Lifeboat Institution; Alan H. Burgoyne, Esq., M.P.; Messrs. John Murray; Messrs. George Bell; Messrs. Cassell and Co.; Lord Kelvin and James White; Messrs. Thomas Walker and Sons; Messrs. Henry Hughes and Sons; the Liverpool Salvage Association; Messrs. Thomas Law and Co.; Messrs. Macvicar, Marshall and Co.; Messrs. J. B. Homer and Son; Messrs. H. Charlton and Co.; Messrs. Swan, Hunter and Wigham Richardson; Sir W. G. Armstrong, Whitworth and Co.; Messrs. Cochrane and Sons, of Selby, Yorkshire; J. W. Isherwood, Esq.; Messrs. Ismay, Imrie and Co.; the Cunard Line; the P. and O. Steam Navigation Company; Captain A. H. Clark; Messrs. Babcock and Wilcox; Messrs. Yarrow and Co.

Further, I must acknowledge the very great assistance I have received from many brother officers and

friends who have given me information and have corrected proofs, and in particular the welcome advice of Lieutenant J. M. Borland, R.D., R.N.R. I owe the deepest debt of all, however, to my wife, without whose help and kindly encouragement the work would never have been undertaken.

TAPRELL DORLING,
Lieutenant, Royal Navy.

H.M.S. *Agamemnon*,
Home Fleet.

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ALL ABOUT SHIPS

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Ancient and Mediæval Ships

It is not difficult to imagine how men first hit upon the idea of using floating objects to enable them to cross rivers, lakes and, eventually, the sea. The earliest and simplest forms of water carriage consisted, doubtless, of logs and rafts, and from these to the "dug-outs," hollowed out of a solid block of wood by means of tools or fire, would not be a very long step. The first kinds of built-up boats were probably constructed by stretching the skins of animals over an interior wooden framework, and to this class belonged the coracles used in ancient Britain, and which are still to be seen in use on our inland waters at the present time. Of the same type also are the modern folding Berthon boats, whose sides are composed of two thicknesses of painted canvas stretched over a wooden frame.

An account of the shipping of countries other than our own is rather beyond the scope of the present volume, but it is impossible, in justice to the subject, to pass on without making some slight mention of the vessels used by the ancient Egyptians, Phœnicians, Greeks and Romans, for these people were the first to use comparatively large vessels for the purposes of war and maritime commerce.

It is often supposed that the Ark of Noah is the oldest vessel of which we have any authentic record, but that well-known authority on ships, Sir George

Holmes, in his most interesting work, "Ancient and Modern Ships," proves that this is not so, and that there is every reason to believe that the Ark was a properly built-up ship, constructed by people who must have had some previous knowledge of ship construction.

Turn up the sixth chapter of the Book of Genesis, and there you will see: "Make thee an ark of gopher wood; rooms shalt thou make in the ark, and shalt pitch it within and without with pitch. And this is the fashion which thou shalt make it of: The length of the ark shall be three hundred cubits, the breadth of it fifty cubits, and the height of it thirty cubits. A window shalt thou make to the ark . . . and the door of the ark shalt thou set in the side thereof; with lower, second and third stories shalt thou make it."

From this we see that the Ark was a three-decked vessel, made watertight by being coated with pitch; further, that her interior was divided up into compartments, and that her dimensions, taking the cubit as 18 inches, were 450 feet long, 75 feet wide, and 45 feet deep. A vessel of this size, says Sir George Holmes, could not have had a registered tonnage of much less than 15,000, and it is hardly likely that a ship of this great burden could have been built by people unskilled in the art of shipbuilding.

There are various dates assigned to the Flood, but it appears probable that it took place between the years 3700 and 2840 B.C., and, to show that the art of ship construction was known long before this time, it may be mentioned that vases bearing crude representations of ships have been found in tombs in Egypt which are supposed to date from between 5000 and 6000 B.C. The vessels depicted are thought to have been as long as 250 feet, so it appears impossible that they can have been mere "dug-outs." In another tomb was discovered a picture of a decked vessel used on the Nile six thousand three hundred and ten years ago, or some five to fifteen centuries before the generally accepted dates for the construction of the Ark, and as this picture showed a ship fitted with a mast and sail it is obvious that even at this remote date shipbuilding could not have been in its infancy.

The Phœnicians, Greeks and Romans subsequently possessed decked ships of the galley type, propelled by oars and sails, and these, we know, were capable of transporting large numbers of men or great quantities of merchandise. The Phœnicians were the first to construct war galleys, whose necessary propulsive power was furnished by sails and two banks of oars; but their example was followed by other people, for the Greek navy, at the Battle of Salamis, in 480 B.C., and consisting of 380 vessels, included "triremes," or galleys driven by three banks of oars. Subsequently, however, vessels with four and five banks of oars, and known as "quadriremes" and "quinqueremes," were built. The Romans also used galleys of a very similar type for war purposes, and it is interesting to note that galleys were used in the Mediterranean as late as the sixteenth century.

Great progress in shipbuilding was made throughout the Mediterranean between the dates 1200 and 100 B.C. The merchant vessels in use were of various sizes, but the largest were probably some 180 feet in length, while sails were used as the primary method of propulsion, oars, however, being fitted for use in a foul wind. The war galleys were similarly propelled, but invariably used oars alone in action.

Outside the Mediterranean much advancement in ship construction had also been made, and Cæsar, in his "De Bello Gallico," describes the vessels in use by the Veneti, a race living on the sea-coast of France in the neighbourhood of what we now call Brittany. The ships of the Veneti, he says, were built of oak of great thickness, while oars were not used, a leather sail alone affording the necessary motive power. The anchor cables were iron chains, while the craft had high bows and sterns, for sailing in safety in a rough sea, and were flat bottomed, to facilitate beaching.

Ships of this kind, manned by the hardy Breton seamen, did all the carrying trade between Gaul and Britain, but at the time of the first Roman invasion of this country (55 B.C.) its inhabitants were still very backward in shipbuilding. Cæsar states that the vessels, or more probably boats, were very slightly constructed of an interior wooden framework, over which hides were stretched. Craft of this sort could have been of little use in rough water, and much less for the purposes of war.

The ancient Saxons, who were notorious as pirates in the North Sea, are said to have made use of ships similar to those of the ancient Britons, but there is no doubt that at the time of their invasion of this country (A.D. 449-495) their vessels must have been far larger and of more substantial build.

The predatory exploits of the Danes, that hardy race of mariners who are supposed to have originally discovered North America, and who at one time or another ravaged the whole seaboard of Northern Europe, soon became a severe menace to the safety of England, and the Saxon kings often maintained large fleets to protect the coast.

The Danish or Viking vessels were very much the same as those used in Norway at the present time. A specimen of one of their ancient boats was discovered in 1880 embedded in clay near the entrance to the Christiania fiord. Although the boat discovered was of a small size, it is highly probable that the larger vessels were modelled upon much the same lines. They had a wide bow, fine lines and upstanding prow and stern. The large square sail gave a great speed when running before the wind; oars could, however, be used if the wind was foul, but, generally speaking, the sail was the usual method of propulsion. The steering was done by means of an oar, or "clavus," over the stern, while the shields of the warriors in the boat were hung round the outside of the gunwale. In this position they were out of the way, while they also served as a breastwork to protect the inmates from the enemy's missiles.

Alfred the Great, who is universally regarded as the founder of our navy, designed vessels which were larger and faster than the Danish craft. Some had as many as sixty oars, and others more, and in the year 897 he met and defeated a fleet of 300 Danish sail off the Dorset and Hampshire coasts. During the reign of Edgar (A.D. 959-75) it is said that no fewer than 3,600 vessels of all kinds, and divided up into three squadrons, were kept at sea. The king himself took a great and personal interest in the welfare of his fleet, for he would embark, in turn, and cruise with each of the squadrons. Pictures of vessels at this period are few and far between, while those which are in existence are more symbolical than strictly accurate in their delineation. It appears probable, however, that they were of much the same type as the old Viking ships, and that one large square sail afforded the necessary means of propulsion. The use of oars, it is said, had been largely discontinued, while in the men-of-war a species of ram, for piercing and sinking the enemy's vessels, had been introduced.

Mediæval Ships

When William the Conqueror invaded this country, in A.D. 1066, he transported his army across the English Channel in a fleet of small unprotected merchant vessels, and without the assistance of a navy. The characteristics of his vessels were much the same as those of the

Vikings, for they had the same broad, upstanding bows and sterns, one square sail, and were steered by means of a paddle at the stern.

Though, as a rule, the ships of the eleventh and twelfth centuries were of small dimensions, the construction of larger vessels was not omitted. You will probably all remember having read about the loss of the *White Ship,* or *La Blanche Nef,* as she is more properly called, with Prince William, the son of Henry I., aboard. She was a 50-oared galley, and, as no fewer than 300 people were drowned when she was wrecked on the Normandy coast, she must have been of a considerable size.

During the reign of Richard Cœur de Lion great encouragement was given to shipbuilding, and to maritime commerce generally, by the expeditions to the Holy Land, in which the king himself took part. We read that a fleet of 110 sail left Dartmouth in A.D. 1190 for Palestine, and that, after being reinforced in the Mediterranean, it consisted of 13 "buccas," 100 "ships of burden," and 50 galleys, each with three banks of oars.

A "bucca," otherwise known as a "buss" or "dromon," was a ship of the largest size, and carried three masts, while the galleys followed the general types, some being propelled by oars alone, and the others by oars and sails. The latter were the largest, and carried as many as 60 men-at-arms, besides 104 rowers and some 20 sailors, and they were fitted with beaks, or rams, for piercing and sinking an enemy's vessel.

The larger sailing ships were provisioned and stored for a year, while their complement, in some cases, amounted to as many as 225 men. Towards the end of the twelfth century very large vessels were used by various Mediterranean powers, and one Venetian vessel we read of was large enough to accommodate 2,000 refugees. Many of the improvements which were subsequently put into all ships owed their origin to the great dockyard at Venice, which employed 16,000 workmen. This institution still flourished at the end of the fifteenth century, and during the war of the Venetians against the Turks a complete and fully equipped galley was turned out every day for 100 consecutive days. This is a feat of which any dockyard might well be proud.

In the time of Henry III. (A.D. 1216-72) the English fleet expanded greatly, principally owing to the large part English vessels had taken in the Crusades. Our sailors, therefore, were enabled to penetrate into seas which hitherto had been unknown to them, and maritime commerce of all kinds increased greatly. The introduction of the compass, too, in the early days of the thirteenth century, rendered navigation a far less hazardous undertaking than before. In the thirteenth and fourteenth centuries there was no Royal Navy as we now know it, and for many centuries the majority of the vessels which fought in our sea battles were merchant ships hired for the occasion. The Cinque Ports, originally five (Dover, Hastings, Hythe, Romney and Sandwich—Winchelsea and Rye being afterwards added), had been constituted by William I. and succeeding kings, who required them to supply the necessary vessels and men for the defence of the coasts in time of emergency, and apparently the only ships kept permanently in commission were the galleys, which patrolled off the coast from Candlemas (February 2) to Martinmas (November 11), and which were provided by the Cinque Ports to guard against the sudden descent of pirates.

Information about the type of ship in use at the end of the thirteenth and beginning of the fourteenth centuries is comparatively meagre. A ship of

A.D. 1284, however, is shown on the Dover seal, and although it is more symbolical than strictly accurate, it affords, nevertheless, one or two interesting points for consideration.

The figure going aloft on the shrouds, and the sail furled on the yard, instead of the yard and sail being lowered bodily on deck, points to the fact that by this time sails were furled aloft, while the raised structures, or castles, at either end of the vessel, probably designed to give elevated positions for the use of archers and men-at-arms in action, are interesting, for they were undoubtedly the beginning of the exaggerated poops and forecastles of our later fourteenth-century men-o'-war. Up aloft will be noticed a species of fighting top, or crow's nest, and this was probably used by archers in action, or for a look-out man or pilot under ordinary circumstances. On the aftercastle will be noticed the Cinque Ports flag, so this vessel probably represents one of the few regular men-o'-war of the period.

In those days tonnage was by no means governed by the same rules as it is now, and from what we can gather the measure of a ton was probably the cubic space occupied by a tun of wine containing 252 gallons. For this reason it is practically impossible to compare ancient vessels with those of the present day from the point of view of actual size. The ships, however, varied from 240 to 60 tons. About this time the "clavus," or steering oar, was superseded by the rudder hung on the stern of the ship.

The reign of Edward III. (A.D. 1327-77) was conspicuous for many great naval expeditions and battles. The men-o'-war of the period, however, were merely merchant vessels of the usual type adapted to the purpose of fighting vessels by being temporarily fitted with raised fore and after castles for the use of archers, and it was not until the introduction of cannon in vessels of war (fourteenth century) that the two classes commenced to become distinct.

On the adoption of cannon considerable modifications in design had also to be introduced, for the side of the vessels had to be heightened, and, in order to counteract this extra height and the extra weight of the guns, the beam of the vessels had to be increased. The sides of the majority of these early war vessels carrying guns had considerable "tumble home," as it is called, the width of the deck in some cases being only half the actual width of the vessel on the waterline.

During the nine years' reign of Henry V., in the early part of the fifteenth century, the naval resources of this country were again greatly developed. Cannon in English vessels, however, do not appear to have been brought in until about the middle of the century, for in the naval battles of 1415-17 no mention is made of their having been used on either side. King Henry took a profound interest in the welfare of his fleet, and under his directions many large vessels were constructed. The men-o'-war of the period were classified under the names of Great Ships, Cogs, Carracks, Ships, Barges and Ballingers, while it is significant that no Galleys are mentioned, their use for war purposes probably being confined to the Mediterranean Powers. The carracks were not built in England, and all those in the King's navy were prizes captured in 1416 and 1417, the tonnage of the largest being 600. Great ships, cogs, and ships were apparently the largest vessels, and we read of the *Jesus* of 1,000 tons, the *Holigost* of 760 tons, the *Christopher Spayne,* of 600 tons, and the *Trinity Royal* of 540 tons. The barges were of about 100 tons, while the ballingers ranged in size from 80 to 120 tons.

The mercantile marine during this period underwent little change, for the country was at war; but there is no doubt that the experience gained in the building and navigation of large vessels had its effect in improving the smaller types of trading vessels.

From this time up till about 1470, and owing to the campaigns in France and latterly to the Wars of the Roses at home, shipbuilding and commerce generally suffered greatly, and made but little progress. In 1475, however, when affairs had quieted down, trade commenced to make phenomenal progress, and commercial treaties were concluded with Denmark, France and certain States in Holland and Germany, while English vessels found their way to the Mediterranean and carried on a large trade with Italy and other countries. A still further advance had been made in shipbuilding by this time.

In our ships used for war purposes in the latter half of the fifteenth century guns were mounted on the upper deck, while the forecastle became more largely developed, and a bowsprit, or "bolt sprit" as it was first called, was introduced. The primary sail consisted of the large mainsail, but from the presence of the boom on the mizen it appears as if a lateen mizen was also fitted. The bowsprit also points to the fact of a sprit sail probably being used. At this time the Portuguese and Spaniards, who had first become well known as navigators in the early fifteenth century, sent out expeditions to various distant parts of the world. The most famous of all these, however, was that of Christopher Columbus, a Genoese navigator, who left Palos in 1492, and sailed to the westward with the idea of reaching India. His famous discoveries are too well known to need recapitulation here, and his ships are what we are principally concerned with.

The largest of these was the *Santa Maria,* a caravel of 233 tons.

She had, as will be noticed, an enormous forecastle and poop, and was fitted with three masts. On the fore and main masts the usual square sails were carried, that on the main having a topsail above it, while on the mizen was a long yard on which was set a lateen sail. On the bowsprit was a square sprit-sail on a yard, and this sail afterwards became a feature in all British ships so lately as the latter part of the eighteenth century. The rate of progress in the days of Columbus could not have been very speedy, for the *Santa Maria* was reproduced for the Chicago Exhibition of 1893, and was sailed across the Atlantic on the same track as that followed by Columbus himself on his first voyage, and it was found that the greatest speed attained was 6½ knots, while the shortness of the vessel, 128 feet over all, caused her to pitch horribly.

John Cabot, a Venetian domiciled in Bristol, left during the latter part of 1496 on a voyage of discovery to the westward. Of his ship we know little except that it must have been very small, for it only carried eighteen men all told; but he succeeded in discovering Labrador, and was therefore the first to land upon the continent of America, for Columbus on his previous voyages had only discovered the Bahamas, Cuba, Hispaniola (Hayti), Dominica, Guadeloupe, Antigua and Jamaica. About the same time also the famous Vasco da Gama doubled the Cape of Good Hope, and travelled to Calicut in India. All these voyages and expeditions had a large influence upon shipbuilding, for they offered inducements to mariners to proceed on voyages across the great oceans, while the shipbuilders also were encouraged to construct vessels suitable for such undertakings.

In the reign of Henry VII. (1485-1509) great attention was not only paid to commerce and voyages of discovery, but also to improvements in the construction of vessels for the Royal Navy, and two vessels were built which excited every bit as much attention in their day as the famous "Dreadnoughts" in ours. These were the *Regent* and the *Sovereign.* The former was launched in 1490, and had four masts and a bowsprit, being armed with 225 small guns known as "serpentines." The second vessel carried 141 serpentines, and it is curious to note that she was built under the supervision of Sir Reginald Bray, the architect of King Henry VII. Chapel at Westminster Abbey.

The *Regent* was burnt in action with a French vessel off Brest in 1512, and was replaced by the famous *Henri Grace à Dieu,* built at Erith on the Thames and launched in 1514. Authorities differ as to the exact tonnage of this vessel, but it was probably between 1,000 and 1,200. There are in existence many pictures of this well-known ship. Judging from her appearance, she must have been anything but weatherly, but her rig was more like that of our present-day sailing ships than that of her predecessors, for upon the foremast she carried a square foresail, topsail and topgallant sail, while the mainmast was rigged in the same way. Upon the mizen and jigger masts she had, apparently, large lateen or triangular sails, with topsails and topgallant sails above them, but how these latter were set it is impossible to say. Upon the bowsprit there was, probably, a square spritsail, and it is interesting to note that no head sails of the triangular kind (jibs) had by that time come into use. The *Henri Grace à Dieu* was armed with twenty-one guns and a large number of small weapons, and these all fired through circular ports, which did not allow the guns to be trained to the right or left. Square ports were not introduced until the time of the Commonwealth.

I must now leave England for a little while to describe the large merchant vessels of the Mediterranean, known as carracks. They were principally used for the purposes of trade, but, being heavily armed, could be utilised as men-o'-war if the necessity arose. In the Genoese carrack of the sixteenth century, a vessel of some 1,200 tons, there are several features worthy of notice.

The peculiar bowsprit, standing out from the bow at an angle of about 45 degrees, carried at its outer end a small mast, on which a square sail could be set in addition to the spritsail on the bowsprit itself; but how this small mast, placed at such an angle, withstood the pressure of the sail is a mystery. On all the other masts square sails and topsails were fitted, but on the mizen mast was a triangular lateen sail in addition. Apparently ten guns a side were carried, besides, we may presume, a number of smaller weapons. Carracks of this kind often reached an enormous size, and we read of one of 1,700 tons which was built at Nice in 1530 for the Knights of St. John of Malta. This gigantic vessel was sheathed with lead, and carried a crew of 300 men, while she was armed with fifty cannon.

The most important naval event of the sixteenth century, however, was the fitting out in 1587-8 of the great Spanish Armada, to subjugate this country. We all know of the disasters which befell this huge fleet, and there is no need to tell the story again here, but it is interesting to know something of the ships which composed it. Some 130 vessels in all first put to sea, and of this number only four were galleys and four galleasses. The former were of the ordinary type, but a galleass was a three-masted vessel which had a single bank of oars, each of which was manned by about six men. The wretched rowers, who were usually prisoners of war or criminals, were kept to their work by men armed with whips, and many unfortunate Englishmen, who had been taken prisoner in the wars with Spain, lived to tell of the awful sufferings of such a life.

Of the other ships of the Armada, thirty were under 100 tons, while ninety-four were between 130 and 1,250 tons in size. The fleet was divided into ten squadrons, and carried some 3,000 guns, while it was manned by 7,865 seamen and 20,671 soldiers. The popular belief as to the enormous size of some of the Armada vessels is apparently without foundation, for many carracks of the period were of far greater dimensions.

The fleet collected by Queen Elizabeth to repel this formidable array consisted of 197 craft, of which only 34 belonged to the Royal Navy. The others were merchant ships subsidised from different ports, and hastily converted into men-o'-war, and the table opposite gives the principal particulars of the largest English vessels, both men-o'-war and merchant ships, while it is interesting from the point of view of the quaint old names.

The size of many of the merchant vessels was under 100 tons, and the total number of men carried in the entire English fleet was 15,551, of whom only 6,289 belonged to the Royal Navy.

During the reign of Queen Elizabeth many trading expeditions were sent out to North America and the West Indies, while others of a more warlike nature visited the ports of Spain. The most memorable feat, however, was the circumnavigation of the globe by Drake, who, eleven years before the time of the Armada, had sailed from Falmouth with five vessels, the largest of which was his flagship, the *Pelican*, of only 100 tons, and the smallest a pinnace of 15 tons. We may well imagine what perils he must have undergone before his arrival in England in November, 1580, when he was knighted by Queen Elizabeth for his great services.

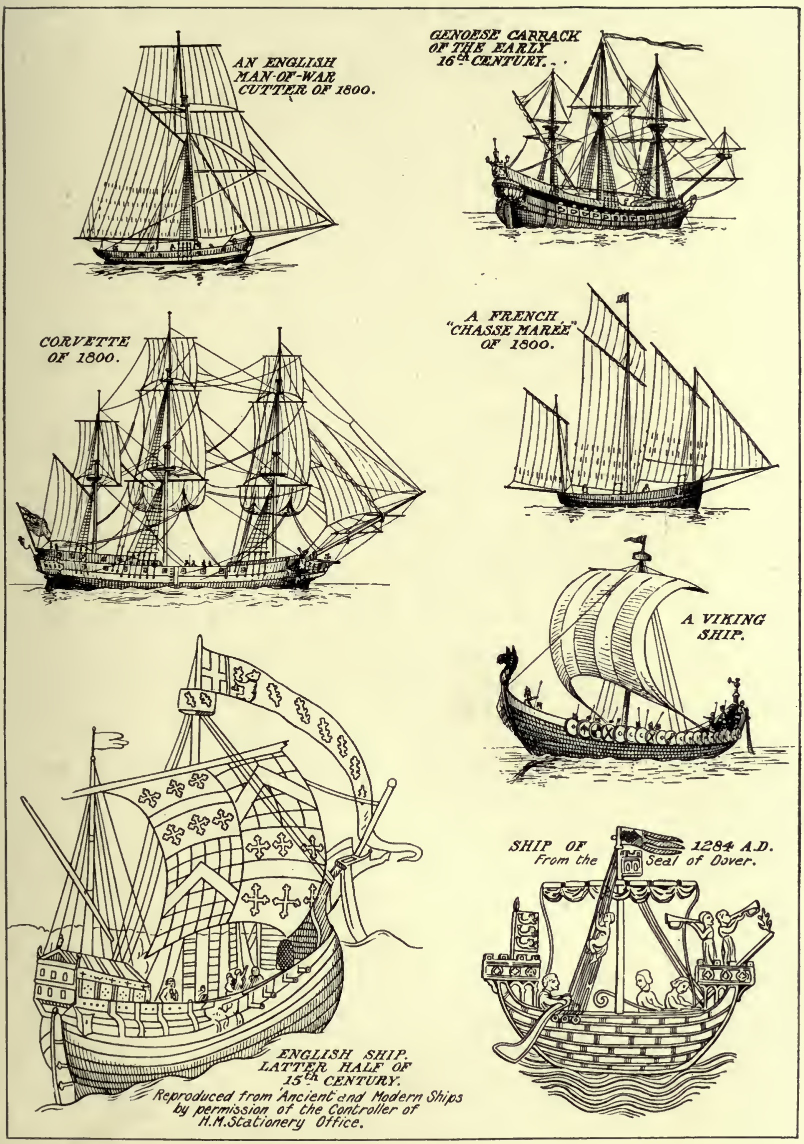
MEN OF WAR AND MERCHANT VESSELS

Name	Tons	Guns	Men	Remarks
Triumph }	1,100	42	500	Flagship of Sir Martin Frobisher.
St. Matthew }				
White Bear }			} 500	
Elizabeth Jonas }	900	56	}	
St. Andrew }			400	
Victory }				
Merhonour }	800	55	400	
Ark Royall }				Flagship of the Lord High Admiral, Lord Howard of Effingham.
Garland }	700		300	
Due Repulse }			350	
Warspight }			300	
Mary Rose }	600		250	
Hope }			250	
Bonaventure }			250	
Lyon }			250	
Nonpareil }			250	
Defiance }	500		250	
Raynbow }			250	
Dreadnought }	400		200	
Swiftsure }			200	
Antelope	350		160	
Swallow	330		160	
Foresight	300		160	
Tide	250		120	
Adventure	250		120	
Crane	200		100	
Quittance	200		100	
Answer	200		100	
Advantage	200		100	
Tyger	200		100	
Tramontain	120		70	
Scout	120		66	
Achates	100		60	
Charles	70		45	
Moon	60		40	
Advice	50		40	
Spy	50		40	
Merlin	45		35	
Sun	40		30	
Gygnet	20			
George Hoy	100			
Pennyrose Hoy	80			
Galleon Leicester	400		160	
Merchant Royall	400		160	

During the same reign very important innovations were introduced. The masts, which originally had been in one long piece, had topmasts fitted to them which could be housed in stormy weather, while chain pumps, far more efficient than those of the older types, were fitted in all new ships. Longer cables were supplied, and with these, says the celebrated Sir Walter Raleigh, "we resist the malice of the greatest winds that can blow." Capstans for weighing the anchors were also brought into use, while there were several important changes adopted in the rig of the vessels themselves.

There was not much further development in ship construction till the early part of the seventeenth century, when, during the reign of James I., the celebrated naval architect, Phineas Pett, came to the front and started a new method of shipbuilding. Phineas Pett, who was a Master of Arts at the University of Cambridge, saw that many improvements were possible, and his education stood him in good stead, for he substituted new ideas of his own for the old more or less haphazard methods of shipbuilding, and it must be admitted that he was very successful, although at first his ships aroused many apprehensions. Before his day complaints had been heard on all sides as to the inferiority of English vessels, both men-o'-war and merchant craft, for in strong build, speed, manœuvring power, and ability to lie to easily in a gale they were sadly deficient. Pett, however, succeeded to a great extent in remedying these obvious faults.

The *Prince Royal* was one of the first important vessels built under the new regime, and much of the useless top hamper was done away with, while the old form of beak or prow, derived from the old galleys, was abolished. The ship was built in 1610, and her armament consisted of six 32-pounders, two



EARLY SAILING SHIPS—I.

24-pounders, twelve 18-pounders, and many smaller guns. The elaborate decoration of vessels of this period is very noticeable, and the scrollwork and carving on the bow and stern forms a complete contrast to the very plain exterior of one of our present-day men-o'-war.

The most famous vessel built by Pett, perhaps, was the *Sovereign of the Seas,* launched in 1637. She was considered the most powerful ship of war of her time, and was much better built than the *Prince Royal,* for whereas the latter only lasted fifteen years, due to unseasoned timber being used in her construction, the *Sovereign of the Seas,* though engaged in nearly all the naval battles of the seventeenth century, survived for sixty years, and even then was only accidentally burnt as she was in the process of being rebuilt at Chatham. She was launched as a three-decker, but, being found somewhat crank, was cut down to a two-decker in 1652. She was at first of 1,683 tons and mounted over 100 guns.

Very little is known of the trading vessels employed at the end of the sixteenth and commencement of the seventeenth centuries, but, presumably, their type did not alter to any great extent, although it is known that one-masted cutter-rigged vessels had been introduced into the coasting trade. Thanks to the interest the various kings took in their fleets, to the genius of Pett, who, although a great innovator who made many mistakes, was solely responsible for the improvement in type of warships, and also to the superiority of English shipbuilding materials, England at this time occupied a very prominent place in the shipping industry of the world. This position was successfully upheld during the long and trying Dutch wars at the time of the Commonwealth, wars which brought into prominence the names of Blake and Monk, who were perhaps the greatest naval commanders of the period.

This closes the account of mediæval shipbuilding, and before saying anything about the vessels of the seventeenth, eighteenth and nineteenth centuries I will stop to describe the well-known vessels known as "East Indiamen."

The East India Company

No book dealing with a history of shipping can be complete without some mention of the famous East India Company, which for so many years held the complete monopoly of the trade between England and the East.

In 1587 Sir Francis Drake captured a Spanish carrack called the *San Felipe,* which was returning home from the East Indies, and certain papers found in her showed the enormous profits the Spaniards and Portuguese were making out of their trade with India. The papers afforded such valuable information that English merchant adventurers were naturally encouraged to step in and secure some of the profit for themselves, and in 1589 several merchants petitioned Queen Elizabeth for the necessary licence. At first the Queen, fearing the anger of the Portuguese and Spaniards, would not grant the necessary permission, and it was not until 1599 that she gave a charter of incorporation to the Earl of Cumberland and 215 knights and merchants for a term of 15 years. This United Company of Merchant Venturers of England trading to the East Indies subsequently became the celebrated East India, or "John," Company, as it was more familiarly called, which afterwards held by far the greatest commercial monopoly the world has ever known.

The first expedition sailed early in 1600, and consisted of five vessels, the *Dragon* of 600 tons, the *Hector* of 300 tons, two vessels each of 200 tons, and the *Guest,* a storeship of 130 tons. The squadron was under the command of a certain James Lancaster, who received the title of admiral, and 480 men and 20 merchants were employed in the ships, which were, of course, heavily armed.

In spite of the strenuous opposition of the Spaniards and Portuguese, who naturally took exception to what they considered usurpation of their legitimate trade, Lancaster succeeded in establishing friendly relations with the King of Acheen, in Sumatra, and a "factory," or depot, was established at Bantam in Java. In 1603 the fleet returned to England, and the profits of their first voyage were enormous, for the ships were laden with silks, spices and other Eastern produce which sold at home for a very great sum.

In 1609 James I. granted a new charter to the company, and in the same year the *Trade's Increase,* of 1,200 tons, and the largest merchant vessel launched in England up to that time, was built. Her career was not a fortunate one, however, for while being careened at Bantam, in order that repairs to her hull might be carried out, she fell over on her side and was burnt by the natives. The loss of this ship was a great blow to the company, but, as will be seen later, they could well afford it.

In 1611 the *Globe* cleared a profit of no less than 218 per cent., while the following year the *Globe, Hector* and *Thomas* made a profit of no less than 340 per cent. on the invested capital. The trade increased rapidly, and by 1617 the stock of the East India Company had reached a premium of 203 per cent.!

This, however, had not been achieved without great difficulty, for in 1613, when four small vessels—the largest was 650 tons—had been sent out, the Portuguese attacked them with a fleet of six galleons, three ships, two galleys and sixty smaller vessels. The latter were, however, severely defeated, and the English were allowed to accomplish their purpose with the results we have already seen.

By the end of the eighteenth century the "John" Company had become possessed of a large portion of the continent of India, and maintained its own army, forts and government, while the number of ships in its fleet increased year by year. In 1772 the company owned thirty-three vessels of a total tonnage of 23,159.

To all intents and purposes the "East Indiamen" were men-o'-war, for the original charter allowed the company to fly the naval pennant in its ships, while during the latter part of the eighteenth and the commencement of the nineteenth centuries the ships were built, rigged, fitted out and armed exactly like the frigates of the Royal Navy. They fought in many important naval actions, and won many victories, principally against the French squadrons in East Indian waters. Strict man-o'-war routine was invariably carried out, and the watches were divided up into messes of eight men each, and lived on the main deck. Here they slung their hammocks, and twice a week the captain, followed by various officers, would go the rounds to see that everything was correct. The ships were kept in a thorough state of cleanliness, the decks being washed and holystoned regularly, while on Sunday divine service was conducted by the captain. Drill with the guns, cutlasses, muskets and boarding-pikes was carried out every day, while discipline was enforced in the usual man-o'-war fashion by the liberal application of the cat-o'-nine-tails. Large crews were carried, and the men were provided with plenty of good food and as much rum as was good for them. These little details will all show that there was nothing of the slovenliness of a merchant ship about one of the old East Indiamen.

Besides being men-o'-war these fine old ships were also freight carriers and passenger vessels, and it is said that the accommodation provided was most luxurious. Other accounts, however, state that the passengers were required to furnish their own cabins, even to providing berths, washstands, lamps, chairs and other necessaries; and this, considering the passage money for a subaltern was £95 and that for a general £234, seems rather niggardly when one takes into consideration the enormous profit made. The food provided for the passengers, though plain, was the very best of its kind, and it is said that it was an unwritten, but nevertheless unalterable, law that there should always be champagne and plum pudding on the table on Sundays and Thursdays.

The officering of the ships was entirely in the hands of the directors of the company, and many well-connected people were attracted by the enormous possibilities of the service. Midshipmen were nominated and had to be between the ages of thirteen and eighteen, while second mates had to be at least twenty-two, chief mates twenty-three, and captains twenty-five. The pay and perquisites of the latter in these hard times read like a fairy tale, for it was no rare thing for the captain of an East Indiaman to receive between £6,000 and £10,000 a year. One captain is said to have netted no less than £30,000 as the result of a twenty-two months' voyage out and home. Other officers were proportionately well provided for, so it will be seen that the East India Company's service was a far more lucrative profession than the Royal Navy. The uniform of the officers consisted of a blue coat with black velvet facings, gilt buttons with the company's crest, buff waistcoat and breeches, and the usual cocked hat and sword.

The ships themselves were invariably fine, well-built vessels fitted out regardless of expense, but their passages were terribly slow, for every evening, no matter how fine the weather, all the light sails were furled and the royal yards sent down on deck. As there were no other competitors in the trade to the East, safety and comfort were the main objects of the East India Company, speed being a matter of quite secondary importance. In the early part of the nineteenth century the vessels were all over 1,000 tons, and each carried as a rule twenty-six guns and was manned by 130 men all told.

The monopoly of the trade in India and China, legalised though it was by successive Acts of Parliament, could not continue for an indefinite period, and much dissatisfaction was aroused on the part of the public and private shipowners, who strongly disapproved of the company's methods. The upshot of this was that in 1813 the trade to India was thrown open to all British ships, while in 1833, to encourage British shipping further, the trade with China was also thrown open. This did away with the old type of East Indiaman, for the company, realising their inability to compete with the enormous fleets of privately owned vessels, either condemned or sold their entire fleet within three years.

Thus vanished the old East Indiamen, which for so many years had carried on the Eastern carrying trade. Some of the gallant old vessels, however, still did good work on other routes, and for all we know one or two of them may still be afloat under foreign flags, their stout old hulls still breasting the ocean surges with the same regularity as they did seventy and eighty years ago.

Great competition in the Eastern carrying trade now arose between the various British shipowners, and frigate-built ships, manned in many cases by the officers and men of the old company, traded between England and the East. They were run on a far more economical basis, while speed was more thought of. In other ways, however, the old traditions held good, and the service remained very much the same as it was before. Until 1849 these frigate-built vessels and small barques of 350 to 700 tons carried on the service, but in that year the Navigation Laws were repealed, and the trade between England and her Colonies was thrown open to the ships of all nations. English shipowners thus found it was necessary to construct a new and faster type of vessel, which would successfully compete with those sailing under foreign flags, and this brings us to the Clipper Ship era. These, however, we will deal with in the chapter on "Sailing Vessels in the Mercantile Marine."

Modern Wooden Sailing Ships

The war vessels of the latter part of the seventeenth century, thanks to the innovations introduced by Phineas Pett, were great improvements on those which had come before them. Much money was spent on new vessels during the Commonwealth period, and the following vessels, built in the middle of the century, are typical of the larger type of men-o'-war then employed:

Year Built	Name	Tons	Guns
1655	*Naseby*	1,229	80
1656	*Dunbar*	1,047	64
1656	*London*	1,047	64

On the Restoration, in 1660, Charles II. and his brother, the Duke of York, afterwards James II., both took a very great interest in the Navy, and although at one time it greatly deteriorated in efficiency, many fine vessels were built. Typical warships of the largest class constructed in this reign were the *Royal Charles* and *Britannia,* launched in 1673 and 1682 respectively. Both were fine ships, the latter being of 1,739 tons, and both mounted 100 guns and carried 780 men. The rig in those days consisted of the usual square sails, with the lateen sail on the mizen and the two spritsails on the bowsprit.

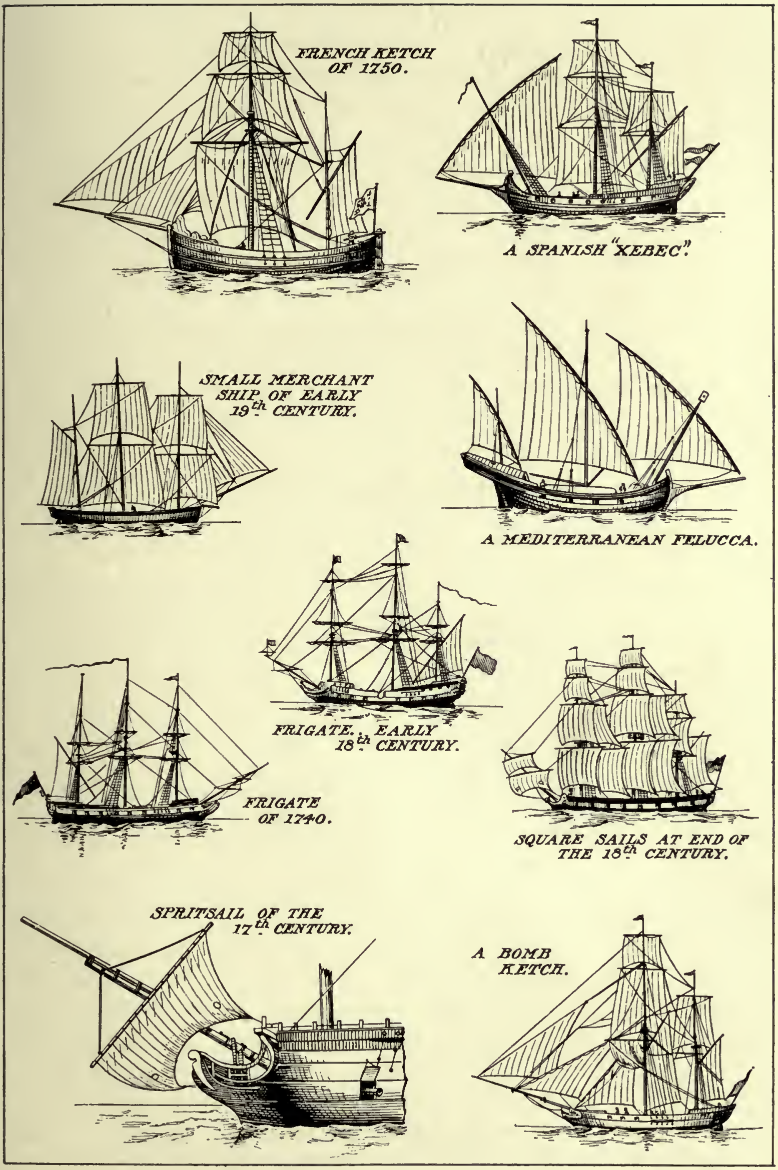
The accompanying plate shows the spritsail of a seventeenth-century man-o'-war, and in it will be noticed two holes. These were for letting the water out of the sail, which otherwise might have burst with the weight.

Most of our seventeenth-century vessels thought fit to take their place in the line of battle were what are known as "third rates," the "first rates" and "second rates" being only employed for special services. The following table gives the particulars of the various types of vessels in the Navy in 1688:

Name	Tons	Guns	Crew
First Rate	1,110–1,740	90–100	600–815
Second Rate	1,000–1,500	82–90	540–660
Third Rate	750–1,174	60–74	350–470
Fourth Rate	342– 680	32–54	180–280
Fifth Rate	211– 373	26–32	125–135

The first proper frigate was built at Chatham in 1646, and was called the *Constant Warwick*. She was a comparatively small vessel, her burden being only 315 tons, but she carried 40 guns and 140 men. She was looked upon as a great success, and is said to have wrought great havoc among the privateers swarming in the Channel. Although small, she was undoubtedly the origin of the larger frigates built later on, and which did much invaluable work during the naval wars of the eighteenth and nineteenth centuries.

About this time, also, vessels known as "bomb ketches" were introduced in France, and were soon afterwards brought into use in our Navy. They were,



EARLY SAILING SHIPS—II.

as a rule, small ships of about 200 tons, very strongly built, and very broad in proportion to their length. Two masts were fitted: a large mainmast placed amidships, and a small mizen mast farther aft, and on both of these the usual square sails were set. In the earlier vessels of this type the bowsprit carried the usual spritsails of the period, but these subsequently gave way to the triangular jibs. The space between the mainmast and the bow was taken up by the mortar, or shell gun, the recoil of which was minimised as much as possible by filling the hold underneath the weapon with lengths of old rope. The bombs themselves weighed some 200 lb., and were principally used for bombarding fortifications ashore. It will be readily understood what a terrific effect these projectiles had when compared with the old 32-lb. solid shot.

By the early part of the eighteenth century the type of ships had not greatly altered, but improvements had been effected in the manner in which the timber for the vessels was seasoned and prepared. In 1715, also, improvements were devised to allow the bilge water to circulate more freely to the pumps, while better ventilating appliances were fitted. In pictures of frigates of about this period it will be noticed that they still carry the lateen sail on the mizen, while there are also spritsail yards on the bowsprit.

There is, unfortunately, very little information about the merchant shipping of this time, but the East India Company were the largest shipowners in existence and launched many fine vessels. These, however, have been more fully described in the portion of this chapter dealing with the history of the company.

The French trading vessel of the middle of the seventeenth century was rigged as a ketch, and carried the usual square sails on the mainmast and the head sails on the bowsprit. On the mizen she had a sail similar to the present-day "spanker," but the "gaff," or spar at the head of the sail, was continued forward to counterbalance the sail itself, and this shows the transition between the old lateen sail and the more modern "spanker," or "driver," as it is called.

In the Mediterranean "feluccas" were largely used for trading purposes, though in time of war they mounted guns and became privateers, a rôle for which their great speed made them particularly adaptable.

Our plate shows one of these vessels, and it will be noticed that she carries three lateen sails, a rig which is still seen in Mediterranean craft and in the Arab dhows of the Red Sea.

By the middle of the eighteenth century complaints were made as to the weakness of our warships at sea, and it was found that, owing to their small dimensions and inferior shape, our vessels were frequently outsailed by those of foreign countries. Their armament, moreover, was too light, and this was first brought to the public notice by the capture, in 1740, of a Spanish 70-gun frigate, the *Princessa,* by three British vessels of equal rating but smaller dimensions. The Spaniard was only taken with great difficulty, and it was obvious that a newer and improved class of ship was desirable.

The first attempt towards introducing a better type was made in 1746, when the *Royal George* was laid down. She was launched in 1756, and was of 2,050 tons, and carried 100 guns and 750 men. She rendered great service to her country in various naval engagements, but was lost, as will be remembered, at Spithead in 1782, when being inclined to have repairs carried out to her bottom. She capsized and foundered, and about 600 persons, including Admiral Kempenfeldt, perished.

Other vessels of an improved type followed the *Royal George,* and the most famous of these was the

Victory, laid down in 1757. Her name afterwards became known all over the world as the flagship of Lord Nelson at the battle of Trafalgar, and the gallant old ship still floats peacefully at her moorings in Portsmouth harbour. When first launched, the *Victory* was of 2,162 tons, and carried 100 guns and 800 men, but the vessel as we see her to-day is very unlike her original self, for the masts are now far shorter, while the hull floats higher in the water.

Genuine frigates—that is, comparatively large cruising vessels with a high speed, and carrying all their guns on one deck—were introduced into the Navy in 1741. The first of these ships carried 32 guns, but 36-gun frigates were built in 1756.

In 1761 copper sheathing was introduced, and previous to this time lead, and that only occasionally, was used for coating the ships' bottoms. The action of the water caused the wooden hulls to get foul and decay with great rapidity, and the introduction of copper sheathing lengthened the lives of the ships to a considerable extent. The first vessel so sheathed was the 32-gun frigate *Alarm.*

A sketch on p. 24 shows the square sails in use towards the end of the eighteenth century, and it will be seen that the ship here depicted has her "studding sails," or "stun'sails," set, while she also has the sprit-sails on the bowsprit.

The stun'sails were extra sails rigged out from the yards on the fore and main masts, and were used when the ship was running before the wind. They are still to be seen in some of our larger sailing vessels of the present day, and they were used in the Navy until the abolition of sails.

The "corvette" was a species of vessel rather smaller than a frigate, but still of fair speed and heavily armed. Ships of this class were used in the Royal Navy until the abolition of sails, the corvettes of the late nineteenth century being barque rigged but having also steam power.

During the later years of the eighteenth century the size of both line-of-battle ships and frigates greatly increased, and in 1790 the *Hibernia,* of the former type, was launched. She was of 2,500 tons—a very large ship for those days—and carried a mixed armament of 110 guns, consisting of 32-, 24-, 18- and 12-pounders.

Two years later a 40-gun frigate, called the *Acasta,* was launched. She was of 1,142 tons, and carried thirty 18- and ten 9-pounder guns. One of the greatest improvements carried into effect at the end of the eighteenth century was the raising of the lower tier of gun ports, which enabled the guns to be fought in any weather.

During the war between Great Britain and the United States, which commenced in 1812, the majority of actions fought were single-ship duels, in which our frigates were greatly outclassed, and in many cases were captured. In 1812 alone the British 46-gun frigate *Guerrière* was captured by the American 54-gun vessel *Constitution,* the brig *Frolic* was taken by the *Wasp,* the *Macedonian* was captured by the *United States,* and the *Java* surrendered to the *Constitution.* All the engagements were fought with great heroism on the part of the men, but in all cases the captures were due to the inferior armament of the vessels themselves, the American vessels carrying many more guns on the same tonnage. In consequence of these losses the size of British frigates was much increased.

Our mercantile marine at this period consisted, except in the case of the vessels belonging to the East India Company, of comparatively small ships. Development to any great extent had been impossible owing to the wars at the close of the eighteenth and commencement of the nineteenth century, during which the English Channel swarmed with English and French privateers. The French fishing boats, mostly "chasse-marées" and luggers, were unable to carry on their legitimate business owing to the English men-of-war off the coast, and many of them were armed with guns and converted into privateers. It is said that no fewer than 154 of these vessels were fitted out from Boulogne during the five years ending in 1800, while they captured 202 prizes to the total value of £51,740. Only 16 of them were taken by the English vessels.

These "chasse-marées" preyed on our convoys, and would often carry off a defenceless merchant ship from under the very nose of a British frigate, while, thanks to their superior speed and handiness, they usually managed to evade capture. Our plate shows one of them, and the enormous sail area in comparison with the size of the boat will at once be noticed. The vessels themselves rarely exceeded 50 tons, but carried a crew of 40 fishermen—far more than that of an ordinary merchant ship.

The merchant vessel of the early nineteenth century was usually barque or brig rigged, while others were much like the small coasters of the present day.

In the Mediterranean at this time there were strange vessels called "xebecs," most of which were owned by the Spanish. They carried a large lateen sail on the foremast, which raked well forward over the bows, while on the main and mizen masts they had the more modern square sails. Many craft of this kind were heavily armed and used as frigates.

The smaller types of vessels in the Royal Navy at this time consisted of sloops, brigs and cutters. A sloop, as a rule, was a three-masted vessel, smaller than a frigate, but the term was often used in referring to small vessels of any kind other than cutters. A brig was a square-rigged vessel with two masts, and, compared with other ships, very fast under sail; these were, consequently, used for dispatch work. They were often known as "coffins," for they were sometimes very much overmasted, some capsizing and being lost in heavy weather. The man-o'-war cutter of the early nineteenth century was a one-masted vessel, carrying, as a rule, ten small guns. Her rig differed from the cutter of the present day, for she carried a square topsail and topgallant sail, the former being cut with a semi-circular foot to enable it to clear the head sails. The short topmast was stepped abaft the mast, and how it stood the strain of the enormous topgallant sail is a mystery. It was probably, however, housed in all except the finest weather. Cutters, though small, often gave a good account of themselves, principally through their speed and handiness, and one, the *Entreprenante,* was present at Trafalgar.

In 1815 further improvements in the construction of men-o'-war were effected by Sir Robert Seppings. Among other modifications, he succeeded in arranging the framework of the larger vessels so that the ship should not strain in a heavy sea. The shape of the bow was also altered, the curve being carried right up to the upper deck, and not, as was the case in earlier vessels, cut straight across to form a vertical wall extending to the level of the lower-deck gun ports.

Steam was introduced into the Royal Navy some few years previous to the accession of Queen Victoria, and the first vessels propelled by the new power were fitted with paddle wheels. In 1840, however, the screw propeller was brought into use in the Navy, and many of the larger vessels were so fitted. By 1850 the Navy consisted of 339 sailing and 161 steam vessels, while four years later there were 315 sailing vessels, 97 screw and 114 paddle steamers.

CHAPTER II

The Modern Battleship

THE first idea of plating ships with iron originated, it is said, with Napoleon III., Emperor of the French. The battle of Sinope, fought between the Russian and Turkish fleets on November 30, 1853, and resulting, as we all know, in the almost total destruction of the latter, proved without a doubt that unprotected wooden ships could no longer withstand the fire of the heavy shell guns which at that time were being mounted in ships. The inevitable result was that both ourselves and the French hit upon the idea of armouring vessels with iron plates to enable them to resist the hostile shell fire.

In 1855 the first of these armour-clads was built. They were known as "floating batteries," and were vessels of little speed, designed to act solely against land fortifications. The ships of this kind built in Great Britain were completed too late to take part in the Russian war, but three of the French floating batteries took part in the bombardment of Kinburn on October 17, 1855, with a marked degree of success. Their heavy guns wrought terrible havoc with the Russian works on shore, while the fire from the forts produced practically no effect upon the armoured sides of the vessels.

A typical British floating battery was the *Thunderbolt,* launched in 1856. She had a displacement of 1,970 tons, was 186 feet long, and had 4½-inch iron armour on a wood backing 20 inches thick, protecting her sides and gun battery. She carried the heavy armament of sixteen 68-pounder shell guns, but had a speed of only 5 knots. As ships, these floating batteries were quite unmanageable, but for use in bombarding the enemy's works they were undoubtedly very valuable.

The bombardment of Kinburn proved conclusively that wooden ships were no longer of any great use in modern naval actions, and soon afterwards the French commenced to reconstruct their fleet by putting armour on the sides of the old wooden ships. The famous *Gloire,* the first ironclad battleship, was launched at Toulon in 1860. The ship was a wooden one, but was plated with 4½-inch iron armour from stem to stern, and down to 6 feet below the water-line, while her speed was 13½ knots. The following year our first armour-clad battleship, the celebrated *Warrior,* was completed. She and her sister ship, the *Black Prince,* had 4½-inch iron armour covering two-thirds of their length, the bow and stern being left unprotected. With a horse-power of 4,000—as against the 300 of the floating batteries—they could steam 14 knots, while each carried ten 250-pounder and sixteen 115-pounder rifled muzzle-loading guns.

In those days the dividing line between the battleship and the cruiser was not so clearly defined as it is now, and by some the *Warrior* has been called an armoured cruiser. Whichever she was, however, does not really matter, for from her all our later armoured vessels, battleships and cruisers alike, were evolved. It is, perhaps, as well to explain the present-day difference between a battleship and cruiser. A battleship, as her name implies, is a vessel designed to take her place in the line of battle. As such she must be a good sea boat, to provide a steady gun platform in all weathers; she must have a comparatively high speed, coupled with an economical consumption of fuel, so as to ensure her being able to keep the sea for a considerable time without replenishing her stock of coal or oil fuel; she must carry a heavy gun armament well protected by armour, so that she can stand a heavy hammering without being severely damaged.

A cruiser, on the other hand, originally superseded the old-time frigate, which was used for scouting purposes in conjunction with a fleet of line-of-battle ships. Cruisers, when first built, carried lighter guns, thinner armour, and had a far greater speed than a battleship. Now, however, in the case of our new "battle cruisers," as they are sometimes called, the two types are becoming merged into one again, for they carry the same calibre guns, but a lesser number than a battleship, though otherwise they have the distinctive features of a cruiser, for they have thinner armour and greater speed. It is interesting, whilst upon this subject, to compare the modern battleship *Neptune* with the cruiser-battleship *Indefatigable*, both of which ships were launched in 1909. Their particulars are as follows:

Ship	Tons	Horse-Power	Speed	Thickest Armour	Guns
Neptune	19,900	25,000	21	12 in.	10 12″ 16 4″
Indefatigable	18,750	43,000	26	10 in.	8 12″ 16 4″

It will be noticed that there is no great difference in tonnage, but that the horse-power of the cruiser has to be no less than 18,000 more than that of the battleship to give her the 5 knots more speed. On the other hand, the battleship has the thicker armour and carries two more 12-inch guns.

We had arrived, I think, at 1860 and the completion of our first true armoured vessels, the *Warrior* and *Black Prince*. Subsequent to these ships joining the fleet, many of the old wooden line-of-battle ships were cut down and converted into armoured frigates, while others were built as armoured vessels and had armoured hulls.

The Civil War in America was the cause of another alteration in battleship design, for on March 9, 1862, was fought the memorable engagement in Hampton Roads between the Federal armoured turret vessel *Monitor* and the Confederate armoured ship *Merrimac.* The latter had originally been a 60-gun frigate, which had been set on fire and sunk to prevent her falling into the hands of the enemy, but the Confederates successfully raised her, and, finding her little damaged, with great ingenuity converted her into an armoured vessel by cutting her down to the waterline and building a rectangular armoured casemate on the hull. This structure was heavily armoured and contained five heavy guns, while the vessel herself was propelled by steam. Early in March this formidable craft was ready for sea, and on the 8th of that month she proceeded out of harbour and attacked the Federal fleet outside. The latter were all wooden vessels, and the *Merrimac* succeeded in sinking the frigate *Cumberland,* while she forced the *Congress* to surrender.

It had been known in Washington that the enemy were converting the *Merrimac* into an armoured vessel, and eventually a Mr. Ericsson persuaded the authorities to allow him to build a vessel to cope with her according to his own ideas. She was completed in 100 days, a most wonderful performance, even in these days of rapid shipbuilding, and was to all intents and purposes a steam-driven raft with a bottom like that of an ordinary ship. Amidships there was an armoured turret in which were mounted two 11-inch 150-pounder shell guns, and this was practically the only thing which appeared above the water, for in fighting trim the vessel's freeboard was only 2 feet. The turret was turned by steam to point the guns in any required direction. This remarkable vessel met the *Merrimac* in action on March 9, 1862, and in the fight, although neither ship could properly claim a real victory, it was proved that the turret vessel was greatly superior to the ship with guns mounted on the old broadside system.

As a result of this engagement the British Admiralty, in 1863, sanctioned the construction of our first turret vessel. She was the well-known *Royal Sovereign,* and had originally been a screw three-decker. Designed by Captain Cowper Coles, she had a freeboard of 6 feet, and carried five 250-pounder rifled muzzle-loading guns in turrets. Her armour belt was of 5½-inch iron, while that on the turrets was 4½ inches thick. The engines, of 2,300 horse-power, drove her 5,000 tons at a speed of 12 knots, but the vessel was not an unqualified success, as the wooden hull had not been originally designed to carry the heavy weight of armour and guns now imposed upon it. She was, however, at the time of her completion, considered to be quite the most formidable vessel in the navy.

Although ships carrying their guns on the broadside still continued to be constructed, the increasing size of the guns and thickness and consequent weight of the armour rendered a change in design advisable, and in 1866 the *Bellerophon,* a vessel of 7,550 tons, was completed. She had a designed speed of 12 knots, although it is said she could actually steam 14. The hull was not completely covered with armour, but had a belt of 6-inch iron right round the water-line. In the centre of the ship the battery of ten 250-pounder and five 115-pounder rifled muzzle-loading guns was enclosed in an armoured redoubt shut in at the ends by 5-inch iron athwartship bulkheads.

The construction of vessels of this type continued for ten years, various improvements being made from time to time. In some of the later vessels the guns were able to fire right ahead and astern by the side of the ship being cut away forward and aft, the weapons themselves being in the corner of the battery. This feature can be seen in the *Alexandra,* which, with a very similar vessel, the *Téméraire,* was completed in 1877. The former of these vessels originally carried two 11-inch and ten 10-inch rifled muzzle-loaders, while are armament of the *Téméraire* consisted of four 11-inch and four 10-inch weapons of the same type.

During this period a number of turret vessels were also constructed, and one of these was the ill-fated *Captain,* completed in 1869. She was of approximately 8,000 tons, could steam 14½ knots, and carried four 12-inch muzzle-loading guns mounted in turrets at each end of an armoured breastwork. This unfortunate ship, as is well known, capsized and foundered near Cape Finisterre on September 7, 1870. She sank in three minutes, and of her 490 officers and men only 18 were saved. Her loss was attributed to her too low freeboard—only six feet—heavy superstructure, masts and hurricane-deck.

The *Devastation, Thunderer* and *Dreadnought,* vessels of very similar type, were completed in 1873-75. The two former were of 9,330 tons, while the latter had a displacement of 10,820 tons. They were protected by a belt of 12-inch armour on the water-line, while above this, and extending for about two-thirds the length of the ship, was a redoubt protected by 12-inch armour. At the ends of this were mounted the two turrets of 14 inches in thickness, each containing two 12-inch muzzle-loaders in the case of the *Devastation* and *Thunderer,* and two 12.5-inch muzzle-loaders in the *Dreadnought.* The freeboard of these vessels was only four feet, thus making them very wet in a seaway, but in spite of this they were remarkably fine ships at the period at which they were built.

In 1881 the *Inflexible,* the first ship with her turrets

Photo : Symonds & Co., Portsmouth.

H.M.S. "DEVASTATION."

mounted *en échelon,* as it is technically called, was completed for sea. As may be seen from pictures of this vessel, the turrets containing the heavy guns were disposed on either side of the ship, the port turret being forward and the starboard one aft, the idea being that both pairs of guns could fire right ahead and right astern as well as on both sides. The guns themselves were 16-inch muzzle-loaders, while several smaller weapons were also carried on the superstructure as an auxiliary battery. Several vessels of this type were built, but shortly after they were launched torpedo boats were beginning to be built, and it was found necessary to design a new type of ship which should carry her guns—or, at any rate, the lighter ones—on the broadside, so that a heavy fire could at once be concentrated on attacking torpedo craft.

The battleships thus designed were the six ships of the "Admiral" class, so-called because they were named *Collingwood, Howe, Anson, Camperdown, Rodney* and *Benbow,* after the famous admirals bearing those names. They were all completed for sea between 1886 and 1888, and had a speed of 16½ knots. The *Collingwood,* the earliest vessel of the class was armed with four 12-inch, six 6-inch, and twenty smaller breech-loading guns, while the next four carried four 13.5-inch, six 6-inch, and twenty-two smaller guns. The *Benbow* was a slightly larger vessel and carried the increased armament of two 16.25-inch—the famous 111-ton gun—ten 6-inch, and ten smaller weapons. The heavy guns in all these vessels were mounted on the barbette system. In this system the guns are mounted on turntables, which revolve with the guns inside the barbette, a heavily armoured structure over the top of which the guns fire. By this method the weapons are carried at a far greater height above the water than was the case in the turret, but the breech of the guns is exposed and is therefore liable to injury from the enemy's fire.

In 1887 the two sister vessels, *Sans Pareil* and

Victoria, were launched, being completed for sea two years later. They were vessels of 10,470 tons, 17 knots speed, and had an armour belt 16 to 18 inches in thickness. Their armament consisted of two 16.25-inch 111-ton guns mounted in a turret forward, one 10-inch gun aft, and ten 6-inch guns in the battery.

These two vessels had a comparatively low freeboard forward, and thus suffered from the same defects as the earlier turret vessels. The superstructure, however, was continued right aft, giving the ships a very peculiar appearance. The funnels were placed fore and aft, while one military mast was fitted; there was also a light pole mast for signalling purposes placed close to the navigating bridge on the fore end of the superstructure. The *Victoria,* whilst flagship on the Mediterranean station, sank in June, 1893, from the results of a collision with the *Camperdown.* The admiral, Sir George Tryon, and a large number of officers and men lost their lives, the disaster being one of the most terrible which has ever occurred in the annals of our navy.

The *Nile* and *Trafalgar* were also completed in 1889 and had 1,000 tons more displacement and half a knot less speed than the "Victoria" class. They were fine ships for their day, for they carried two turrets, one at either end of the ship, and in each of these were mounted two 13.5-inch guns, while six 4.7-inch quick-firers were placed behind armour in the battery amidships. These, however, were afterwards replaced by 6-inch guns. These ships were undoubtedly a great advance on their predecessors, but being low freeboard turret vessels, with the heavy guns close to the water, it was found that in bad weather, whilst steaming head on to a heavy sea, the effective working of the heavy guns was seriously impaired. It was therefore considered necessary to adopt the barbette system once more, and when the Naval Defence Act of 1889 was passed it was decided that the greater number of the new battleships should have their heavy guns mounted in this manner.

The eight vessels of what are generally known as the "Royal Sovereign" class—the *Royal Sovereign, Repulse, Resolution, Revenge, Royal Oak, Ramillies, Empress of India, Hood*—were completed in 1892-3, and were of 14,150 tons displacement, 17 knots speed, and carried an armament of four 13.5-inch and ten 6-inch guns. In all of them, except the *Hood,* which was a low freeboard turret ship, the heavy weapons were mounted in barbettes. A belt of armour with a greatest thickness of 18 inches protected the water-line for two-thirds of the length of the ship, and this armour was terminated at both ends by a 16-inch transverse bulkhead to evade the possibility of a raking fire damaging the engines, boilers, and guns situated in the centre portion of the vessel. Above this, again, and extending between the heavy guns, was a 5-inch armour belt extending to 9½ feet above the water-line, while the main deck 6-inch guns were behind this. The six 6-inch on the upper deck, three on each side, were protected by shields placed on the gun mountings and revolving with the guns, while the heavy 67-ton guns—13.5-inch—were mounted in barbettes covered with 17-inch armour. These vessels were undoubtedly of a very fine type, and up to a few years ago were still to be found in our active fleets, their design being also generally adopted for all succeeding battleships down to the introduction of the "King Edward VII." class in 1903.

Various other smaller battleships were completed between the *Royal Sovereign* and the inception of the "Majestic" class in 1894, but their type conformed very closely to that of the former, their displacement and armament being somewhat smaller, to enable them to proceed, if necessary, through the Suez Canal, to the Far East.

The nine fine ships of the "Majestic" class were completed between 1895 and 1897, and were named *Majestic, Mars, Hannibal, Magnificent, Prince George, Jupiter, Victorious, Illustrious, Cæsar.* They had a displacement of 14,900 tons, and had two-thirds of the 'midship part of their length covered with 9-inch Harvey steel, which was infinitely better protection than a greater thickness of the old compound armour. An armoured deck, of an average thickness of 4 inches, was fitted in the neighbourhood of the water-line throughout the whole length of the ship, and this curved downwards towards the sides to render it more difficult for a hostile projectile to find its way into the engines, boilers, magazines, etc., below it. The heavy guns were mounted in barbettes armoured to a depth of 14½ inches, and were situated at either end of the battery, while the disadvantage of having their breeches exposed was nullified by heavy armoured hoods placed over the guns. The twelve 6-inch guns were mounted eight on the main deck, four each side, and four on the upper deck, two each side, and these were protected by being placed in armoured boxes, or "casemates," as they are called, made of nickel steel 6 inches thick. The ships carried two military masts, in the fighting tops of which were originally placed 3-pounder Hotchkiss guns for repelling torpedo attack, and the light armament was strengthened by the addition of many 12-pounder quickfirers placed on the upper and main decks. The funnels, of which there were two, were carried side by side across the vessel, and this feature was also identical in the "Royal Sovereign" class. The "Majestics" have only recently begun to be withdrawn from our active fleets. They were very fine and efficient vessels, while at the time of their completion they were considered the most powerful battleships in the world.

In 1897 the construction of the six battleships of the

"Canopus" class commenced. They were lighter vessels than their predecessors, being only 12,950 tons displacement. They carried, however, the same armament as the "Majestic," four 12-inch and twelve 6-inch guns, the former being mounted in hooded barbettes forward and aft, and the latter being placed in armoured casemates on the upper and main decks. Their speed was 18¼ knots, but the weight of the vessels was greatly brought down by a reduction in the thickness of the armour, that on the water-line belt being only 6 inches in thickness, as against the 9 inches of the "Majestics." The thickness of the armoured deck and on the secondary gun positions was also less, and there appears to be little doubt but that these vessels were designed for the express purpose of being able to use the Suez Canal if necessary. The funnels are one before the other, and not side by side as in the cases of the *Royal Sovereign* and *Majestic*. Contemporary with the construction of these lighter battleships the eight vessels of the "Formidable" class were built. Their names are *Formidable, Irresistible, London, Bulwark, Venerable, Implacable, Queen* and *Prince of Wales*. The last named was completed in 1904. They displaced 15,000 tons, could steam 18 knots, and carried the usual battleship armament of four 12-inch and twelve 6-inch guns. Their armour, however, was thicker than the lighter ships of the "Canopus" type, but their appearance was very similar, the only difference on looking at them casually being the thickness of the funnels.

More ships of a somewhat similar type were launched in 1901, namely, the six vessels of the "Albemarle" class—*Albemarle, Duncan, Exmouth, Russell, Cornwallis* and *Montagu*. The last-named, as will probably be remembered, no longer figures upon the Navy List, as she was wrecked and became a total loss on the rocks at Lundy Island in the Bristol Channel.

Their displacement was 14,000 tons, and their speed 19 knots, while the armour was thinner than in the case of the "Formidables." The gun armament, however, remained the same, while the appearance hardly altered at all. The *Triumph* and *Swiftsure* were not originally built for the British Navy, but were purchased complete in 1904. They are light battleships of 10,800 tons, 19 knots speed, comparatively light armour, and carry four 10-inch and fourteen 7.5-inch guns. In appearance they are totally unlike any other ships in our navy, for the funnels are very widely spaced and two enormous cranes are carried amidship for the hoisting in and out of the boats.

We now pass to some of the latest of the pre-"Dreadnought" battleships, the eight vessels of the "King Edward VII." class, which were all completed between 1904 and two years later. They were named *King Edward VII, Dominion, Commonwealth, New Zealand, Hindustan, Britannia, Africa* and *Hibernia,* and at the time they were completed were considered to be quite the finest battleships in the world. Their tonnage was 16,350, and their speed was 18½ knots, while they were heavily armoured, and carried the enormous armament for that time of four 12-inch, four 9.2-inch, and ten 6-inch guns. The 12-inch guns were mounted in the usual hooded barbettes forward and aft on the upper deck, while the 9.2-inch guns were placed in armoured turrets one at each corner of the upper deck battery. The 6-inch guns were no longer mounted in casemates, but were placed on the main decks in a battery behind 7-inch armour, while armoured bulkheads separated the guns one from the other. In appearance these vessels are something like the earlier types, but a closer inspection will show that their funnels are thicker, while they can also be recognised by the 9.2-inch guns on the upper deck.

The *Agamemnon* and *Lord Nelson,* launched in 1906 and completed in 1908 and 1909 respectively, were quite a new departure, for in these vessels the 6-inch guns were abolished, the armament consisting of four 12-inch and ten 9.2-inch guns. The former were mounted in hooded barbettes on quarterdeck and forecastle, while the ten 9.2-inch weapons were disposed in turrets on the upper deck, three each side of the ship. The foremost and after turrets each side contained two guns, while the centre ones were provided with one only. The vessels have two funnels fore and aft and two masts, the after one of which is on the tripod system. The latter is a feature which is noticeable in all our later battleships; the three legs supporting the mast do away with the necessity of having stays to support it, while they also lessen the possibility of the mast being brought down by an enemy's shell, as it is said that two legs of the tripod can be completely severed and the mast still left standing. These vessels are very heavily armoured, for on the water-line amidships they carry armour 12 inches thick, while forward and aft on the water-line it is 4 inches. Above the main belt amidships and carried right up to the upper deck is 8-inch armour, while that on the gun positions varies from 12 to 7 inches in thickness. The ships have a displacement of 16,500 tons and a speed of 18 knots, and have a somewhat peculiar and un-English like appearance.

The "Dreadnought" Era

By some people our modern "Dreadnoughts" are said to be the outcome of the Russo-Japanese war, but this may be regarded with a certain amount of doubt, for long before that time an Italian naval constructor had designed a monster vessel something similar to these battleships.

The *Dreadnought* herself was laid down at Portsmouth dockyard on October 2, 1905, was launched in February, 1906, and completed the same December. The feat was a world's record in battleship building, for the vessel was completed, from the laying of the keel-plate to her commissioning, in fifteen months. The British example was soon followed by other maritime powers, and before long Germany, France, the United States and Japan had commenced the construction of vessels of the same type. The original *Dreadnought*, as stated above, was built at Portsmouth, and his late Majesty King Edward VII. launched her on February 10, 1906. She is 490 feet long with a beam, or width, of 82 feet, and has a displacement of 17,900 tons, while her armour belt is of hardened steel 11 inches thick. Her armament consists of guns of all one calibre—i.e. the 12-inch—and these weapons are 45 feet long and throw an 850-lb. projectile with an initial velocity of 2,900 feet a second. The heavy shot will, at a distance of three miles, penetrate 13 inches of hardened steel, while the gun, which weighs 58 tons, can be fired twice a minute, or even more often under specially favourable conditions. These enormous weapons are mounted in pairs in five barbettes, which are placed one on the forecastle, one on each side amidships, and two farther aft. No earlier battleship had carried more than four 12-inch guns, so in this respect the celebrated *Dreadnought* was entirely original. Twelve-pounder guns are fitted to repel torpedo attack, and of these twenty-seven are mounted. She is driven at a speed of 22 knots by turbines of 23,000 horse-power, and these have proved so successful that they have been fitted in all the succeeding battleships. The water-tube boilers are of the Babcock-Wilcox type, while the ship has two rudders and four screw propellers. For further information on these points, however, I must refer you to the chapters on "Propelling Machinery" and "Shipbuilding."

Another innovation in the *Dreadnought* was the absence of all watertight doors, the transverse bulkheads being carried right up above the water-line, and lifts being provided to afford communication from one compartment to another. This feature is noticeable in all our later ships, and greatly minimises the risk of the vessel sinking through damage by collision, explosion, or grounding. For the first time in the Navy, also, the officers lived forward and the men aft, the idea being that the former were thus nearer the positions which they occupied in action or whilst on duty. The conning tower, from which the ship is worked in action, is protected by 11-inch armour, and the masts are on the tripod principle, the advantages of which have been explained before.

In the comparatively short time since the *Dreadnought* has been launched, however, the construction of these huge battleships has developed very rapidly. The succeeding ships are in groups, the first being the *Bellerophon, Téméraire* and *Superb,* completed in 1909, of 18,600 tons, 22 knots speed, and with a main armament like the *Dreadnought*, but with sixteen 4-inch guns for repelling torpedo attack instead of the 12-pounders. The next group are the *St. Vincent, Vanguard* and *Collingwood,* completed in 1910. Their tonnage is 19,250, while their speed and armament are similar to the ships of the first group. There is little or no difference in appearance between these six vessels, but they carry two large tripod masts, instead of the one large and one small one in the *Dreadnought*.

The third type comprises the *Neptune, Hercules* and *Colossus,* all completed in 1911. The former is of 19,900 tons, while the two latter are sister vessels of 20,250 tons each. The designed speed is 21 knots, but it is said 22 knots has been attained with a horse-power of 25,000. The armament consists of ten 12-inch guns mounted in pairs in five barbettes, two of which are mounted *en échelon*. The first pair of guns can fire right ahead and either side to some distance abaft the beam, while the second, placed on the port side, can fire on both sides. The third pair of guns are mounted in a barbette placed on the starboard side, and have a similar arc of fire to the last named. Right aft are the other two barbettes, the two guns in one firing directly astern over the barbette immediately abaft them. The three vessels above described are not, strictly speaking, sister ships, although their guns are mounted in the same way. The *Neptune* has two tripod masts, while the *Hercules* and *Colossus* have only one each.

The fourth group are what are known as "super-Dreadnoughts," and represent a still further advance in size and gun-power. The *Orion* is now serving as a flagship in the First Fleet, while the *Conqueror, Thunderer* and *Monarch* are also in commission. All these fine vessels, which are 545 feet long, are of 22,680 tons, while the turbine engines are of 27,000 horse-power, sufficient to drive the ships at 21 knots. The armament consists of ten 13.5-inch guns, mounted in five turrets, all of which are placed in the centre line of the ship. There are two turrets superimposed forward and aft, and one amidships, so each of the guns is able to fire almost all round the horizon.

Four more vessels of a still larger type are the *King George V., Audacious, Ajax* and *Centurion*. They are of 24,000 tons, mount ten 13.5-inch and twenty 4.7-inch guns, while their speed is the same as that of the *Orion*.

The newest battleships of all are the *Delhi, Benbow, Marlborough* and *Iron Duke,* the first-named being so called in commemoration of the Delhi Durbar.

It will be noticed that all our modern "Dreadnoughts" have been given good old names which have been in use in the navy for many hundreds of years. Ships called the *Téméraire, Neptune, Conqueror, Ajax,* *Orion, Bellerophon, Colossus, Thunderer* and *Dreadnought* were present at the ever-memorable battle of Trafalgar on October 21, 1805, and with such a glorious record behind them, the present-day bearers of these historic names may be depended upon to give as good an account of themselves in battle as did their predecessors of over a century ago. The ships may have changed, but I think I am safe in saying that the spirit of the men has not, and if ever we are called upon to fight another Trafalgar those men will fight and die for their country in exactly the same way as did their valiant ancestors.

There is no knowing but that the future will bring about as great a change in the design of battleship as is evident between the "Dreadnought" and earlier types. Internal combustion engines for large vessels are by no means in their infancy, and before long we may have battleships of 30,000 tons with no funnels, and mounting heavier guns than have yet been dreamt of.

CHAPTER III

The Modern Cruiser

THERE are at the present time in our Navy two different types of cruisers, the armoured and the protected varieties. The former species can again be divided into separate types as follows:

(1) The modern *armoured battle-cruisers* of the "Invincible" and later types. These vessels have a greater speed and carry the same calibre guns as, but a lesser number than, battleships. They are, however, far superior in armament to all battleships previous to the *Dreadnought*.

(2) The older types of *armoured cruisers*, of the "Shannon," "Cochrane," "Carnarvon," "Kent," "Drake," or "Cressy" classes, which carry lighter guns, but have a higher speed, than battleships.

All vessels of the types enumerated under (1) and (2) carry an armour belt on the water-line and an armoured deck throughout the whole length of the hull, which covers the engines, boilers, magazines, shell-rooms and other vital positions. The ships themselves will, however, be described in detail later.

Protected cruisers, latterly, have been of comparatively small tonnage, of great speed, but, as their name implies, have carried, as a rule, thin side armour and the usual protective deck only. Their guns are also lighter than those of the armoured cruisers. The only really large vessels of this description are the *Powerful* and *Terrible,* launched in 1895, and the *Argonaut* and her seven sister-vessels completed between 1898 and

1902. Both these types, however, are now obsolete and are no longer found in our active fleets.

It is as well, perhaps, when describing the gradual evolution of modern cruisers, to differentiate between those of the "armoured" and "protected" varieties, and I will therefore deal with the former species first.

The *Warrior,* as I have already said, was, with the exception of the old floating batteries, the first armoured vessel in the British Navy. She cannot be said to have properly belonged to either the battleship or cruiser types as we now know them, but was, however, the common root of all armoured ships. She was launched in 1860, and has been described in Chapter II.

From then until 1875 the line of demarcation between armoured cruisers and battleships was not very rigidly drawn, and the first true vessel of the former type was not completed until fifteen years after the launch of the *Warrior.* This was the *Shannon,* a vessel of 5,390 tons, and with a speed of 12 knots. She carried two 18-ton and seven 12-ton muzzle-loading guns, besides the usual armament of light and machine guns, and had an iron armour belt of 8 to 9 inches in thickness, and a protective deck 3 inches thick. Her total cost was £287,269, which seems a very small amount compared with the £1,768,995 of the present-day *Invincible.* The *Shannon* had three masts, with the usual yards and sails, and as she only carried 580 tons of coal, I think it is safe to assume that the steam power was only meant for use in cases of necessity—when the wind was foul and, of course, in action.

In 1876 the *Northampton* was launched, and she was of 7,630 tons displacement, while her engines, of 5,500 horse-power, drove her at a speed of 12½ knots. Her armament consisted of four 18-ton and eight 12-ton muzzle-loaders, with twenty-five small machine guns, while she carried four torpedo tubes instead of the two in the *Shannon.* Her armour belt was 6- to 9-inch iron, the protective deck being 3 inches. The coal capacity was 1,150 tons, more than double that of her predecessor, while her cost ready for sea was £395,804. I must now hark back a bit—to 1866, in fact—to describe the three sister-vessels, *Northumberland, Agincourt,* and *Minotaur.* These three ships were launched in the year mentioned, and were originally classed as battleships. Subsequently, however, they were placed in the armoured cruiser class, and for this reason I will deal with them in this chapter.

Launched in 1866, and completed two years later, they had a tonnage of 10,780, and engines of 6,500 horsepower, which drove them at a speed of 13.5 knots. The armament consisted of seven 250-pounder rifled muzzleloaders, while the iron armour on the water-line belt and main gun position was 5½ inches in thickness. The coal carried was only 750 tons. These fine ships originally had five masts with the usual sails, while their length, 400 feet, made them by far the longest ships in the navy at the time they were launched.

To revert to the cruiser proper. In 1883 were launched the *Warspite* and *Impérieuse,* armoured cruisers of 8,400 tons and some 16½ knots speed. They had a composite armour belt 10 inches in thickness, an armoured deck 3 inches thick, and 8- to 9-inch protection over the gun positions. The armament consisted of four 9.2-inch breech-loading guns, one forward, one aft, and one on either side, and ten 6-inch quick-firers of an early type, besides twenty-six smaller weapons. The coal carried amounted to 1,130 tons, while the ships cost some £509,500 ready for sea. They were originally intended to be brig-rigged—that is, with two masts carrying the usual square sails—but the idea was subsequently abandoned, and the ships were fitted with one military mast amidships. There is no doubt that for their day these vessels were very powerful, and for a considerable time they were looked upon as the finest armoured cruisers in the world.

Three years later—1886—the "Australia" class of cruisers commenced to be launched. They were the first vessels originally designed without sails of any kind, and had a displacement of 5,600 tons and a speed of 18 knots. The armament consisted of two 9.2-inch breech-loaders and ten 6-inch quick-firing guns, while the armour belt was 10 inches in thickness and the armoured deck 2 to 3 inches. Nine hundred tons of coal were carried, and the ships cost some £258,390 each ready for sea.

Between 1886 and 1899 no real armoured cruisers were launched, the thirteen years, as will be seen later when we come to discuss the development of protected cruisers, being spent in the construction of the latter types of vessel.

In 1899 the *Cressy* was launched, and by 1901 no fewer than six vessels of this type were afloat. With a displacement of 12,000 tons and a horse-power of 21,000, their speed was almost 22 knots. The armament consisted of two 9.2-inch breech-loading and twelve 6-inch quick-firing guns, while the armour belt was of 6-inch steel and the armoured deck half that thickness. The coal carried amounted to 1,600 tons, and the ships cost some £749,324 each to build. The ships had four funnels and two masts, a feature which commenced with the construction of the protected cruisers *Powerful* and *Terrible* in 1895, and has been a conspicuous feature of so many of our armoured cruisers. Since 1899 the construction of armoured cruisers has gone on rapidly, and, for convenience, I will give the various types, with their particulars, in tabular form.

From the following table it will be seen how rapidly the size, armament and cost of our armoured cruisers have developed. Compare the *Drake* of 1901 with the *Queen Mary* of 1911. Their displacements respectively

THE GROWTH OF THE ARMOURED CRUISER

Date of Launch	Ship	Others of Class	Tonnage	Horse Power	Speed Designed	Length	Armament	Armour		Coal or Oil	Cost	Notes as to Type
								Belt	Deck	Tons	£	
1899	*CRESSY*	*Aboukir, Bacchante, Euryalus, Hogue, Sutlej.*	12,000	21,000	21	440	2 9·2" B.L. 12 6" Q.F. 19 smaller	6"	3"	1,600	749,324	Commencement of high tonnage. 4 funnels.
1901	*DRAKE*	*Good Hope, King Alfred, Leviathan.*	14,100	30,000	23	500	2 9·2" B.L. 1 66" Q.F. 19 smaller.	6"	3"	2,500	1,002,977	Increased speed and armament. 4 funnels.
1902	*MONMOUTH**	*Berwick, Cornwall, Cumberland, Donegal, Essex, Kent, Lancaster, Suffolk.*	9,800	22,000	23	440	14 6" Q.F. 21 smaller	4"	2"	1,600	734,858	Smaller tonnage and armament. 3 funnels.
1903	*ANTRIM*	*Argyll, Carnarvon, Devonshire, Hampshire, Roxburgh.*	10,850	21,000	22·3	450	4 7·5" Q.F. 6 6" Q.F. 26 smaller	6"	2"	1,800	906,335	Improved "Monmouth" class. 4 funnels.
1904	*BLACK PRINCE*	*Duke of Edinburgh.*	13,550	23,500	22·3	480	6 9·2" B.L. 10 6" Q.F. 30 smaller.	6"	¾"	2,000	1,193,414	Heavier armament.
1905	*NATAL*	*Achilles, Cochrane Warrior.*	13,550	23,500	22·3	480	6 9·2" B.L. 4 7·5" Q.F. 30 smaller	6"	¾"	2,000	1,218,244	Modified "Black Prince" type.
1906	*MINOTAUR*	*Defence, Shannon.*	14,600	27,000	23	490	4 9·2" B.L. 10 7·5" Q.F. 29 smaller	6"	1"	2,250	1,438,065	Greater speed.
1907	*INVINCIBLE*	*Indomitable, Inflexible.*	17,250 Turbine	41,000	25	530	8 12" B.L. 16 4" Q.F. 5 smaller.	7"	2¾"	2,500	1,768,995	Single-calibre guns. Cruiser-battleship
1909	*INDE-FATIGABLE*	*New Zealand.*	18,750 Turbine	43,000	26	555	8 12" B.L. 16 4" Q.F. 6 smaller.	8"	3"	2,500	1,547,426	Improvement on *Invincible*
1910	*LION*	*Princess Royal*	26,360 Turbine	70,000	28	660	8 13·5" B.L. 16 4" Q.F. 6 smaller.	9¾"	3"	3,500	?	Larger guns and tonnage. Further imprvmnt.
1911	*QUEEN MARY* †	*Tiger.*	28,500 Turbine	?	28	?						

* *Bedford*, of same type, has been lost. † Details of this ship unknown at time of writing.

Photo : Stephen Cribb, Southsea.

H.M. SUPER-DREADNOUGHT CRUISER "LION" BEFORE HER TRIALS.
During her trials the heat from her fore-funnel was so intense that it twisted the fittings on the bridge. Before she was put into commission, therefore, the position of her fore-funnel had to be altered.

Photo : West & Son, Southsea.

H.M. SUPER-DREADNOUGHT BATTLESHIP "MONARCH."

are 14,100 and 28,500 tons; the speed has gone up five knots, while if the *Queen Mary* has a similar armament to the *Lion,* the weight of her total shell fire will be 100,000 lb. to the 2,360 lb. of the *Drake*.

The type also has greatly altered within the past few years. The *Minotaur* was the last vessel to be built with the usual four funnels and two masts; but the *Invincible* has three funnels and two tripod masts similar to those of the "Dreadnought" battleships. In the latter vessel, also, all watertight doors have been done away with, and the bulkheads running across the ship are continued right up to above the water-line, in the same manner as was described in a previous chapter when referring to the later battleships.

In many cruisers the height of the foremost funnel has been increased, while that of the others has remained the same. This has been done with the idea of taking the smoke clear of the navigating bridge when the wind is blowing from aft.

In dealing with the discussion as to the evolution of the British protected cruisers, it will save you a great deal of unnecessary trouble if I give a list of the ships, from 1867 downwards, in tabulated form. This list, by the courtesy of Mr. Alan Burgoyne, M.P., I am permitted to cull from the "Navy League Annual," the authorised publication of the Navy League.

The protected cruisers now found in our active fleets comprise those of the "Edgar" (1890) and succeeding classes. Many have been converted for use as subsidiary vessels, torpedo-boat destroyers and submarine depot ships, mine-laying purposes, etc.; but all these will be separately dealt with in another chapter.

The later protected cruisers are those of the "Amethyst," "Topaze," "Diamond" and "Sapphire" types, the last-named three of which are used, on account of their speed, in connection with our destroyer flotillas. The *Boadicea, Blonde, Bellona, Blanche,*

THE EVOLUTION OF THE BRITISH PROTECTED CRUISER

NOTE.—Up till about 1885 protected cruisers were generally fitted with sails, and till quite recently triangular sails called trysails were supplied to all vessels, other than battleships, for use in emergency.

Date of Launch	Class	Displacement in Tons	Designed I.H.P.	Designed Speed	Best Known Speed	Length in Feet	Beam in Feet	Draught in Feet	Armament	Torpedo Tubes	Coal Capacity	Complement	Notes as to Type
				Knts.	Knts.						Tons		
1867	Eclipse	1,760	1,950	12·5	12·9	212	36	16·3	12 64-pr. M.	Nil	250	—	Corvette, Wooden Hull
1868	Inconstant	5,780	7,000	16	16·2	337·3	50·25	25·5	10 12-ton M., 6 6½-ton M., 6 20-pr. B.	Nil	750	600	Iron Frigate [*Eclipse*
1869	Briton	1,860	2,150	13	13·13	220	36	17	14 64-pr. M.	Nil	250	—	Corvette, Wooden Hull, Improved
1869	Active	3,080	4,000	14	15	270	42	21·3	10 6-in. B., 2 64-pr. M.	Nil	410	357	Iron Corvette Ship-rigged
1873	Shah	6,250	7,000	15	16	334	52	26·5	2 12-ton M., 16 6½-ton M., 8 5-in. B.	3	890	—	Iron Frigate, Final Development
1874	Rover	3,460	4,750	14	14·53	280	43·5	23	14 6-in. B., 11 Smaller	2	410	—	Iron Corvette
1875	Boadicea	4,140	4,500	14	14·7	280	45	23·6	12 6-in. B., 4 5-in. B., 14 Smaller	3	570	426	Do. Heavier Armament
1877	Iris	3,730	6,000	17	17·98	300	46	22	2 64-pr. M., 4 6-in. B., 4 5-in. B.	4	780	280	Steel Despatch Vessel
1878	Champion	2,380	2,000	12·5	13·1	225	44·5	18	2 4½-ton M., 12 64-pr. M., 9 Smaller	2	470	265	Steel Corvette, Deck Protected
1882	Leander	4,300	5,000	16·5	17	300	46	20·6	10 6-in. Q.C., 4 3-pr. Q., 12 Smaller	4	1,000	297	Second-class Cruiser
1883	Rapid	1,420	1,400	13	13·1	200	38	13·6	2·6-in. B., 10 5-in. B., 5 Smaller	Nil	400	159	Composite Corvette
1884	Calliope	2,770	4,000	13·75	14·6	235	44·5	20	4 6-in. B., 12 5-in. B., 12 Smaller	2	550	291	Steel Corvette
1885	Archer	1,770	3,500	16·5	17	225	36	14·5	6 6-in. B., 11 Smaller	3	475	172	Steel Torpedo Cruiser
1885	Thames	4,050	5,700	17	18	300	46	19·5	2 8-in. B., 10 6-in. B., 13 Smaller	4	900	—	Second-class Cruiser
1886	Fearless	1,580	3,200	17	—	220	34	14·5	4 5-in. B., 12 Smaller	3	450	156	Steel Torpedo Cruiser
1888	Medea	2,800	9,000	19	19·9	265	41	16·6	6 6-in. Q.C., 9 6-pr. Q., 5 Smaller	4	400	216	Third-class Cruiser.
1889	Barham	1,830	4,700	19	20	280	35	13·3	6 4·7-in. Q., 6 Smaller	2	140	160	Do. do.
1889	Blake	9,000	20,000	21	21·5	375	65	25·5	2 9·2-in. B., 10 6-in. Q., 25 Smaller	4	1,800	590	First-class Cruiser
1890	Philomel	2,575	7,500	19	—	265	41	15·5	8 4·7-in. Q., 13 Smaller	2	440	217	Third Class, Improved "Barham" Type
1890	Edgar	7,350	12,000	19·5	20·97	360	60	23·75	2 9·2-in. Q., 10 6-in. Q., 19 Smaller	4	1,250	544	First Cl., Modification of "Blake" Type
1891	Apollo	3,400	9,000	20	20·4	300	43	16·5	2 6-in. Q., 6 4·7-in. Q., 20 Smaller	4	535	273	Second Class, Naval Defence Act
1893	Astræa	4,360	9,000	19·5	19·74	320	49·5	19	2-6 in. Q., 8 4·7-in. Q., 17 Smaller	4	1,000	312	Do. Improved "Astræa" Type
1894	Eclipse	5,600	9,600	19·5	20·1	350	53	20·25	5-6 in. Q., 6 4·7-in. Q., 21 Smaller	3	1,050	477	Do. All 4·7-in. Q., replaced by 6-in. Q.
1895	Terrible	14,200	25,000	22	22·5	500	71	27	2 9·2-in. Q., 12 6-in. Q., 32 Smaller	4	3,000	840	First Cl., four more 6-in. Q., added later
1896	Pelorus	2,135	7,000	20	20·7	300	36·5	17	8 4-in. Q., 10 Smaller	2	520	234	Third-class Cruiser
1896	Arrogant	5,750	10,000	19	19·9	320	57·5	21	4 6-in. Q., 6 4·7-in. Q., 16 Smaller	3	1,175	480	Second Cl., 4·7-in. Q., later replaced by
1898	Hermes	5,600	10,000	20	20·9	350	54	20·5	11·6-in. Q., 9 3-in. Q., 10 Smaller	2	1,100	477	Do. [6-in. Q.
1898	Argonaut	11,000	18,000	20·75	21·32	435	69	25·25	16 6-in. Q., 12 3-in. Q., 16 Smaller	2	2,000	677	First Class, Modified "Terrible" Type
1902	Encounter	5,880	12,500	21	21·1	355	56	20·25	11 6-in. Q., 8 3-in. Q., 9 Smaller	2	1,225	312	Second Class. Better speed than *Hermes*
1903	Amethyst	3,000	9,800	21·75	23·62	360	40	14·5	12 4-in. Q., 10 Smaller	2	300	296	Third Class. Better Speed than *Pelorus*
1908	Boadicea	3,300	18,000	25	27·9	385	41	13·5	6 4-in. Q., 8 Smaller	2	450	275	Do. Slightly Increased Tonnage
1909	Blonde	3,360	18,000	25	28·8	385	41·5	13·5	10 4-in. Q., 8 Smaller	2	450	295	Do. More Powerful Armament
1909	Bristol	4,820	22,000	25	26·84	430	47	15·25	2 6-in. Q., 10 4-in. Q., 8 Smaller	2	850	376	Do. Better Sea-keeping Powers
1910	Yarmouth	5,250	22,000	25	—	430	48·5	15·5	8 6-in. Q., 4 Smaller, 2 Machine	2	1,000	380	Do. More Powerful Armament

EXPLANATIONS.—M = Muzzle-loader; B. = Breech-loader; Q.C. = Breech-loaders Converted to Quick-firers; Q. = Quick-firer.
In tracing the evolutions of protected cruisers it was found impossible to maintain the sequence of the different classes. Thus a vessel built as a second-class cruiser might well be reckoned third-class after a lapse of ten years.

Active and *Amphion* are utilised for the same purpose, and it should be remembered that all these six vessels are fitted with turbine engines. In the "Town" class of cruisers there are three slightly different types; the five ships of the "Bristol" class, the four of the "Weymouth" type, and the six "Chathams." As will be seen from the list, they vary slightly in size and armament. They also are all fitted with turbine engines. Several vessels of the latter type will be built for the Commonwealth of Australia and the Dominion of Canada, but at present (1912) it appears as if there would be some delay in the completion of these units.

I must now turn to another type of vessel in the navy—the scouts. Strictly speaking, they do not come under the heading of protected cruisers, as their light armament unfits them for use as such.

Scouts, all the world over, have the same duty—that is, the tracking of and searching for the enemy, and as the general commanding an army uses his scouts to keep in touch with the opposing forces, so a fleet must be provided with small fast craft capable of spying out and reporting upon the movements of the hostile fleet. The scouts at present in the navy are eight in number, and are used in connection with our destroyer flotillas, work for which their high speed makes them especially suitable. Suppose an enemy's battle fleet is known to be in the English Channel, and that it is wished to deliver a torpedo attack upon it after dark. The scouts with their destroyers will sight the enemy before dark, and will remain in sight, but at a great distance, so long as daylight lasts. Their great speed (25 knots) will enable them to run away if they are chased, but it is their duty to remain in touch with the enemy until the night has fallen. Then the destroyers are launched to the attack, and their chance of success is greatly magnified, for the scouts have been able to tell them the rough whereabouts of the enemy and what course he is steaming.

The following is a list of the eight scouts now in the navy, and it will be noticed how applicable their names are to the work which they would be called upon to perform in time of war. Each ship, also, is a sister to the vessel whose name begins with the same letter as her own.

Ship	Tonnage	Speed	Armament	Torpedo Tubes	Date Completed
Adventure *Attentive*	2,940	25	10 12-pdrs. 8 smaller	2	1905 1906
Foresight *Forward*	2,945	25	14 12-pdrs.	2	1905
Pathfinder *Patrol*	3,000	25	10 12-pdrs. 8 smaller	2	1905
Sentinel *Skirmisher*	2,940	25	10 12-pdrs. 8 smaller	2	1905

This exhausts the list of protected cruisers and scouts now in the service. Other vessels, which were originally built as the former but have now been converted to some other use, will be dealt with in Chapter V.

CHAPTER IV

Torpedoes and Submarines

Torpedoes as first invented consisted merely of iron canisters filled with gunpowder designed to be exploded against the side of an enemy's ship while she lay at anchor. The canister, of course, was water-tight, and could be attached to the wooden hull of a vessel by means of a long screw, while the explosion was either effected by means of an internal clockwork arrangement or by a line, which, on being pulled, fired a species of pistol and so ignited the gunpowder. As may well be imagined, the fixing of a torpedo of this kind involved the running of a great deal of risk by the men detailed to carry out the work, and although in some cases good results were achieved, the method cannot be said to have been a great success.

The name of "torpedoes" was also given to what we should now call "mines" on their first being used in naval warfare. These were iron canisters moored in a channel through which hostile ships were expected to pass. They were exploded by being touched by the hull of a passing vessel, and were used with effect in the Civil War in America.

The next sort of torpedo was of the spar variety. This consisted of a charge of explosive carried at the end of a long spar, which was exploded against the hull of a hostile vessel either by means of a trigger and line, or by electricity. The spar was mounted in a small steamboat, which steamed close to the ship it was desired to blow up, and was then launched out until the charge was under the ship's bottom, when it was fired. Spar torpedoes were not abolished until comparatively recently, but to carry out a successful attack with weapons of this kind was a matter of considerable difficulty and great risk, for it was hardly possible for a steamboat to approach a hostile ship without being fired upon and sunk long before she got within striking distance.

Automobile torpedoes, or those containing their own motive power, are those generally in use at the present time in the world's navies, and the best known of these is the Whitehead weapon. Captain Luppis, of the Austrian navy, was the first man to complete an automobile torpedo, and although it at first proved itself to be erratic, untrustworthy, and very slow, in course of time Mr. Whitehead, who developed the invention, was enabled to produce the wonderful machine now used.

A torpedo, as you all probably know, looks like a steel cigar, and is some 16 to 18 feet long. At first they were manufactured of various diameters, but the torpedoes now used in the British Navy are of three sizes: 14 inches, 18 inches, and 21 inches in diameter. I do not intend to give a very elaborate or detailed description, for you would probably not be interested if I did, but, as I said before, the torpedo is cigar-shaped, with a very blunt head; at the tail will be seen the twin propellers which drive it, while just in front of these are horizontal and vertical fins fitted with rudders, which, actuated by the internal mechanism, keep the weapon straight and at a proper depth when running.

Let us take a torpedo, however, and go through its various compartments in proper order. First comes the head, which in war time contains the explosive charge of guncotton, built up in sections to fit inside. This guncotton explodes on impact by means of an appliance fitted in the nose of the torpedo, while a safety device prevents the head being exploded until the weapon has travelled a certain distance after leaving the torpedo tube. In peace time what is called a "collision head" is utilised, and this, of course, contains no explosive, and merely crumples up on hitting a vessel. What is known as "Holmes light" (after the name of the inventor) is contained in the "collision head," so when, in practice, the torpedo comes to the end of its run, the action of the water on the preparation of calcium in the Holmes light will create a large volume of smoke and flame, which will enable the torpedo to disclose its whereabouts. Torpedoes each cost £600 to £800, and it would not do for such expensive weapons to be lost every time they were fired in peace times.

The next compartment to the head, as you will see in the diagram, is the "air chamber." This is a cylinder about one-third of an inch thick bored out of an ingot of the finest quality high tensile steel. It will stand a pressure of some 2,250 lb. to the square inch, and the air is pumped in by means of an air-compressing engine and finds its way through to the engines on certain valves being opened.

The third compartment is the balance chamber. Inside this is contained the mechanism which actuates the horizontal rudders at the tail, and so keeps the torpedo at its correct depth, which is accurately set before the weapon is fired.

Behind the balance chamber is the "engine-room," containing the air engines which drive the torpedo through the water, and also various delicate mechanisms for adjusting the range, etc. The engines themselves are enormously powerful for their size, and can drive the weapon along at 35 knots or more.

The "buoyancy chamber" comes next. This compartment contains the gyroscope, which works on exactly the same principle as the gyroscopic tops which will spin at any angle, and consists of a brass flywheel that is started spinning when the torpedo is fired. The flywheel of the gyroscope will always spin in the same plane, and consequently, if the torpedo alters its course to the left or right, the gyroscope wheel remains steady, and, by means of connecting rods, works the vertical rudders to bring the weapon back to its true course. A torpedo gyroscope is a very delicate instrument, and costs some £50. The buoyancy chamber, however, as its name implies, fulfils another purpose, for it gives the necessary buoyancy to enable the torpedo to float after it has been run for practice. In war time, how-

Diagram of a Torpedo

ever, a torpedo floating on the surface would be dangerous alike to friend and foe, so if it is fired and misses its mark, this buoyancy chamber is so contrived that it is automatically flooded and the weapon sinks to the bottom.

The last compartment is the "tail." This contains the gearing for conveying the motion of the engines to the two propellers astern. One propeller revolves in the same direction as the hands of a watch, and the other in the opposite way, the idea of this being that each counterbalances the other as regards its tendency to cause the whole torpedo to turn to right or left.

The latest 18-inch torpedo has a speed of 35 knots for about 1,000 yards, but even this is not great enough for use from destroyers which can steam at 36 knots. The weapons supplied to all the latest battleships, cruisers and torpedo-boat destroyers, therefore, is 21 inches in diameter, and has a speed of 43 knots for a distance of 1,000 yards, and 28 knots, or so, for 4,000. The effective range, however, is 7,000 yards, or roughly 3½ miles, and the explosive charge consists of 300 lbs. of guncotton—one of the most powerful explosives known.

The interior of a torpedo, as may well be imagined, is a maze of complicated machinery, for the weapon has to be fitted with appliances which will ensure its running at a certain depth, maintaining a straight course, and travelling at a known speed for a certain distance. The officers and men of the Navy who are responsible for these deadly weapons of destruction have, therefore, to be specially qualified for their work and undergo courses in the torpedo school ship at Portsmouth, H.M.S. *Vernon*. All big ships carry a torpedo lieutenant, and he is in sole charge of the torpedo armament.

The 14-inch torpedo is practically obsolete, but can still be seen in many of the older torpedo boats. Its explosive charge was only 77 lb., while its speed was 30 knots for about 600 yards, which is wonderful if we do not compare it with the powers of the modern weapon. The rapidity with which so highly developed a piece of mechanism goes out of date is a striking example of the vast strides that are being made by modern science.

In large vessels, such as battleships and cruisers, torpedoes are fired from submerged or under-water tubes by means of compressed air; but in small craft, such as torpedo boats, destroyers, scouts and third-class cruisers, they are discharged from a tube on deck by means of a small powder charge which is just sufficient to throw the weapon clear of the ship's side.

Even in the short space of time torpedoes have been in existence, they have achieved very great results in several naval engagements and wars, and the Japanese torpedo craft during the late war in the Far East were able to sink or disable several ships through their use.

In the next naval war, whenever that may come, they will doubtless be used with still greater effect owing to their increased range, speed and destructive power.

All large vessels in our navy are supplied with a great number of quick-firing guns for use in driving off hostile torpedo craft, but as there are circumstances under which a torpedo boat or destroyer might be able to slip in unobserved, all our large battleships and first-class cruisers are fitted with torpedo nets. These nets are of steel wire, and, when not in use, are kept rolled up on a shelf running round the ship. When it is required to place them in position, they are swung out on a number of steel booms and form a species of curtain about 30 feet distant from the ship and extending from the water to about 20 or 25 feet below it. These nets, however, are by no means infallible, and the best means of protection against torpedo attack is undoubtedly a very heavy gunfire which will sink the attacking craft before she gets within effective range.

We must now leave the subject of the torpedo itself to discuss the craft which are primarily intended to use them as a means of offence.

Torpedo Craft

By 1877 the automobile torpedo had become more or less a reliable weapon, and in this year the British Admiralty ordered their first torpedo boat, the *Lightning.* She was a small craft of only 27 tons displacement, but could steam at the comparatively high speed of 19 knots, while she carried one torpedo tube. Though small, she was a great success, and as time went on all the naval Powers, ourselves included, commenced building torpedo boats, which rapidly developed in size, sea-keeping qualities and speed. Let us take as a typical case the British torpedo boat No. 039, built in 1885. She was a vessel of 40 tons displacement and a speed of 19 knots, and carried as her armament one torpedo tube and a couple of small machine guns.

Our friends across the Channel, the French, built large numbers of small torpedo boats during the 'eighties, and these, as may well be imagined, would have been a source of considerable danger to our fleet in war time. The result was, therefore, that we had to build craft capable of destroying hostile torpedo boats, and, commencing in 1886, many vessels of this kind were built. They were known as "torpedo catchers," or "torpedo gunboats," and were craft of from 500 to 1,000 tons displacement, with a nominal speed of 19 to 21 knots. They were designed to carry two 4-inch or 4.7-inch quick-firing guns, besides several smaller weapons, and, in addition, a couple of deck torpedo tubes; but, as a class, they were found to be too slow for the work they were expected to perform, and, moreover, their seaworthiness left much to be desired. Something better had to be done, and in 1893 the British Admiralty gave an order for several "destroyers," or "torpedo-boat destroyers," as they are more properly called. The first of these were craft of about 250 tons, with a speed on trial of 27 knots, and they fulfilled a double function, for their gun armament—consisting of a 12-pounder and a number of 6-pounders—would enable them to destroy a small hostile torpedo boat of inferior speed, while in addition they carried torpedo tubes, so that they could be used as torpedo boats if the necessity arose. As time went on it was found that the speed of these destroyers was not sufficient, and three years or so after their original inception this was increased to 30 knots, the displacement increasing slightly in consequence. Let us compare two of these craft, built in 1893 and 1899 respectively. It will be seen that the *Leven* has 3½ knots more speed, 130 tons more displacement, and carries one torpedo tube, two 6-pounder guns, and 20 more men than her earlier sister.

Date	Ship	Speed	Tons	Armament	Crew
1893	*Havock*	26.5	240	1 Torpedo Tube 1 12-pr. 3 6-prs.	43
1899	*Leven*	30	370	2 Torpedo Tubes 1 12-pr. 5 6-prs.	63

As time went on, however, even these "thirty-knotters," as they are called, were found, owing to their low freeboard forward, to be deficient in sea-keeping qualities, and in 1902-3 were built the first of what are usually called "River class destroyers," they being all named after rivers of the United Kingdom. These craft have high forecastles, which make them far more seaworthy than previous types, while they have a displacement of between 550 and 600 tons, a speed of 25 knots, and carry four 12-pounder guns and two torpedo tubes. As destroyers, they have always been satisfactory, for they can keep up their speed in a sea in which the old 27- and 30-knot craft would have to ease down for safety's sake. Up to 1899 torpedo craft generally had been driven by ordinary reciprocating engines, but in this year was launched the *Viper,* the first turbine destroyer. Her particulars will be found in the table on p. 66, and although she could hardly be called a 30-knotter, she conformed, nevertheless, to that type of craft.

River class destroyers, the majority of which were driven by reciprocating engines, continued to be constructed until about 1905, when the first of what are usually called the "Tribal class" destroyers were built. These craft are all named after tribes, and there are a dozen of them in the service: *Mohawk, Afridi, Saracen, Ghurka, Amazon, Viking, Cossack, Crusader, Maori, Nubian, Tartar, Zulu.* They vary in displacement between 865 and 1,090 tons, while the armament consists in some cases of five 12-pounder guns, the later boats, however, being armed with two 4-inch quick-firers. They all carry the usual couple of torpedo tubes, and all have turbine engines and burn oil fuel only, the designed speed being 33 knots, although the majority of them have steamed faster than this, the *Tartar* actually doing 40.2 on her trials!

During the time destroyers were gradually developing in size and speed, the construction of torpedo boats was by no means neglected, and the gradual growth in the size, speed and armament of craft of this kind is well shown in the table at the end of the chapter. The latest torpedo boats are those numbered 1 to 36; and, although the first dozen were slightly smaller, they are all practically of one type. The engines of all thirty-six boats are of the turbine variety, while nothing but oil fuel is carried, and this effects a great saving in the number of men required to tend the boilers. It is said that one of these new torpedo boats can steam with one solitary individual in the stokehold, for, instead of having to shovel coal into a furnace, all he has to do is manipulate his burner and oil-feed valves. It will be noticed that in all oil-fuel craft the complements are much smaller than those burning coal; for instance, the oil-burning 36-knot *Amazon,* of 890 tons, has a complement of 68, while the coal-burning *Eden,* of 550 tons, has 70 men.

The ocean-going destroyer *Swift,* launched in 1907, is the only vessel of her type in the service, for she has the large displacement—for a destroyer—of 1,825 tons. She was built as an experiment, and is driven by turbines of 30,000 horse-power, which give her an extreme speed of 38.3 knots. Her armament consists

THE DEVELOPMENT OF DESTROYERS

Date	Name	Class	Tons	Speed	Fuel	Engines	Horse Power	Guns	Torpedo Tubes	Men	Remarks
1893	*HAVOCK*	27 knots	240	26.7	Coal 57 tons	Recipro-cating	3,500	1 12-pdr. 3 6-pdrs.	1	43	First destroyer
1894	*ARDENT*	27 knots	265	27.9	Coal 60 tons	Recipro-cating	4,500	1 12-pdr. 5 6-pdrs.	2	45	
1899	*LEVEN*	30 knots	370	30.3	Coal 92 tons	Recipro-cating	6,300	1 12-pdr. 5 6-pdrs.	2	63	
1899	*VIPER*	—	312	37.1	Coal 88 tons	Turbines	10,000	1 12-pdr. 5 6-pdrs.	2	68	First turbine destroyer
1903	*EDEN*	River	540	26.2	Coal 130 tons	Turbines	7,000	4 12-pdrs.	2	70	
1905	*GARRY*	River	590	26.5	Coal 126 tons	Recipro-cating	7,500	4 12-pdrs.	2	72	
1906	*MOHAWK*	Tribal	765	35.3	Oil 185 tons	Turbines	14,500	5 12-pdrs.	2	60	
1908	*AMAZON*	Tribal	890	36.8	Oil 185 tons	Turbines	15,500	2 4-inch	2	68	
1907	*SWIFT*	Special	1,825	38.3	Oil 200 tons	Turbines	30,000	4 4-inch	2	?	
1909	*SCOURGE*	—	966	27	Coal, 165-215 tons	Turbines	12,500	1 4-inch 3 12-pdrs.	2–21″	70	
1910	*ACORN*	—	780	27	Oil 130 tons	Turbines	13,500	2 4-inch 2 12-pdrs.	2–21″	?	Improved "Scourge"
1911	*ARCHER*	—	780	28	Oil 160 tons	Turbines	13,500 to 14,500	2 4-inch 2 12-pdrs.	2–21″	?	Improved "Acorn"

THE DEVELOPMENT OF TORPEDO BOATS

Date	Number	Tons	Speed	Fuel	Engines	Horse Power	Guns	Torpedo Tubes	Men	Remarks
1877	*Lightning*	27	19	Coal 7 tons	Reciprocating	460	Nil	1	15	First British torpedo boat.
1882	74	17	16.5	Coal 1 ton	Reciprocating	170	1 machine	2	7	Second-class torpedo boat, designed to be carried aboard ship.
1885	039	40	19	Coal 10 tons	Reciprocating	500	2 machine	1	15	
1886	041	60	21	Coal 18 tons	Reciprocating	700	2 3-pdrs.	4	15	Larger displacement. More guns and tubes.
1889	80	85	23	Coal 20 tons	Reciprocating	1,100	3 3-pdrs.	3	19	Increased war value.
1894	91	130	24	Coal 25 tons	Reciprocating	2,400	3 3-pdrs.	3	18	Developed torpedo boat.
1901	98	178	26	Coal 20 tons	Reciprocating	2,850	3 3-pdrs.	3	18	Larger still. More speed.
1902	109	200	26	Coal 42 tons	Reciprocating	2,900	3 3-pdrs.	3	32	Larger.
1906	6	247	26	Oil 20 tons	Turbines	3,750	2 12-pdrs.	3	35	Turbine driven.
1908	31	280	26	Oil 30 tons	Turbines	4,000	2 12-pdrs.	3	35	Latest type.

of two torpedo tubes and four 4-inch guns, so to all intents and purposes she is a scout.

The newer destroyers are practically the same as those of the "Tribal" class, but with less speed. In 1908 were launched the *Basilisk, Beagle, Bulldog, Foxhound, Grasshopper, Harpy, Mosquito, Nautilus, Pincher, Racoon, Rattlesnake, Renard, Savage, Scorpion, Scourge* and *Wolverine,* all of which are now (1912) in commission in the various flotillas. These craft vary in size from 860 to 940 tons, and have turbine engines driving them at 27 knots. Coal alone is burnt, and of this 165 to 215 tons is carried. The armament consists of two 21-inch torpedo tubes of the latest type, one 4-inch quick-firing gun, and three 12-pounders. This class of sixteen boats is usually known as the "Beagle" class. In 1910 were launched the twenty destroyers of the "Acorn" class, consisting of the *Acorn, Alarm, Brisk, Cameleon, Comet, Fury, Goldfinch, Hope, Larne, Lyra, Martin, Minstrel, Nemesis, Nereide, Nymphe, Redpole, Rifleman, Ruby, Sheldrake* and *Staunch.* These craft have a displacement of 780 tons and carry 130 tons of oil fuel, while their turbine engines are designed to propel them at 27 knots, many of them, however, getting as much as 29 knots on trial. They carry one more 4-inch and one less 12-pounder gun than the "Beagle" class, but in all other respects they are the same.

The "improved Acorn" class consists of twenty craft, all of which are now complete. They are named *Acheron, Archer, Ariel, Attack, Badger, Beaver, Defender, Druid, Ferret, Forester, Goshawk, Hind, Hornet, Hydra, Jackal, Lapwing, Lizard, Phœnix Sandfly* and *Tigress.* They have the same tonnage and armament as the "Acorn" class, but carry 30 tons more oil fuel, and have a slightly greater speed.

The new destroyers now being built have speeds of 32 and 33 knots, but otherwise they are much the same as their immediate predecessors, the "Acorn" class.

It should be noted that destroyers are named, while torpedo boats have only numbers; so, apart from size and general appearance, it is always possible to distinguish between the two types.

The subject of destroyers has always been an important one to us British, and the fast craft now being built are able to keep the sea in practically any weather and will consequently be of the utmost assistance in our next naval war, whenever that may come.

Submarines

Submarine navigation is said to have been first attempted in the sixteenth century, and a submarine boat was tried in the Thames in the seventeenth century and another one at Plymouth in 1774. These early experiments did not meet with success, and attempts made by Robert Fulton in the early nineteenth century also ended in failure.

What may be considered as the really first successful submarine was built by Mr. Nordenfeldt at Stockholm in 1883. This vessel was 64 feet long and was built of steel, while the motive power was steam. The crew consisted of four men, who could breathe for six hours under water by means of compressed air, and the vessel could be raised or lowered at the will of her crew, while she carried torpedoes for offensive purposes.

Throughout the latter part of the nineteenth century greater success attended the inventors' efforts and many experiments were made, but it was not until 1901 that the first submarines were constructed for the British Admiralty. These were five in number, and were craft of 122 tons displacement, with a speed of 9 knots on the surface and 7½ below it. They carried one torpedo tube in the bows. Since then many submarines have been built, and I will enumerate the later ones in the form of a table for the sake of convenience:

Number of Boat	Total No. of Boats in Class	Date	Tons	Speed		Torpedo Tubes
				Surface	Subm'gd.	
A 1	1	1902	180	11	7	1
A 2–A 4	3	1903	204	12	7	2
A 5–A 13	9	1904–06	204	12	9	2
B 1–B 11	11	1904–06	314	12	9	2
C 1–C 10, C 12–C 38	37	1906–09	314–321	14	10	2
D 1–D 8	8	1908–11	540–595	16	10	3
E 1–E 12	12	1911–12	728–810	16	10	4

Of the craft mentioned above, A1 has lately been used for experimental purposes, and it is probable that all the A boats will shortly be removed from the Navy List. The D and E classes have twin screws and are undoubtedly a great advance on their predecessors, for besides being speedier, they carry more torpedo tubes. Submarines D4 and onwards, it is interesting to note, mount guns, which can be lowered inside the boat when she is under water.

Having thus briefly described the submarines at present in the British Navy, we will proceed to say something of the general type of these craft. To commence with, I must explain the difference between a "submarine" and a "submersible." The former type of vessel, if you can imagine it cut in half straight across, is circular in section, while the ballast tanks, for raising or lowering the boat by pumping out or letting in water, are inside the hull. The hull of a submersible, however, resembles that of an ordinary ship, the plating being partially double, and the space between the two skins forming the ballast tanks. This type possesses greater powers of flotation than a sub-

Photograph supplied by Messrs. J. Thornycroft & Co., Ltd.

H.M. TORPEDO BOAT DESTROYER "TARTAR."

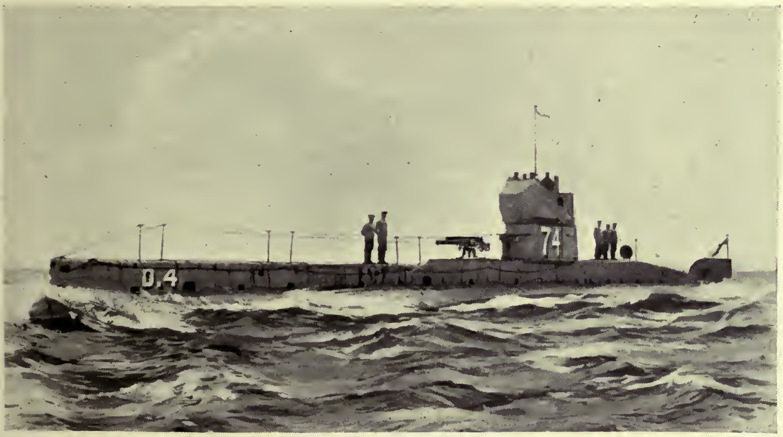


Photo: Stephen Cribb, Southsea.

H.M. SUBMARINE D4.

marine proper, and all the later craft are built on these lines.

Let us now, with the aid of a sectional diagram, examine the interior of a submarine. It is inadvisable for obvious reasons to give details of one of the newest type, but the diagram of one of the older class will do equally well for our purpose.

Starting at the bows, we first have the torpedo tube, while underneath this is the gasolene tank which supplies the engines with the necessary power when running on the surface. Coming farther aft, we have the air flasks, which supply the crew with air when the vessel is submerged, while below these, on the deck as it were, are two torpedoes to replace the one in the tube when it has been fired. Below this deck are placed the electric storage batteries, the use of which will be explained later, the main ballast tanks, the auxiliary ballast tanks, and the compensating tanks. These, as I have already said, are for raising or lowering the vessel in the water by pumping out or admitting water. The after compartment of all contains the engines to drive the boat, and of these there are two—a gasolene engine and an electric motor. The former is used when running on the surface, and also for charging the electric storage batteries which supply the electricity for the motor to propel the boat when under water, for it can be understood that the fumes given off by a gasolene engine would be very dangerous to the crew when the vessel is submerged.

Right aft outside the boat is the screw propeller, protected by a species of guard, while behind this are the vertical rudders used for directing the vessel to the right or left. In the centre of the boat will be seen the conning tower, in which the captain stands before the periscope, a long tube fitted with a series of prisms which enable a view of the surrounding water to be obtained. In the later British craft the conning towers are far larger and stand farther above the hull than that shown in our diagram, and the top of this forms a bridge from which the boat can be comfortably steered when she is running on the surface.

Now, when the ballast tanks are full, they sink the hull of the submarine until only the periscope and top of the conning tower are visible, and when empty the whole of the conning tower, superstructure, and a portion of the hull ride above the water. Even when the ballast tanks are full, the boat has a very slight

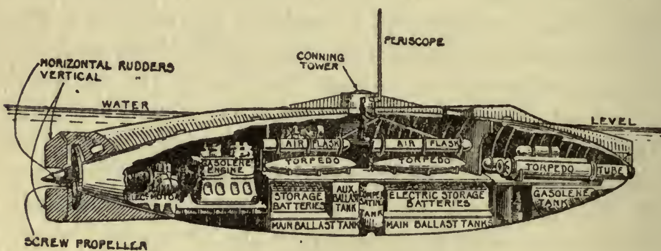


DIAGRAM OF A SUBMARINE

This shows one of the earlier types of British submarines, but it gives a good general idea of what a submarine is. In the later types there are many improvements, but these, of course, are kept strictly secret. The diagram shows the boat as she lies when floating at the surface: the reader will notice that even then only a small proportion of the hull appears above the water level.

reserve of buoyancy, and the diving, therefore, is not accomplished by adding weight, but by propelling the boat down under water on an incline. Hydroplanes, like short, broad fins, are fitted to tilt the nose of the vessel under water, and when once this is done the propeller drives the craft down till it reaches the required depth.

The hull is built strong enough to withstand the pressure of water 300 feet deep, but under ordinary circumstances a submarine does not dive deeper than 50 feet.

The work carried out by our submarines is naturally very dangerous, and the officers and men who volunteer for service in these craft take their lives in their hands; but, still, there is no lack of applicants for this particular branch of the service. Officers receive extra pay at the rate of 6s. a day and the men 2s. 6d.; and well they deserve it, for they run risks which no ordinary sailor is ever called upon to face. An invention has lately been brought into use, however, which enables the men inside an undamaged sunken submarine to escape to the surface. The appliance consists of a species of diving helmet attached to an air-proof jacket which can be secured round the waist. A number of these appliances—one for every man in the boat—are hung in what is known as an "air lock," or compartment which is so arranged that, when the hull of the boat is full of water, there will still be air in the air lock. In the event of the submarine sinking on an even keel the men go to the air lock and put on their helmets, and then emerge from the conning tower hatch and float to the surface. The appliance is a very simple one, and exhaustive experiments have proved it to be satisfactory, and although I believe it has never yet been used in an actual accident, it will doubtless prove its efficiency if the occasion ever arises.

Such, briefly, is the submarine, together with its armament, one of the most wonderful inventions of this remarkable age, and one which will doubtless prove its efficiency in the future.

We can well imagine the anxiety of an admiral commanding a fleet of hostile "Dreadnoughts" when he knows submarines are lurking in the vicinity. He can see nothing, for all a submerged submarine shows above the surface is the top of her periscope, and this is invisible at more than half a mile; and he never knows that the next moment will not bring a deadly Whitehead torpedo speeding on its way towards him at 35 knots. A dull explosion, a column of water at the side of a battleship, and the great leviathan, costing perhaps £2,000,000 and carrying 900 men, will be sent to the bottom by a torpedo costing about £600.

No wonder, then, that many naval officers regard the submarine as one of our best means of defence, for it is quite certain that no foreign fleet will risk spending any unnecessary time in waters in which they are known to be present.

Submarine Mines

Submarine mines can be used for either offensive or defensive purposes in naval warfare. In the former case they can be dropped off an enemy's coast or harbour by specially fitted vessels, or "mine-layers," as they are called, and in this way they were used with great success by the Japanese off Port Arthur during the late Russo-Japanese war. Mines of this sort are fitted to explode when touched by a ship, no matter whether she is a friend or foe to the vessel who laid them, and consequently can only be used in places where friendly ships are not likely to be.

What are known as "observation mines" are used for defensive purposes, and are moored in an entrance to a harbour, being so spaced that a hostile vessel forcing an entrance cannot effect a passage without striking or coming within effective distance of one or other of the mines. They are moored, of course, so that they are below the surface of the water, and they are connected to the shore by an electric cable, being fired from there when a ship is seen to be within the destructive area.

Nowadays guncotton is the only explosive used for submarine mining work, and this is exploded by means of a detonator which is either fired by electricity from the shore or by a battery in the mine itself.

The mines themselves are made of steel, and are usually cylindrical or circular in shape, the larger types containing from 250 to 500 lb. of guncotton.

The results of mine explosions on men-o'-war can best be shown by actual instances which occurred off Port Arthur during the Russo-Japanese war.

During the early days of April, 1904, the Japanese had been busy laying mines off the entrance to Port Arthur, and in a position through which they knew the Russian ships were bound to pass if they attempted to go to sea. In spite of the heavy fire poured upon the mine-laying vessels by the forts, the mines were successfully laid, and the next move of the Japanese was to entice the Russian ships to destruction.

Early on the morning of April 13, 1904, a weak cruiser squadron was sent by Admiral Togo, the Japanese commander-in-chief, to parade up and down off Port Arthur, while the Japanese battleships were kept well out of sight. It had been hoped that this unsupported cruiser squadron would lure the Russian fleet out to meet it and so across the mine field, and this was exactly what took place. Admiral Makarov, the Russian commander-in-chief, left Port Arthur with his fleet, and, getting to sea, pursued the Japanese cruisers, which latter gradually retired until they had decoyed the Russians some fifteen miles to seaward. At the same time Admiral Togo had been informed of the course of events by wireless telegraphy, and his fleet suddenly appeared on the horizon, while the Russians were still in pursuit of the cruisers. The Russian commander-in-chief had not bargained for this, and turned and retraced his course for Port Arthur, pursued by the Japanese battleships.

By half-past ten in the morning the leading Russian vessel, the battleship *Petropavlosk,* the flagship of Admiral Makarov, was barely a mile distant from the harbour entrance. The admiral himself was on the bridge, surrounded by his staff, and signals were being made to the other ships, when suddenly a violent explosion, followed by an enormous column of water and smoke, broke out from the battleship's side. Scarcely had the report died away when another explosion took place, and this, it is said, exploded one of the magazines, for a huge hole was torn in the vessel's hull. The stricken ship listed heavily and began to settle down slowly, turning over as she did so, while her wretched crew made efforts to save themselves; but in under two minutes she had gone to the bottom, carrying with her the commander-in-chief and 590 men.

Two more of the Russian vessels came into contact with mines, but although explosions took place, they were not vitally injured, and managed to regain the harbour. The Japanese also did not escape scot free, for in May, 1904, two of their battleships struck mines which had been laid far out at sea by the Russians. The loss of life was not so great as in the case of the *Petropavlosk,* but both ships—the *Hatsuse* and *Yashima*—sank.

These instances show what a very powerful weapon the submarine mine is.

When a fleet has to go through water which it is thought has been previously mined by the enemy, a channel is cleared by means of vessels fitted with sweeps. These sweeps are long lengths of wire towed along the bottom between two vessels steaming slowly, and any mines encountered are thus broken adrift from their moorings and come to the surface, where they can be destroyed by rifle fire. The vessels used for this purpose are in some cases old torpedo gunboats, but lately the Admiralty have purchased a number of steam trawlers for this work.

CHAPTER V

Other Vessels in the Royal Navy

We have described at some length the battleships, cruisers, torpedo craft and submarines of the Royal Navy; we have discussed the question of their guns and torpedoes, and now, to complete the account of the vessels under Admiralty jurisdiction, I must give a brief account of the various other ships whose names appear in the official Navy List.

We had better, perhaps, start with a description of His Majesty's yachts, the largest of which is the *Victoria and Albert*, of 4,700 tons, launched at Pembroke Dock in 1900. She has a speed of over 20 knots, and is a three-masted, two-funnelled vessel. She is undoubtedly an imposing-looking ship, with her graceful bow and counter, gold scrollwork at bow and stern, and her two encircling gold ribands, carved to represent cables, and although Mr. Keble Chatterton, in his book "Steamships and their Story," says that "grace and delicacy have been avoided for a kind of clumsy impressiveness," I cannot say I agree with him. The smaller Royal yacht, *Alexandra*, is a turbine vessel of 2,050 tons, launched as recently as 1906, and in appearance has the same characteristics as the *Victoria and Albert*. His Majesty also has another little vessel, the *Alberta*, launched in 1863. She is of 370 tons, and is driven by paddle wheels, and was frequently used by Queen Victoria. Now, however, although she still figures on all official occasions, she is no longer used to any great extent by the Royal Family, as she is very slow.

Other yachts whose names appear in the Navy List are the *Enchantress,* the Admiralty yacht, of 3,470 tons, launched in 1903. Another vessel, sometimes called a yacht, but known officially as a dispatch vessel, is the *Alacrity.* She was launched in 1885, is of about 1,700 tons, has a speed of 16 knots, and is under the orders of the Commander-in-Chief on the China station.

Other vessels in the Royal Navy whose function is essentially a peaceful one, are the "surveying ships." At home we have the *Hearty, Research* and *Triton,* the former a twin-screw vessel of 1,300 tons, and the two latter paddle vessels, built in the 'eighties, of 520 and 410 tons respectively. Employed on the same duty abroad are the *Fantome, Merlin* and *Mutine,* converted sloops of about 1,000 tons, and the two converted yachts, *Sealark* and *Waterwitch.* All these vessels are manned by officers and men of the Royal Navy, and few people have any idea of the arduous duties they have to perform, for upon them devolves the work of surveying the coasts and making the charts which are subsequently used by all British vessels. The English charts are undoubtedly the most reliable and trustworthy in the world, and this in itself is a high tribute to the thoroughness with which the officers and men of the surveying branch of the Royal Navy do their work.

At the various naval ports will be found many famous old ships, which are used for a variety of purposes. Nelson's *Victory,* for instance, which was launched in 1765, is still to be seen peacefully swinging at her moorings in Portsmouth Harbour, and until quite recently was used as a signal school. Now, however, she is more or less of a show ship, but still performs a useful purpose, for the Commander-in-Chief's flag is flown from her masthead, while all the courts-martial take place aboard her in the apartments which were once inhabited by the immortal Nelson. Other old vessels, but not quite so ancient as the *Victory,* are used for various other purposes, such as torpedo school ships, establishments for the training of boy artificers, etc. Thus, the *Actæon,* the torpedo school ship at Sheerness, was once the steam frigate *Ariadne.* The famous *Warrior,* the first armoured ship in the British Navy, now forms a portion of the *Vernon,* the torpedo school ship at Portsmouth; while the famous old five-masted *Minotaur,* launched in 1869, is now known as *Ganges No. II.,* and forms an overflow ship for the training establishment for boys at Shotley, near Harwich.

Many more modern ships are also used for other purposes than those for which they were originally intended. The *Blake* and *Blenheim,* for instance, cruisers launched in the 'nineties, are now used as depot ships for destroyers; while the *Hecla,* a merchant vessel purchased in 1878, is utilised for the same purpose. The cruiser *Bonaventure* (completed in 1894), *Forth* (completed in 1888), *Mercury* (completed in 1880), *Thames* (completed in 1887), *Arrogant* (completed in 1898), and several others are all used as depot ships for submarines, stationary or otherwise; but more sea-going vessels for use with submarines—the *Adamant, Alecto* and *Maidstone*—are now built, and these have been specially designed for their work.

Many of the cruisers of the "Apollo" type have been converted into mine-laying vessels, and in war time they would be employed in dropping mines off an enemy's coast; while many torpedo gunboats, launched between 1890 and 1896, small vessels ranging in size from 810 to 1,000 tons, are specially fitted to enable them to sweep for the enemy's mines. Lately, also, several North Sea trawlers, vessels with a tonnage of about 550, have been bought by the Admiralty, and have been adapted for mine-sweeping purposes, work for which their stout build makes them particularly useful.

Besides the torpedo-boat destroyer depot ships, which are all capable of doing repairs to their tenders, there are the repair vessels, the *Assistance* and *Cyclops,* of 9,600 and 11,300 tons and 14 and 13½ knots speed respectively, attached to the Home Fleet. These craft are fitted up solely for the purpose of carrying out repairs which cannot be undertaken by the various ships in the fleet, and they have workshops on board in which are all the necessary machines and tools for making good the defects.

On foreign stations are employed many small vessels known as "sloops." These are ships of about 1,000 tons, fitted with sails as well as engines. They are useful in many ways, such as for visiting coasts which a larger vessel could not approach. On the China station are many gunboats, and of these the *Bramble, Britomart* and *Thistle* are twin-screw craft of 710 tons, armed with 4-inch guns, and principally designed for river work. Several shallow-draught gunboats, varying in size from the *Robin* (of 85 tons) to the *Widgeon* (of 195 tons), are also stationed on the Chinese rivers, and they are all armed with light guns, and have a draught of barely 2 feet, so they can steam in the shallowest water. These small gunboats are particularly used for putting down piracy and smuggling, in both of which occupations the Chinaman excels. The *Dwarf,* a sister ship to the *Bramble* and *Britomart,* is stationed on the West Coast of Africa; while the *Sphinx,* a special-service paddle vessel, of 1,130 tons, spends the greater part of her time in the Persian Gulf.

In connection with the Royal dockyards at home and abroad, large numbers of tugs, tank vessels, ammunition craft, store ships, provision ships, mooring vessels, dredgers and mudhoppers are also employed.

The tugs are either paddle or screw craft, the former being the commonest, for a paddle vessel draws far less water and is much handier in a crowded harbour than a ship driven by screws. They are all under 1,000 tons displacement, but they have plenty of work to do, and in the naval ports they are constantly to be seen at work assisting large battleships and cruisers out of the harbour, and rendering assistance to ships berthing in a place where the tides are very strong and the water crowded with men-o'-war.

I am afraid the above short description gives but a feeble idea of the very important work carried out by the smaller vessels of the Royal Navy. The duties of their officers and men, however, are often harder than those of their comrades in the big battleships, for they may be chasing gun-runners up the Persian Gulf, or sweltering up some Chinese river, a thousand miles from the nearest civilisation, where the sight of another white man is looked upon as a blessed relaxation. On the other hand, they may have to winter at some place with an unpronounceable name in North China, where the snow blizzards bring 40 degrees of frost in their wake; but, in spite of it all, they enjoy their lives, and although no sailormen that ever yet lived were content unless they had their grumble, they are doing work which, though it is little talked or known about at home, goes a long way towards keeping up the prestige of the British Empire and the honour of the flag.

CHAPTER VI

Naval Guns Past and Present

THE subject of naval gunnery is necessarily an abstruse one to the average person, but as a book which deals with the history of our ships would hardly be complete without a chapter on this all-important matter I will give a brief history of naval gunnery from the earliest times up till now. According to all accounts, guns were first mounted in British vessels in the year 1346, at which time Edward III. made an expedition to France. Existing records prove conclusively that cannon were supplied to two vessels in 1358, while it is tolerably certain that the Moors and Venetians used them in their naval campaigns of 1350 and 1377. Guns in those days for use on board ship did not throw a shot weighing above two or three pounds, but it is a curious fact that many of them were breech-loaders. By 1488 we had ships carrying 180 guns each, the majority of which were what are known as "serpentines," throwing a ball weighing approximately one pound.

The size of the weapons gradually increased, and by the early part of the sixteenth century portholes cut in the sides of the ships for the guns to fire through had come into general use. The *Mary Rose,* a vessel of 500 tons, lost in the action with the French off the Isle of Wight in 1523, was one of the ships fitted with these, the lower tier being only 18 inches off the water's edge. They were open for fighting the guns, and a sudden squall heeling the vessel over, the sea entered, and the ship capsized and sank. In 1836 several of the guns were recovered, and among them was an 8-inch breech-loader and several more brass weapons with a bore of 5.2 inches.

By the time of the Spanish Armada our men-o'-war were armed with a very varied assortment of weapons. Some of them had very quaint names, such as "Cannons Royal," "Culverins," "Basilisks," "Sacars," "Minions," "Falconets," "Rabinets," "Port Pieces" and "Fowlers." In all there were over twenty separate varieties in use, and these differed in size from the Cannon Royal, with an 8½-inch bore and weighing 8,000 lb., to the Rabinet, with a bore of 1 inch and a weight of 300 lb. The former threw a shot weighing 66 lb. to a range of 1,930 paces, while the latter flung a ½-lb. projectile to a range of about 1,000 paces. The heavier guns were muzzle-loaders mounted on beds of wood, but the smaller weapons were often breech-loaders mounted on iron pivots. In the former variety the powder was placed in position by means of a ladle. The necessary quantity was placed in the bowl of the ladle, which was then thrust into the bore of the gun and inverted. On top of the powder were placed the necessary wads, and then the shot itself. In the breech-loaders the shot and wad were placed in the rear end of the gun, while a sufficient quantity of loose powder was put into the portable chamber. The latter was then firmly wedged into place, and the gun was ready for firing.

This method of loading with loose powder was extremely dangerous and unfitted for use on board ship, and before long cartridges were introduced. These consisted of the ordinary quantity of powder enclosed in canvas or paper covers, and our present-day "cartridge paper," so largely used for drawing purposes, owes its name to these cartridges being originally made of paper of much the same kind. All guns were fired by means of a slow match, which was always kept smouldering. Powder was poured down the vent in the breech of the gun until it reached the charge below, the lighted end of the slow match was then applied, and the gun went off. This method of firing remained in use until the beginning of the nineteenth century. In guns firing cartridges the latter had to be pricked so as to ensure the flame from the powder in the vent reaching that contained in the charge.

Under Cromwell the various guns were reclassified and renamed according to the size of the projectiles they threw, and at the same time the mountings were much improved, the old bed giving way to a truck carriage on wheels. The truck carriage remained in use for many centuries, and those of you who have visited Lord Nelson's flagship *Victory* at Portsmouth will probably remember having seen them there.

At the beginning of the nineteenth century the largest guns were the 32- and 42-pounders. Other guns, known as carronades, had also been introduced, and they were known by this name as they had first been manufactured at the Carron Foundry, Stirlingshire, in 1776. Their particular advantage lay in their being able to throw a heavy shot with sufficient accuracy to such distances as ships then fought at—i.e. about 400 to 600 yards. They required fewer men to work them, were much lighter weapons, and were cast with a loop underneath, a bolt passing through which fastened them to the carriage. They were made in all sizes from 6- to 68-pounders, and the execution they wrought at close quarters was enormous; they were known in the service as "smashers."

The *Victory* at the battle of Trafalgar carried 42-, 32-, 24- and 12-pounders, and in addition two 68-pounder carronades. Guns of this type were mounted in our men-o'-war until about 1839, when a new type of 68-pounder, invented by Colonel Dundas, was adopted in the service. At about this time also guns designed to fire shell and hollow shot were introduced, although in 1838 8-inch shell guns had superseded the 32-pounders in some of our ships.

Shells, or hollow projectiles containing an explosive or compound designed to set alight to an enemy, were by no means an innovation. They had been used in Holland in 1495 and in our navy in 1634, but up till 1838 were only fired from bomb vessels or mortar boats specially fitted for the purpose.

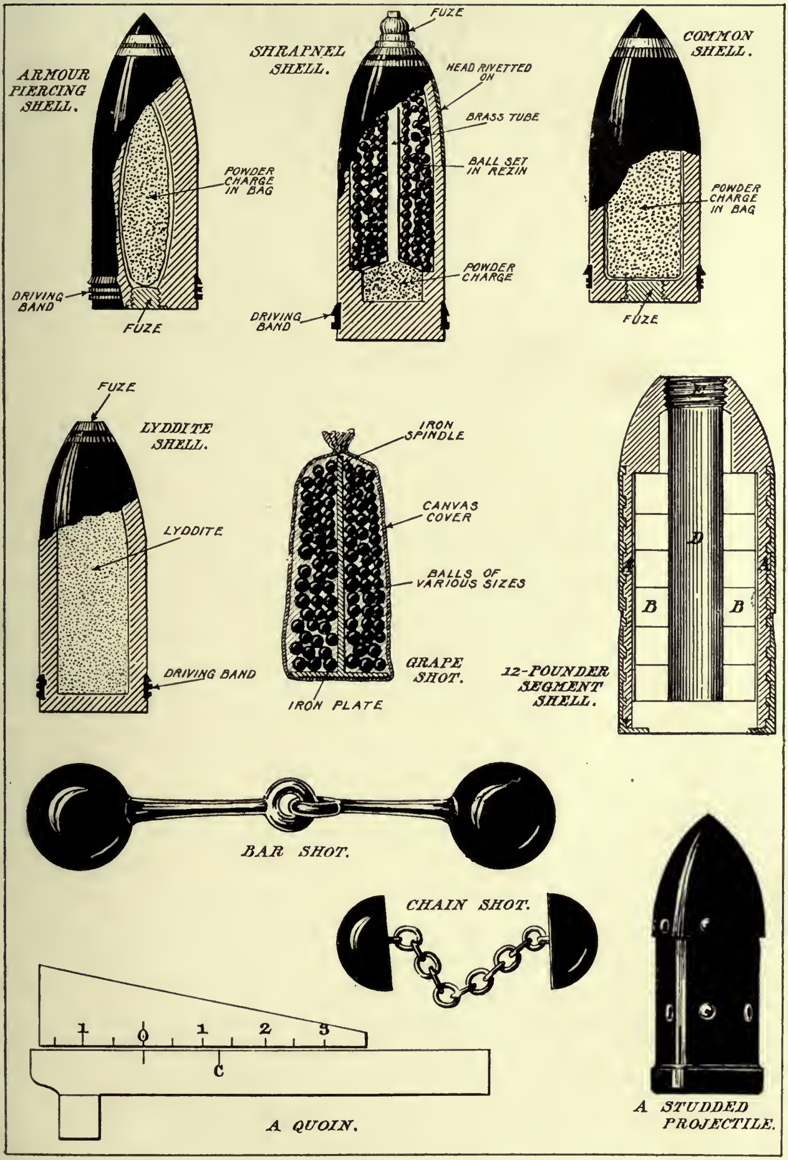
Soon after the war with Russia a gun throwing a 10-inch shell was introduced and mounted in several frigates, and it is interesting to note that even in 1870 this type of weapon had not entirely disappeared. In 1860 the flagship of the Mediterranean fleet, the three-decker *Marlborough,* carried sixty-two 8-inch shell guns, fifty-eight 32-pounders and one 68-pounder pivot gun, all of which were, of course, muzzle-loading.

Flint locks, for firing the guns instead of using the slow match, had been devised in 1781, but it was not until nine years later that they were generally introduced. The guns so fitted were fired by means of a lanyard, which, when pulled, caused a hammer to fall and ignite some special composition placed over the vent of the weapon. The spark caused by the fall of the hammer ignited the composition, and the flame from this travelled down the vent until it reached the powder charge in the chamber below and so fired the gun. Early in the nineteenth century also the paper with which the cartridges were covered was done away with, and flannel introduced instead. This material was used for the purpose for almost sixty years, but now all the charges used for our modern guns are covered in silk cloth manufactured from the refuse silk on the outside of the cocoons, as it is found to be more readily consumed.

In Nelson's time the method of aiming was most rough-and-ready, for all that was done consisted in running the eye along an imaginary line on the exterior of the gun which was supposed to be parallel to the bore. As may be imagined, accurate shooting was out of the question with this method, but naval actions of those days were fought at such a close range that the matter was not of really vital importance.

The necessary elevation was given to these old-fashioned guns by means of a quoin. This consisted of a wedge-shaped block of wood thrust under the breech of the gun, and pushing it in or pulling it out raised or lowered the weapon as necessary. In moving the guns to the right or left, or "training," to use the correct term, handspikes, or iron-shod poles with square heads, were employed as levers under the inner ends of the gun carriages, while tackles were also fitted to assist in this. The recoil of the gun was limited by a stout rope, called a "breeching," which passed through an eye on the breech of the weapon and was made fast on either side to ringbolts in the side of the ship. Up till 1856, when Mr. (afterwards Lord) Armstrong constructed guns of wrought iron, cast iron had almost exclusively been used in their manufacture. Bronze had been utilised in earlier days for the making of lighter guns up to 32-pounders, but since 1880 steel has superseded all other metals for gun construction.

Breech-loading cannon are by no means so modern as people are inclined to think, for they were in use at the beginning of the sixteenth century, as the gun raised from the *Mary Rose* will show. Rifling, or the cutting of grooves in the bore of a gun to give an elongated projectile the necessary spin so that it may remain point on towards the object at which it is fired, is not a very recent innovation, for there is in existence at Woolwich a rifled gun bearing the date 1542. A rifled gun has several advantages over the smooth bore. In the first place, the conical projectile, the length of which is greater than its diameter, is naturally far



SHOT AND SHELL.

heavier than a spherical projectile of the same diameter, and the loss of power due to what is known as "windage" is also greatly obviated. Windage is the escape of gas round the projectile when the gun is fired, and as a spherical shot could never fit very tightly in the bore, the loss in power was considerable. The rifled projectile, as the reader will readily understand, fitted much closer, and the escape of gas was therefore much less.

In 1846 experiments were carried out with foreign-made breech-loading rifled cannon, but the result of the trials did not warrant their adoption. An Englishman called Mr. Lancaster then entered the field, and he invented a gun with a slightly elliptical bore which caused the shot to rotate in the same way as in an ordinary rifled gun. Several of these weapons were mounted in gunboats employed in the Baltic and Black Seas during the Russian war of 1854; but unfavourable reports concerning them were received, for the shot sometimes jammed in the bore, and some of the guns burst, while the flight of the projectiles was often erratic. They were therefore withdrawn in favour of the 68-pounder.

In 1854 Lord Armstrong submitted proposals for rifled breech-loading weapons of a new design, and two years later the first gun was completed and was subjected to a series of exhaustive trials. These were successful, and many were mounted on board the vessels of the British and other navies. About the same time as the Armstrong guns had first been tried, Mr. Whitworth brought out a gun whose bore was of an hexagonal spiral form. This weapon was a breech-loader, but was not a success, for on being tried against the Armstrong gun, the latter was found to be much superior.

The first Armstrong breech-loading cannon, however, soon gave way to muzzle-loading guns built by the same firm, for it was found that the former were inclined to be dangerous, the guns often being fired with the breech not properly closed.

By 1865 smooth-bored cannon had been condemned, and the rifled muzzle-loading guns were adopted. The lighter types of the Armstrong breech-loading guns, however, still remained in use. By 1868 a 10-inch 18-ton gun, throwing a 410-lb. projectile, had been adopted, while in 1874 the 12.5-inch 38-ton gun, firing an 820-lb. shot, was introduced. A year later the first 80-ton gun, with a 16-inch bore, the largest muzzle-loading gun in the Navy, was constructed, and weapons of this type were subsequently mounted in the turrets of the battleship *Inflexible,* and at the bombardment of Alexandria in July, 1882, they did good work in that ship. They fired a shot weighing 1,700 lb. to a range of about seven miles, and were mounted on heavy steel carriages, while the recoil was absorbed by a series of hydraulic buffers and compressors.

In 1879 Lord Armstrong again urged upon the Government the advantages of breech-loaders, and after a series of trials the manufacture of the new type of breech-loader was commenced. They soon afterwards entirely superseded the old muzzle-loaders, although many of the latter remained in the vessels in which they were already mounted. The new guns were constructed on the principle of shrinking coils and tubes over an inner tube, and the largest weapons manufactured on this principle were the 13.5-inch 67-ton guns of the battleships of the "Royal Sovereign" class and the famous 111-ton guns, of a 16.25-inch bore, mounted in the *Benbow, Sans Pareil* and the ill-fated *Victoria.* The latter were the largest guns ever built in England, and their length was nearly 44 feet, while they threw an 1,800-lb. projectile with a charge of 960 lb. of powder. These great weapons did not long remain in vogue as the ideal guns for mounting afloat, for their weight and that of their ammunition was so enormous that it was quite impossible to mount more than two of them in any one ship. The life of the guns was also a very short one, and for these reasons their use was discontinued and the 13.5-inch guns, described above, were introduced. These remained in vogue until about 1894, when the new wire-wound 12-inch 46-ton guns were mounted in the battleships of the "Majestic" class. The idea of using wire ribbon for strengthening guns is said to have originated in America in 1850, but at that time it was not adopted. Twenty years later, however, the subject again came up, and between 1875 and 1879 no fewer than forty wire guns, the largest of which was a weapon with a bore of ten inches, were constructed at Elswick. In 1887, as a result of experiments with a 9.2-inch gun, it was decided to adopt the method, and a brief description of the process may be interesting.

The winding of the wire is performed by means of a lathe so adjusted as to move sideways up and down the tube as the winding proceeds. The tube which is being covered with the wire is slowly revolved and thus draws the wire off the drum, while an arrangement ensures the wire being tightly compressed as it is wound. By careful adjustment this tension is regulated so that it varies between about 35 and 50 tons on the square inch at the commencement to about 20 to 35 when finishing off. The speed of winding is about 80 feet a minute, and in one of the older 12-inch guns no less than 113 miles of wire are used. Thirty-six working days of eight hours each are required to wind a gun, while the weapon itself takes about nine months to make. Towards the muzzle of the gun there are 14 layers of wire, and this amount varies gradually until at the breech end there are no fewer than 92. The wire itself is about $\frac{1}{4}$ inch across and $\frac{6}{100}$ of an inch thick, and is tested to a breaking strain of 90 to 110 tons on the square inch. All the modern heavy guns, from the new 13.5-inch down to the 4-inch are constructed on this wire principle, and although at first there was some difficulty in obtaining the necessary girder strength—that is, preventing the tendency of the muzzle to droop—this has now been rectified. The guns now in use in the Navy are of various calibres, but the chapters on battleships and cruisers will have given you an idea of the gradual growth and development of the weapons.

Calibre of Gun	Weight in Tons	Length	Weight of Projectile	Remarks
14.2″	—	53′ 3″	1,600	Is probably going to be mounted in the new British battleships.
13.5″	86	51′ 10½″	1,250	Mounted in the cruisers of the "Princess Royal" class and in later battleships.
12″	69	50′ 0″	850	12″ guns are mounted in battleships of "Majestic" and later classes up to and including "Dreadnoughts."
9.2″	28	39′ 5″	380	Mounted in "King Edward" and "Agamemnon" classes of battleships and many cruisers.
7.5″	16	32′ 2¾″	200	Mounted in cruisers principally.
6″	7¾	25′ 0″	100	Mounted in cruisers and battleships as secondary armament.
4.7″	—	—	50	Mounted in small cruisers.
4″	—	—	25	Mounted in small cruisers and destroyers, and in battleships as anti-torpedo-boat guns.
12-pdr.	—	—	12	Mounted in smaller destroyers, and in cruisers and battleships as anti-torpedo-boat guns.
6-pdr.	—	—	6	Mounted in the older destroyers.
3-pdr.	—	—	3	Mounted originally in battleships and cruisers for use against torpedo boats.

Photo: Stephen Cribo, Southsea.

THE 12-INCH GUNS OF H.M.S. "NEPTUNE."

The heavier guns have their charges covered in silk cloth, but the lighter quick-firing weapons have a brass cartridge case with the charge inside it. In the 6- and 3-pounders the cartridge case and projectile is all in one, so the speed of loading is greatly increased.

The big guns are mounted in what are known as "hooded barbettes," and these armoured structures have openings through which the muzzles of the guns project for about two-thirds of their length. When the guns are to be pointed at any particular object the whole turret is revolved by electricity or hydraulic power, but manual training arrangements are fitted in case the machinery breaks down. The smaller guns are moved by hand. Heavy guns are loaded by machinery, which rams home the projectile and cordite charge, but in 6-inch guns and below all the loading is done by hand.

In a short chapter like this it is quite impossible to describe fully all the very intricate and complicated mechanism which operates the guns at present used in the Navy. Manual labour, however, is done away with as much as possible, and the "gun-layer"—as the man is called who fires the weapon—has little to do except to keep the cross wires of his telescopic sight on the object he is firing at. If he wishes to turn the guns to right or to left he moves a little handle, and the machinery below trains the gun in the required direction. Moving this handle up or down elevates or depresses the gun as necessary by the same invisible power, and he has only to pull a small, innocent-looking trigger to send a huge shell, weighing very nearly a ton perhaps, towards the enemy.

In the smaller guns the training and elevating is all done by hand by means of wheels and bevel gear, but the operation of firing is just as simple as in the other case. In the lighter kinds of quick-firing guns there is a shoulder-piece against which the gun-layer leans, and the gun is so light and beautifully balanced that he can turn it right or left, up or down, with very little exertion.

It is practically impossible to fix the actual date at which gunpowder was discovered, but it did not come into general use until a German monk called Schwartz discovered the proper method of mixing the ingredients in A.D. 1320. Seven years later it was employed in England for warlike purposes, and was adopted on the Continent shortly afterwards. English black powder is composed as follows: Saltpetre 75 per cent., charcoal 15 per cent., and sulphur 10 per cent. Powder, however, is no longer used for firing projectiles, being only utilised for saluting purposes and filling shell.

"Cordite" is now the propellant employed in all modern guns, and this consists of 58 per cent. of nitroglycerine, 37 per cent. of guncotton, and 5 per cent. of vaseline. In the newer sorts of cordite there is more guncotton and less vaseline, but they have the same advantages as the older kind. It is made in long sticks or cords, having the appearance of an opaque and elastic-looking substance. It has the advantage of being practically smokeless, and is far more powerful than the old-fashioned powder.

Projectiles have been used from the earliest ages, and long before the introduction of cannon. Stone shot were hurled from "ballistæ" and other engines of war from the very earliest times, and on cannon being invented they were still retained. They were soon found, however, to be too brittle to resist the force of the powder, and in 1346, at the battle of Crécy, we had three cannon throwing iron balls.

At the siege of Cadiz in 1596 cast-iron shells filled with lead, to increase their density and weight, were thrown by mortars to a range of nearly four miles. These mortars were very short, large-mouthed cannon, throwing a very heavy shell, and have their present-day counterparts in the howitzers employed ashore.

Red-hot shot were introduced in the early part of the eighteenth century, but their full value was not demonstrated until the siege of Gibraltar—1779-1783—when the attacking vessels were repulsed and set on fire by their use. The shot were heated in furnaces until they assumed a dull red tint, and were then fired from the guns with a reduced charge.

"Case shot" or "canister" consisted of a thin sheet-iron cylinder with iron ends filled with balls. It was merely an improvement on the early method of firing from guns stones, nails, bits of iron, bolts, etc., commonly called "langridge."

You have probably all read about "grape shot." This consisted of a canvas cartridge containing iron balls, and it did great execution at close quarters. It was not abolished until the "sixties."

"Bar shot" and "chain shot" were also used in very early times, and these, as will be seen from the plate, consisted of two shot or half-shot joined together with an iron link or chain. They were chiefly intended for cutting the rigging of a hostile ship, and in some cases were fired from double-barrelled guns. The use of shell, or projectiles filled with a bursting charge of powder, first became general in the sixteenth century. The fuse of the shell was ignited by the discharge of the gun, and the missile burst into small fragments on the flame reaching the powder inside.

Shrapnel shell were ordinary shell filled with a number of bullets and just sufficient powder to open them. They were first used against the French at the battle of Vimeira, in 1808, and their manufacture, in a modified form, has continued until the present day. "Carcases" were incendiary projectiles, and were spherical iron balls filled with a composition which burnt violently and was difficult to extinguish. They were designed for setting fire to an enemy's ship or works on shore.

Projectiles of these various kinds continued in use until 1858, which year saw the manufacture of the Armstrong breech-loading rifled guns. These weapons fired a lead-coated conical projectile, and the lead coat bit into the rifling when the gun was fired, and so gave the shell the necessary rotation.

When the heavy rifled muzzle-loading cannon were introduced, a different method of rotating the projectile became necessary, and studs, as seen in the plate, were fixed to the outside of the shot. These "took" in the grooves in the bore of the gun, and so gave the shot the necessary spin.

The projectiles now in use with our modern guns are fitted with what is known as a "driving band," which will be illustrated in the explanatory figures. This is a copper strip slightly larger than the bore of the gun, fastened round the base of the projectile, and when the latter is fired the copper is forced into the grooves of the rifling, and so gives the necessary spin to the shot.

Shell now employed in the naval service are of the following kinds:

Armour-piercing shell are made of forged or cast steel, with a cavity in the body to contain the bursting charge. They have comparatively thick walls, and, as their name implies, are designed for use against armour.

Common shell are designed for use as a man-killing missile, and for firing against the thinner parts of an enemy's ship. They have comparatively thin walls, and contain a heavy bursting charge of powder.

Lyddite shell are supplied for all guns of 12-pounder size and upwards. Lyddite, the substance with which they are filled, is simply picric acid brought to a dense state. It is an extremely powerful explosive, and causes the shell to burst into many fragments. The explosive is poured into the shell in a liquid state and then solidifies. Lyddite shell were used with great effect during the South African War, and are supplied to ships as a man-killing projectile.

Shrapnel shell are used for field service with all guns of 12-pounder calibre and upwards. They are made of forged steel, and contain a large number of balls and a small bursting charge which opens the shell, upon which the balls in the body continue their flight and spread out over a fan-shaped area. They are fitted with a time and percussion fuse, which is set to act 100 yards before reaching the enemy.

This is the only form of shell fitted with a time fuse, all the remainder being arranged to burst upon impact.

Practice projectiles contain no explosive, and are used for practice alone. They can always be distinguished, as they have a yellow band round them.

Naval gunnery is a subject to which full justice cannot be done in a short chapter like this, but if I have told you a few things you did not know before I am quite content. Remember always, though, that battles are not won by guns alone, but rather by the men behind them.

CHAPTER VII

Sailing Vessels in the Mercantile Marine

THE evolution of sailing vessels in the mercantile marine of Great Britain previous to the advent of the famous clippers has been dealt with in Chapter I. of this volume; and here I propose to give a brief account of the clippers themselves, and also of the sailing vessels seen around the coasts of Great Britain at the present time. A later chapter of this book will tell you how to distinguish between the various types of sailing ships, and I will endeavour to tell you something of the work they do.

The Clippers

To the shipowners and shipbuilders of the United States of America is principally due the credit of having effected the greatest improvements in the building of mercantile sailing ships, for in 1815, when the war between England and the United States ceased, the first of the celebrated New York-Liverpool sailing packets was built. These packets—for many of them were constructed—were comparatively small vessels, and had not the fine lines and speed of the ships which came afterwards; but for all that they afforded the only regular means of communication between the United States and Europe, and winter and summer alike they sailed across the Atlantic with all the speed that was in them. Between 1825 and 1850 the American packet ships flourished, but at the latter date their doom was sealed, for voyages across the Atlantic were already being made by steamers. For the long-distance passages, however, such as to China and Australia, and for cargo-carrying purposes generally, the sailing ships still held their own. The clipper ship era really first commenced in 1843, as a result of the growing demand for a more rapid delivery of tea from China, and continued until 1869, when the opening of the Suez Canal and the increasing number of steamers did away with the competition in the building of these fast sailing ships.

In England very little was done during the early part of the nineteenth century towards improving the type of the sailing merchantmen. One vessel, the *Scottish Maid,* of 150 tons, was built in 1839 to compete with the paddle steamers running between Aberdeen and London, while a few vessels of her type, with perhaps a slightly larger displacement, entered into competition with the American sailing ships in the China opium trade. This competition of the 'forties, however, was never really serious, and on the whole the Americans had it all their own way. A good type of American clipper of this period was the *Sea Witch,* a vessel of 890 tons, built in 1846. One of her best day's runs was 358 miles, or an average of nearly 15 knots for the whole 24 hours, a speed which could hardly be reached by any steamer of that period.

The repeal of the Navigation Laws in 1849 greatly stimulated the shipbuilding industry of this country, although at first great consternation and not a little alarm was caused by the action of the Government in repealing the laws. Many British shipowners, seeing the ground cut away from beneath their feet, resolved to sell their ships, while others decided to register their vessels under foreign flags. It is not surprising that the new regime aroused a certain amount of alarm, for the Navigation Laws, instituted in 1660 to arrest the maritime progress of the Dutch, restricted the importation and exportation of goods between England and Asia, Africa and America to British vessels, of which the masters and three-fourths of the sailors were to be British.

The repeal naturally changed the condition of affairs, for the trade between England and her Colonies was thrown open to foreign ships; and the Americans, with their fleets of fast sailing ships already built, were not long in securing the commerce which had been so opportunely thrown open to them. Prior to 1849, as I have said before, there had been competition in China between British and American ships, but the latter possessed vessels outsailing ours by two feet to one, and spreading as much canvas as a line-of-battle ship. The discovery of gold in California in 1849, and the subsequent rush to the scene, served to accentuate the efforts of our rivals; and after 1849 their ships sailed from California to China, and loaded cargoes direct from London to New York, receiving as much as £10 a ton freight. British vessels, on the other hand, owing greatly to their poor speed, were not receiving half this amount, and in 1850 things looked so bad that it appeared as if the grand old Red Ensign would be ousted from the sea by the triumphant Stars and Stripes. The first American ship to carry a cargo of tea from China to London was the *Oriental* of 1,000 tons. She had left Hong Kong on August 28, 1850, and after a passage of ninety-seven days arrived at the West India Docks on December 3, 1850. She delivered 1,600 tons of tea, and her freight from Hong Kong amounted to £9,600, her original cost complete for sea having been some £14,000. No ship like her had ever before been seen in England, and she caused great excitement and attracted the attention of thousands. She was a beautiful vessel, with her long, sharp, black hull lying low in the water and her tall, raking masts towering above those of all the English craft. She carried skysail yards on all her masts, and lower, topmast, topgallant, and royal studding sails—sails which had never been thought of in this country. It was only too painfully evident that the habit of shortening sail every night, which had been inculcated by the old East India Company, would never do if we were to enter into serious competition with the Americans; and before long British shipowners were forced to realise the danger of their position, and commenced to build ships of the new clipper type.

The first of these was the *Stornoway,* launched at Aberdeen in 1850, and built to the order of that well-known Eastern firm, Messrs. Jardine, Matheson and Co. On her maiden voyage the new vessel sailed from the Downs to Hong Kong in 102 days, the fastest passage between these ports which had ever been accomplished by a British ship. Other vessels of much the same type soon followed, and in 1856 the *Lord of the Isles,* an iron ship built at Greenock, succeeded in beating the fastest American clippers in the passage home from China with the new season's tea. The *Lord of the Isles* registered 770 tons, and was an extremely sharp vessel, while her captain earned for her the nick-name of the "diving bell," owing to his habit of driving her into one side of a sea and out at the other. There is no doubt that what is known as "carrying on" was indulged in to an enormous extent, and the clippers carried clouds of canvas when other craft were under double-reefed topsails. Thanks, however, to the care with which they were built, and to the constant watchfulness on the part of the master and officers, comparatively few accidents of a serious nature occurred. We are told, however, that in some of the American clippers the braces were padlocked to prevent the crew casting them off on their own account when they thought the "old man," as the master was always called, was carrying too much sail. No racing yachts were handled with greater care or skill, and it is said that some of the clippers did as much as 18 knots with a favourable wind. Our cousins across the Atlantic declared their crack vessels could do 20, but certainly 18 is no exaggeration. One of the best known American clippers was the celebrated *Great Republic,* launched in 1853. She was the largest clipper ship ever built, her tonnage as launched being 4,555, while she was 335 feet long, 53 feet beam, and carried a donkey-engine on deck to hoist the yards and work the pumps. Unfortunately, however, when nearly ready for sea, some sparks from some burning buildings fell aboard her, and she was almost completely destroyed, and had to be scuttled to prevent her total loss. She was, however, subsequently rebuilt, and although her size was somewhat reduced she was still 3,360 tons on being recompleted. She carried four masts, but the sail area had been cut down from the original specification, double topsails being fitted to economise in the number of men required to work her. She was still a remarkable ship, for her sail area amounted to 4,500 square yards, while the hull was strengthened from end to end by a diagonal lattice-work of iron.

Even with her reduced rig the *Great Republic* made the passage from Sandy Hook to Land's End in thirteen days, and on her arrival in London she had to lie in the Thames, as there was no dock large enough to take her. The French Government subsequently chartered her for use as a transport during the Crimean War, while she was used for the same purpose during the Civil War in America. In 1869 she was sold to a Liverpool firm, and was renamed the *Denmark,* but three years later foundered off Bermuda during a hurricane. The best 24 hours' run ever accomplished by this vessel is said to have been 413 miles, or an average of about 17.2 knots.

The supremacy held by the American merchant ships was maintained until about 1856, when, in England, iron had begun to supersede wood for shipbuilding purposes. The consequence was that the advantage held by the Americans in their practically unlimited supply of timber—that commodity always having been scarce in England—vanished, and American ships were no longer built for, or chartered or bought by, British shipowners. The Civil War between the Northern and Southern States also helped to increase the British mercantile marine, and the most famous British clippers were undoubtedly those built between 1860 and 1869. In 1863 the first of what were known as the "composite" ships were built; these had an iron framework, over which the wooden hull planking was placed. This year also saw the first British sailing vessel fitted with steel lower masts, topmasts, topsail and lower yards and bowsprit, the standing rigging being of steel wire rope. The first ship so fitted was the *Seaforth,* of 1,200 tons, but these features were subsequently adopted in all the later vessels. Many of these famous clippers sailed with the speed of steamers, and made the most marvellous passages.

Some of the vessels made their names famous through their quick passages, and the *Thermopylæ,* on her first voyage, sailed from London to Melbourne in sixty days, the fastest passage ever recorded between those ports in the days of sailing ships. There was always the keenest rivalry between the different ships, and to show the sort of thing that went on I will give an account of the famous race home from China in 1866.

It had been mutually arranged that nine clippers should sail from Foochow with the new season's teas on board, and as nearly as possible on the same day. The anchorage presented a busy scene, for the nine vessels, the *Ada, Black Prince, Chinaman, Fiery Cross, Flying Spor, Serica, Ariel, Taeping* and *Taitsing,* were all working day and night to finish loading in order to get to sea. The *Fiery Cross* was the first vessel to finish, and she was towed out to sea early on May 29, while the *Ariel* left at 10.30 a.m. the following day, the *Serica* and *Taeping* sailing twenty minutes later. The *Taitsing* sailed at midnight on the 31st, and the other vessels had not finished loading in time to take part in the great race. All the competitors were well known as fast ships, and their crews and captains used every effort towards making a record passage. The *Fiery Cross* was the first to round the Cape of Good Hope forty-six days out from Foochow, but the *Ariel* was almost on her heels, while the *Taeping, Serica* and *Taitsing* were respectively one, four and eight days behind.

By the time the latitude of the Azores had been reached, the *Ariel* led, but was closely followed by the *Taitsing, Fiery Cross, Serica* and *Taeping* in the order named. Between there and the entrance to the English Channel the two last-named vessels passed the *Fiery Cross* and *Taitsing* and closed on the *Ariel,* and at day-break on September 5 the *Ariel* and *Taeping* sighted each other off the Lizard. Now the race became keen indeed, for there was a strong southerly wind and a calm sea, and both vessels, with their lee scuppers awash, were dashing along at a good 15 knots. Both were under the same canvas, with main skysails and all studding sails set and drawing, and they raced up the Channel side by side, now one and then the other drawing a little ahead. Off Dungeness both ships embarked their pilots at the same time, and at 8 a.m. on September 6 the *Ariel* passed Deal with the *Taeping* eight minutes astern of her. The other three ships were not far behind, for the *Serica* passed Deal at noon on September 6, and, after the usual scramble for tugs, the *Taeping* arrived in the London Docks at 9.45 p.m., the *Ariel* in the East India Docks at 10.15 p.m., and the *Serica* in the West India Docks at 11.30 p.m.

As early as 1845 the steamers of the Peninsular and Oriental Company had carried passengers between England and the East via the Mediterranean and Red Sea, but, as the Suez Canal had not then been cut, the freights, owing to the difficulty and expense of transporting goods across the Isthmus of Suez, were very high. For this reason the steamers could not compete with the clippers, who carried their cargoes to the East round the Cape of Good Hope at greatly reduced cost. Several sailing vessels with auxiliary steam were tried in the China trade at about this time, but did not prove a success. The *Erl King,* launched at Glasgow in 1865, was one of the better known of these.

Until the opening of the Suez Canal in 1869 the sailing clippers held their own, but by 1871 the number of steamers had increased so enormously that it was seen that the days of the former were numbered. By degrees, then, these beautiful ships were driven on to other trade routes, and the famous clipper era closed.

Many of them did good work for a further considerable period, but one by one they were broken up or wrecked. The famous old *Thermopylæ,* I believe, is now a school hulk off Lisbon, while the *Titania,* it is said, is still running between European and South American ports under the Italian flag. There may be one or two others still doing useful service, but as a class of their own the clippers have vanished. This brief account of these famous vessels, to which through lack of space I cannot do full justice, will give some idea of how they came to be evolved and what their function was, and we must now leave them and discuss the sailing vessels of the present day.

Present-Day Sailing Vessels

Many are the different types of sailing craft seen round the British Isles, and they vary in size from the enormous five-masted barque, with her steel hull, masts, yards and standing rigging, to the picturesque Brixham trawler, with her weatherworn, tanned sails.

Without attempting to wade through a sea of statistics, I may say that there are only 957 sailing vessels of over 100 tons burden owned by firms in the United Kingdom, and these figures may be relied upon, for they are taken from Lloyd's Register for 1910-11. The majority of the larger sailing vessels now in existence are employed in carrying cargoes to which speed in reaching their destination is not a matter of vital importance, and, as they burn no coal, they are more economical to run if great speed is not required. With their maze of labour-saving devices—donkey engines to trim the yards and hoist the sails, double topsails and topgallant sails—they bear little resemblance to the craft of half a century ago, and one of the old clipper commanders would doubtless be surprised at all the innovations.

In these days of small profits expense has to be cut down to the uttermost farthing, and the labour-saving devices have been brought into use not with the idea of doing Jack a good turn, but so that a smaller number of men will be able to sail the ship. To-day it is by no means a rare thing for a sailing ship of perhaps 2,000 tons to have 18 able seamen all told, whereas one of the old 1,000-ton tea clippers would have had as many as 35. It is regrettable, I will admit, but nevertheless it is so. In all sailing vessels the canvas is

From print supplied by G. Thompson & Co.

THE CLIPPER "THERMOPYLÆ."

By permission from the "Illustrated London News."

THE CLIPPERS "ARIEL" AND "TAEPING" RACING OFF THE LIZARD.

reduced to manageable proportions by dividing up the total area into as many sails as possible, and in the picture of a modern sailing ship which is before me as I write I count no fewer than 28 sails. To think of this enormous area of canvas being controlled by 18 men is astounding, and it makes one shiver to think what may sometimes happen in the case of a sudden emergency.

All the heavy sails in a ship can be "reefed," as it is called, and in square sails this is accomplished by having rows of reef points attached to the reef bands running horizontally across the sail at varying distances from its head. These reef points are short lengths of rope worked into the sail, and the latter is then hauled up and these reef points made fast to the yard, so that the area of the sail is greatly reduced, although a portion of it still remains in position.

The largest sailing-ship owners of the United Kingdom are the Anglo-American Oil Company, whose barge *Navahoe* is, I believe, the largest sailing vessel in the world. The ships belonging to this company transport petroleum and its products from the United States to various ports in the United Kingdom.

The *Arctic Stream,* belonging to Messrs. Thomas Law and Company, of Glasgow, is a good example of a modern sailing ship, and is undoubtedly a noble-looking craft with her lofty spars, well-cut canvas, and shapely hull. She has a gross tonnage of 1,584, and was built by Messrs. Russell and Company, of Glasgow, in 1885. She might be called a clipper ship, for she is extremely fast, and has made the passage from Glasgow to Sydney, in Australia, in 93 days; Newcastle, N.S.W., to Talcahuano, Chile, in 33 days; Talcahuano to Queenstown in 77 days, etc. She has carried lumber, wheat, coal and nitrate, and her usual voyage is from the United Kingdom to Australia, across to the West Coast, and home. This trip is occasionally varied by one straight out to the North Pacific, round Cape Horn, with a general cargo, and home again with wheat. Her best passage home from the North Pacific is 111 days from Astoria to Queenstown. This vessel carries a crew of 23, of whom six are apprentices.

Though numbers of British sailing vessels are being superseded by steamers, there are still certain trades in which "wind-jammers" hold their own. With no coal bills, they cost less to run than steamers, and although, of course, they usually take a longer time to reach their destination, exceptionally good passages like those of the *Arctic Stream* are often made.

Some of the larger owners of sailing ships in the United Kingdom are enumerated below:

Owners	Ships	Total net Tonnage	Port
Andrew Weir and Co.	14	26,000	Glasgow
Thomas Law and Co.	12	21,000	Glasgow
Macvicar, Marshall and Co.	8	20,000	Liverpool
Robert Thomas and Co.	11	18,000	Liverpool
George Milne and Co.	15	22,000	Aberdeen
John Stewart and Co.	12	18,000	London

As regards the smaller vessels round the United Kingdom, the rig most frequently seen is undoubtedly the one-masted cutter, with her large mainsail, topsail, foresail and jibs. Many of the larger racing yachts are rigged in this way, as are also pilot vessels and many fishing boats. The pilot vessels can always be distinguished by the red and white flag they fly at the masthead when they are on their station, and they carry in addition a large number on their sail. All fishing boats also carry numbers and letters on their sails and bows, the latter denoting the port to which they belong, and, as a rule, the first and last letters of the port are used. Thus: WY means Whitby, FY Fowey, etc. There are, however, a great many exceptions, for the port from which the boats are registered is often that of the nearest large harbour. The Hastings boats, for instance, are marked RX, which means Rye. So that you may be able to distinguish these boats when you see them, I give some of the more important letters in the form of a table :

ENGLAND AND CHANNEL ISLANDS

Aberystwith	A B	Harwich	H H
Barnstaple	B E	Hastings (Rye) ..	R X
Berwick-on-Tweed ..	B K	Hull	H
Bideford	B D	Jersey	J
Bridport	B T	Lowestoft	L T
Brixham	B M	Milford	M
Cardigan	C A	Newcastle-on-Tyne	N E
Dartmouth	D H	Newhaven, Sussex ..	N N
Deal	D L	Penzance	P Z
Dover..	D R	Plymouth	P H
Falmouth	F H	Ramsgate	R
Folkestone	F E	Shoreham	S M
Fowey	F Y	Southampton ..	S U
Grimsby	G Y	Weymouth	W H
Guernsey	G U	Whitby	W Y
Hartlepool	H L	Yarmouth	Y H

SCOTLAND

Aberdeen	A	Inverness	I N S
Ardrossan	A D	Kirkwall	K
Ayr	A R	Leith	L H
Banff	B F	Oban	O B
Campbeltown ..	C N	Rothesay	R O
Dundee	D E	Troon	T N
Glasgow	G W	Ullapool	U L
Greenock	G K	Wigtown	W N

IRELAND

Belfast	B	Skibbereen	S
Cork	C	Tralee	T
Dublin	D	Waterford	W
Dundalk	D K	Wexford	W D
Limerick	L	Youghal	Y
Londonderry.. ..	L Y		

A cutter, owing to the enormous area of canvas in her mainsail, needs a large number of men to manage her in anything like bad weather, and for this reason many of the larger fishing smacks are rigged as yawls. A yawl carries a far smaller mainsail, but, to make up for the deficiency, carries a small mast aft on which a mizen is set.

Generally speaking, any brown-sailed fishing boat is referred to as a "smack," but this is really incorrect, for a "smack" is a cutter-rigged vessel of between 20 and 50 tons. The yawl-rigged trawlers hailing from Hull and other ports on the East Coast often have a tonnage of little short of 100, and they go away to sea for six weeks at a stretch, sending their catches home at frequent intervals. Smaller fishing craft are often rigged as cutters, and numbers of them are seen in the seas round about our coasts. Their sturdy hulls will put up with any amount of bad weather, and the fisherman himself likes weather which to an ordinary landsman would be anything but pleasant. He feels he is in his element when the wind is cutting the tops off the seas and driving them to leeward in sheets of spume and spray, and it is a fine sight to see a trawler under such conditions. She tugs at her trawl until the warp is strained as taut as a steel bar, and her bellying brown sails, driving her to leeward, are saturated with the spray. Her movement is violent, for the weight of the trawl takes away from her buoyancy, and green seas are coming on board every minute until the deck is ankle-deep. One man alone will be visible at the tiller, and the others will be down below in the noisome little den of a cabin sleeping the sleep of the just. A smacksman's life is a very hard one, for he never takes off his clothes, and in bad weather is never dry the whole time he is at sea.

Many of the West Country and Scotch fishing craft are luggers, and these are double-ended—that is, the bow and stern are the same shape—and their usual size is about 20 tons. Upon the foremast they set an enormous lugsail, which seems to eclipse the hull beneath, while the mizen lugsail is very nearly as big. These craft are very speedy, and although the huge sails have to be dipped every time the boat goes about on a new tack, it is wonderful to see the way they are managed. The Cornish luggers are known all the world over, and in 1852 one of them, of only four tons, named the *Mystery,* was navigated from Newlyn in Cornwall to Melbourne in Australia. She was manned by two men and a boy, and, calling at the Cape of Good Hope for provisions, carried the Cape mail to Melbourne. On her arrival she was engaged by the Post Office authorities for the work of carrying the mails from incoming ships up the river to Melbourne, work for which her great speed made her particularly suitable.

The line-fishing boats of Great Britain are usually small craft of under five tons, and as a rule their canvas shows signs of hard wear and is very much patched. They catch their fish on long lines on which are hundreds of baited hooks, and for this reason are often known as "hookers."

One might go on for ever describing the many different types of sailing craft of the British Isles, but space, I am afraid, will not allow a more detailed description. In Chapter XXII. you will find set out the rigs carried by different classes of sailing vessels, and I do not think I need tell you about them here; there are one or two things, however, I should like to say.

Brigs—i.e. vessels with two masts, with square sails on both—are very rarely met with nowadays. In olden times they were much used for bringing coal down from the North Country, but steamers now do this work, and the old brigs have gone. Brigantines are only occasionally seen, but the homely "topsail schooners" are still met with in large numbers, for they do a lot of the coasting work round the British Isles. It is a well-known fact that a fore-and-aft rigged vessel will sail much closer to the wind than one with square sails, while another advantage of the former is that it requires fewer men to work it, as there are no heavy square sails or yards to be furled. A square-rigged ship, however, will sail much faster with the wind astern or on the quarter, and it was probably on account of this that the topsail schooner came to be evolved. She has all the advantages of a fore-and-aft rigged vessel, but carries, in addition, a light fore-topsail and topgallant sail to assist her on her way in a fair wind; these sails, and the yards on which they are set, are very light, and require few men to work them, so the topsail schooner is an economical craft greatly used in the coasting trade. Schooners proper carry no square sails at all, and two-masted vessels of this type are frequently seen. Those with three masts usually hail from the West Country.

Another type of coasting craft is the barge, and she carries a large spritsail on the foremast, with, perhaps, a topsail above it, while aft she has the usual smaller mizen, which is very often a spritsail. The sheet of this latter is often made fast to the extremity of the rudder, so the mizen then fulfils the purpose of a second rudder in the air. Barges have an enormous carrying capacity, and have practically flat bottoms to enable them to sail in shallow water, so they are fitted with what is known as a "leeboard," which is a heavy piece of wood shaped something like the blade of an oar. The thin end is pivoted on the gunwale, and the broad part is lowered into the water until it is far below the bottom of the boat, where it serves, to a certain extent, as a keel and to prevent the ship making so much "leeway." Leeway, I should explain, is the angle between a ship's fore-and-aft line and her track through the water.

There are many other types of small craft met with in our waters, but I have enumerated some of the commoner varieties usually seen round our shores. Chapter XXII. will enable you to recognise the principal kinds of vessels at a glance.

CHAPTER VIII

Steam Vessels in the Mercantile Marine

Although a history of marine steam navigation is rather beyond the scope of this work, it is as well, I think, to devote a certain amount of space to the subject, for it will enable a comparison to be made between the old methods of propulsion and those which are in use at the present time. In about 1707 a certain Denis Papin, a French engineer living in Germany, constructed a steam vessel driven by oars, and to him undoubtedly belongs the credit of being the first man to drive a vessel by steam. He carried out his experiments on the River Weser, but the boatmen, for some reason or another, attacked the inventor, who barely escaped with his life, while his boat was totally destroyed.

Twenty-nine years later Jonathan Hull, or Hulls, a native of Gloucestershire, took out a patent for a new method of steam navigation, and he proposed fitting a boat or small vessel with a steam engine which should drive a couple of paddle-wheels over the stern. He thought his craft would be useful for towing sailing ships, but, although the idea was ingenious, he was rewarded by no real practical result.

The famous James Watt, it will be remembered, patented his steam engine in 1769, and in 1776 the Marquis de Jouffroy purchased one of these engines and fitted it to a small boat. Although at first his efforts did not meet with success, in 1783 his boat, in the presence of 10,000 witnesses, steamed several times on the Saône between Lyons and the Isle de Barbe.

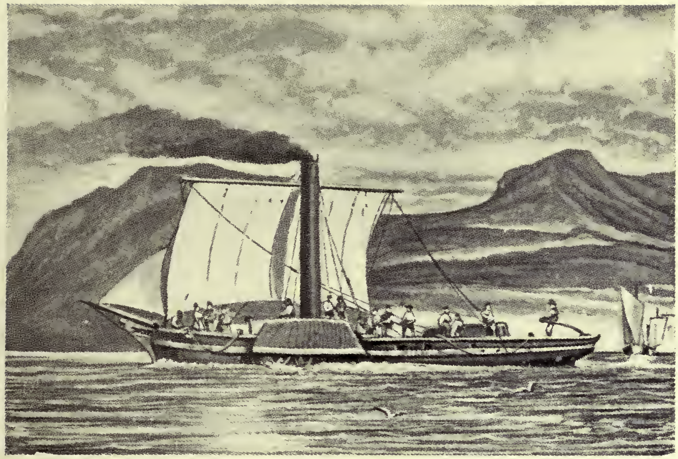
It was in 1788 that the first successful attempts towards discovering a means of marine propulsion were carried out in Great Britain, and in this year Messrs. Miller and Symington, the former being a very wealthy Edinburgh banker, carried out practical experiments with a steamboat on Dalswinton Loch in the south of Scotland. Their craft had a double hull, the boiler being in one portion and the engine in the other, while the paddle-wheel driving the boat was placed between them. The engine—of one horse-power—is said to have given the boat a speed of five miles an hour. The following year Mr. Miller bought a canal boat, and after fitting her with a twelve horse-power engine built by the Carron Ironworks, tried her, with the result that she steamed seven miles an hour fully laden. The boat was driven by the usual paddle-wheel placed over the stern.

For some little time nothing more was done to further the successful achievement of steam navigation, but in 1801 Symington constructed a paddle steam vessel for Lord Dundas. This craft, the *Charlotte Dundas,* was completed in 1802, and on her trials created great excitement by towing two loaded barges of 70 tons each at a speed of 3¼ miles an hour. The proprietors of the Forth and Clyde Canal, however, were of the opinion that the wash of the paddles would destroy the canal banks, so the *Charlotte Dundas* was finally laid up without much further use.

In 1803 Mr. Livingston, the American Minister to France, in conjunction with the celebrated Fulton, who had been trying experiments with steam vessels for nine years, made two more or less successful experiments on the Seine. In the same year Fulton witnessed a trial of the *Charlotte Dundas,* and obtained some valuable information, with the result that he entered into negotiations with the famous engineering firm, Messrs. Boulton and Watt, of Birmingham, for the manufacture of the working parts of a marine engine, which were to be delivered in the United States by 1806. These engines were fitted, in 1807, to the *Clermont*, which became a great success, for she ran on the Hudson River, between New York and Albany, for some considerable time. She was a small craft, being but 133 feet long, and had a speed of about five knots, but nevertheless she was the pioneer of the magnificent steamer service ultimately established on the inland waterways of the United States.

Several amusing stories are told about the *Clermont*. People who saw her described her as "a monster moving on the water, defying winds and tides, and breathing fire and water," while on one occasion a colony of Dutch farmers living on the banks of the Hudson were so alarmed one night at the noise of her paddles and the stream of sparks issuing from her funnel that it is said they fled to the woods with their families, being under the impression that his Satanic Majesty himself had arrived upon the scene and contemplated paying them a visit. A reproduction of the *Clermont*, it is interesting to note, was built for the Hudson-Fulton celebrations of 1909. She was an exact copy of her predecessor, and, as may be imagined, attracted a considerable amount of attention.

Long before the time of Fulton, John Fitch had invented a small steamboat which travelled on the Delaware River. This vessel was completed in 1786, and was driven by a number of oars placed at the sides, to which were fastened cranks worked by a steam engine. Although it could hardly be called a practical method of propulsion, it certainly worked, and Fitch ultimately built another vessel travelling eight miles an hour, and which ran between two and three thousand



THE "COMET."

From a contemporary drawing in the Victoria and Albert Museum.

THE "CLERMONT."

miles during the summer of 1790. The unfortunate man's efforts did not meet with the sympathy of his countrymen, who termed him "crazy," and this preyed upon his mind to such an extent that he ultimately took his own life.

In 1804 a steam vessel, driven by a screw propeller, was completed in America by John Stevens, and she attained a speed of six miles an hour. Four years later the same inventor, aided by his son, constructed a vessel which proceeded from New York to Philadelphia by steam and afterwards ran on the Delaware. These early successes in the United States, after the first few years of incredulity had passed, aroused great interest throughout the civilised world, for although the engines were small and wasted a great quantity of fuel it was considered a marvellous thing for a vessel to be able to travel against wind and tide. In America the building of steamers developed very rapidly, and by 1823 it is said there were no less than 300 steam-driven craft at work on the inland waters.

We must now see what had been going on in the meanwhile in our own country. In 1800 an hotel proprietor living on the Clyde—Henry Bell by name—tried experiments by placing a boiler and paddle engine in an ordinary pleasure-boat. His results were very successful, and he submitted plans for an improved marine engine to Messrs. Boulton and Watt, who, however, were rather discouraging in their reply. Left entirely to his own resources, Bell faced and finally overcame all his difficulties, for in 1811 we find him superintending the building on the Clyde, by Messrs. J. and C. Wood, of the famous *Comet*. This vessel was designed to carry passengers between Glasgow and Bell's hotel and bathing establishment at Helensburgh, and was 40 feet long, 10½ feet wide, and of about 25 tons. The machinery had been constructed by John Robertson, of Glasgow, the engines being of four horse-power, driving two four-armed paddle-wheels on each side. These engines are still in existence at the Science Museum, South Kensington, where an excellent model of the *Comet* can also be seen. In this primitive steamer the funnel was very tall and acted as a smoke-stack and as a mast from which a square sail could be set to help the vessel along when the wind was favourable. Nearly all steamers of this period carried sails of one sort or another, for great reliance could not be placed on the engines.

The success of the *Comet* was remarkable, and as a consequence in a short time four larger steam vessels came to be built; while by 1814 no fewer than five were running on the Clyde. Within two years steamers had appeared on the Mersey and Thames, and in 1817 the *Caledonia,* 94 feet long, 15½ feet wide, and with engines of about 20 horse-power, was purchased by James Watt, junr., and, after having been fitted with new engines, she proceeded from Margate to Rotterdam, and from there to Coblentz. She did the trip at an average speed of 7½ knots, and is said to have been the first steamer on the Rhine. In Great Britain the construction of steamers was now firmly established, and before long they were running with a certain amount of regularity between Greenock and Belfast, Dover and Calais, and Holyhead and Dublin.

Soon afterwards public attention was called to the subject of ocean steam navigation, and in the discussion as to its possibility which ensued the celebrated Dr. Lardner advanced many elaborate objections against the possibility of a steamer crossing the Atlantic in safety. His ideas, looking at them from a modern point of view, are distinctly amusing, for after saying that the weather conditions obtaining in the Atlantic were such that a steamer could never cross he went on to assert that, owing to the possibility of fire, collision with icebergs, the coating of the boilers with soot, and their liability to leakage, one might just as well expect to make a journey on wings to the moon as to make a voyage from Liverpool to New York by a steamship. These opinions were not, however, generally endorsed by the public on either side of the Atlantic, and the results of the first attempts at crossing the ocean by steam subsequently upset all the theoretical objections against it.

The first of these efforts was made by a vessel built at New York, and called the *Savannah*. She had originally been intended as a sailing packet, but while on the stocks she attracted the attention of Captain Moses Rogers, who had commanded some of the earlier steamboats. At his suggestion the vessel was purchased by a Savannah firm, who fitted her with a paddle engine and boilers. The former could be detached from the shaft and taken aboard within twenty minutes, when the ship, having three masts and being ship-rigged, could proceed under sail alone. Her thirty-two cabins, we are told, were sumptuously fitted out for the accommodation of intending passengers, but nobody volunteered to make the trip, being probably put off by the fear of the ship being set on fire by her furnaces or blown up by her boilers.

After a trial trip or two the *Savannah* eventually left the place whose name she bore on May 22, 1819, on her adventurous passage across the Atlantic. By June 17 she was off Cape Clear, Ireland, and an American schooner, seeing the vessel with volumes of smoke issuing from her, reported her as a ship on fire. The revenue cutter *Kite* thereupon proceeded to the relief of the supposed ship in distress, but great was the surprise of the commander of the *Kite* when he found he could not come up with a vessel with no sail set. Eventually, however, the cutter fired several guns, when the *Savannah* stopped and was boarded, and not until then did the man-o'-war's captain discover he had been chasing a steamer.

The *Savannah* eventually arrived at Liverpool at 5 p.m. on June 19. During the voyage her paddle-wheels had only been working for eighty hours, the greater part of the trip being made under sail alone; but for all that the *Savannah* was the first ship fitted with steam engines to cross the Atlantic. The subsequent history of this vessel is interesting, for after her return to America her engines and boilers were removed, and she was used as a sailing packet pure and simple until she became a wreck off Long Island in 1822.

It was not until long after the *Savannah's* feat that steam communication across the Atlantic was finally established, but great progress was made in the meanwhile in the building of steamers for use in the coastal and inland navigational routes of this kingdom. The *James Watt,* built by Messrs. J. and C. Wood, of Glasgow, and launched in June, 1821, was the largest coasting steamer of the period. She was of 420 tons, and had a paddle-wheel on each side of the hull, her paddles being driven by engines of 100 horse-power. As was usual at that time, she was three masted and rigged as a schooner.

Four years later the first steam voyage to India round the Cape of Good Hope was accomplished by the little *Falcon,* of 176 tons. Like the *Savannah,* however, the *Falcon* was really a sailing vessel fitted with auxiliary engines. The same year the *Enterprise,* of 420 tons and 120 horse-power, made the passage from England to Calcutta in 113 days, of which 103 days were actually spent under steam, 10 days being occupied in replenishing the fuel. This craft had an average speed of a fraction under 9 knots.

We now come to an event which did more to prove

From a contemporary drawing in the Victoria and Albert Museum.

THE "SIRIUS," THE FIRST STEAMER TO CROSS THE ATLANTIC (1838).

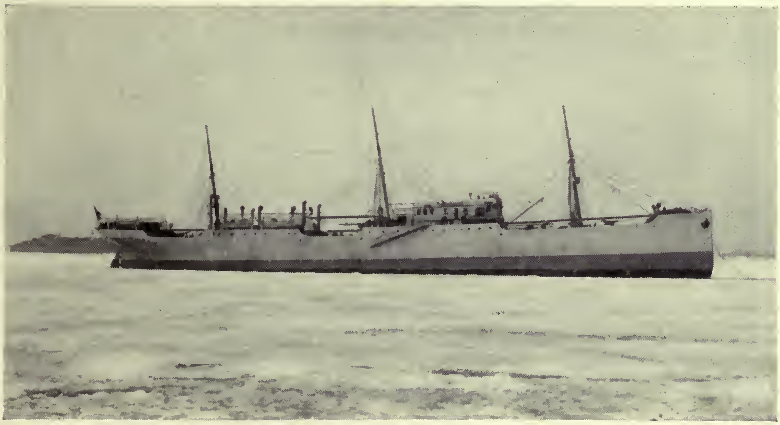


Photo supplied by the East Asiatic Co., Ltd.

THE "SELANDIA," THE FIRST OCEAN-GOING SHIP DRIVEN BY INTERNAL COMBUSTION ENGINES (1912).

the possibility of transatlantic steam navigation than any which had preceded it—the voyage of the *Royal William*. This ship had been built at Quebec during the winter of 1832-3, and had a tonnage of 1,370, and was fitted to carry sixteen passengers. Her engines, of 180 horse-power, were made in England by Messrs. Boulton and Watt, and were placed on board at Montreal, and in 1833 the ship made the 2,500-mile run from Picton to Portsmouth in seventeen days, a certain portion of which, however, is said to have been spent under sail alone.

The year 1838 was famous in the annals of steam navigation, for during it were made the first continuous steam voyages across the Atlantic. The ships principally concerned were the *Sirius, Great Western, Liverpool* and *Royal William,* the latter being the second steamer of that name. The *Sirius* was of 700 tons and 320 horse-power, was rigged as a brigantine, and had originally been employed in the coasting trade between London, Bristol and Cork. She took seventeen days in accomplishing the voyage from Queenstown to New York. The *Great Western* was a larger vessel of 1,321 tons and a horse-power of 750, and had been designed and built especially for the Atlantic. Great pains had been taken to give her the necessary longitudinal strength to enable her to withstand the heavy Atlantic waves, and she succeeded in making the passage from Bristol to New York in fifteen days, averaging a speed of 8.2 miles an hour. Both financially and otherwise the *Great Western* was a great success, and it is said that on being docked after having run 35,000 miles she did not show a wrinkle in her copper, so well had she been built. She afterwards made some quicker passages across the Atlantic, the shortest out being 12 days 10 hours from wharf to wharf, and between the years 1838 and 1843 she ran 234,000 miles, the average speed outwards being 9½ miles and homewards 11½ miles an hour. She was sold to the Royal Mail Steam Packet Company in 1847, and was finally broken up ten years later. The *Royal William*, built in 1838 for the passenger trade between Liverpool and Dublin, made her maiden trip from Liverpool to New York in July, 1838. She was very similar to the *Sirius*, and accomplished the trip in about the same time. Both these vessels were not large or seaworthy enough for the heavy weather usually experienced in the Atlantic, and before long they were taken off this route.

Another large and famous transatlantic steamer of this period was the *British Queen*, of 1,862 tons, built in 1839. She was considered the most magnificent steamer of her day, and her owners declared, with a certain amount of pride, that she had "a spacious saloon" which was "upwards of 60 feet long, 30 feet broad, and 8 feet high." The ladies' cabin, we are also told, was 16 feet square. Though bare figures give little idea of size, it is interesting to compare these dimensions with the first-class dining saloon of the White Star liner *Olympic*, which is 114 feet long, 92 feet broad, and has seating accommodation for 532 people.

In 1840 was established the British and North American Steam Packet Company, its principal promoter being the well-known Mr. Samuel Cunard, who was instrumental in obtaining from the British Government an annual subsidy of £81,000 for a monthly (and afterwards fortnightly) service of mail steamers between Liverpool, Halifax and Boston. The company, which afterwards became known as the Cunard Company, commenced a mail service on July 4, 1840, when the *Britannia*—one of the Cunard fleet of four ships, the others being the *Acadia, Caledonia* and *Columbia*—left Liverpool for Boston, and succeeded in accomplishing the voyage in 14½ days. The dimensions of the four above-mentioned ships, it should be noted, were all approximately the same, and they had a tonnage of 2,050, a horse-power of 740, and were 207 feet in length. They were the last really important vessels to be constructed of wood, for at about this time builders were beginning to look upon iron as a substitute. Not only was timber becoming very scarce and expensive, but it was practically impossible to build a wooden vessel more than 300 feet long, owing to her longitudinal weakness.

Iron ships had been constructed as early as 1818, when the sailing craft *Vulcan* was launched on the Monkland Canal, near Glasgow. The material in this case was so good and the workmanship so excellent that in 1875—and possibly more recently still—the little vessel was still at work carrying coal on the Forth and Clyde Canal. The first iron steamer was the *Aaron Manby,* launched in 1821, and she successfully accomplished a voyage to France. For several years iron steamers were only used for inland navigation, but by the end of the 'thirties the new material had proved itself to be very suitable for shipbuilding purposes, and the *Great Britain,* completed at Bristol in 1843, was the first important ship to be constructed of iron. In many other ways she was a departure from all established precedents, for not only was she a very large vessel—3,270 tons—but she was the first really large ship to be driven by a screw propeller. Her length was 322 feet, and she was provided with six short masts, five of which were rigged with fore-and-aft and one with square sails. She was used on the transatlantic service, doing the passage in fifteen days, but subsequently changed hands and was used on the Australian route, finally having her engines removed and being converted into a sailing vessel pure and simple. An incident which occurred during her chequered career, however, showed the confidence that could be placed in iron as a shipbuilding material.

In September, 1846, the *Great Britain* ran ashore in Dundrum Bay, Ireland, and remained for eleven months exposed to the most terrible weather. She was eventually refloated and taken to Liverpool, and it was found that although her iron bottom was greatly damaged it was still possible to repair her, whereas if she had been a wooden vessel she would never have survived.

After this and several similar incidents the iron shipbuilding trade of this country became firmly established, and during the 'fifties nearly all the large steamship companies used iron in the building of their passenger steamers. One well-known iron ship-rigged steamer was the *Himalaya,* built for the P. & O. Company at Blackwall in 1852. She was the largest screw steamer of her day, and was some 340 feet long, with a displacement of 4,690 tons. Driven by engines of 3,600 horse-power she attained a speed of 13½ knots on her maiden voyage to Gibraltar in 1853. The next year she was bought by the Admiralty for use as a transport, and in this capacity she was employed until 1893, when she was dismantled and converted into a coal hulk at Devonport, where she still remains.

The Cunard Company had commenced building iron screw steamers in 1852, but for various reasons this method of propulsion did not meet with the favour of passengers, so the company decided to revert to the old-fashioned paddle-wheels in their next ships, the *Persia* and *Scotia,* built in 1855 and 1862 respectively, being so propelled. The former had a gross tonnage of 3,300 and accommodated 250 passengers. Her paddle-wheels gave her a sea speed of 12.9 knots, and on four occasions during the year 1856 she made the trip from New York to Liverpool in less than nine days.

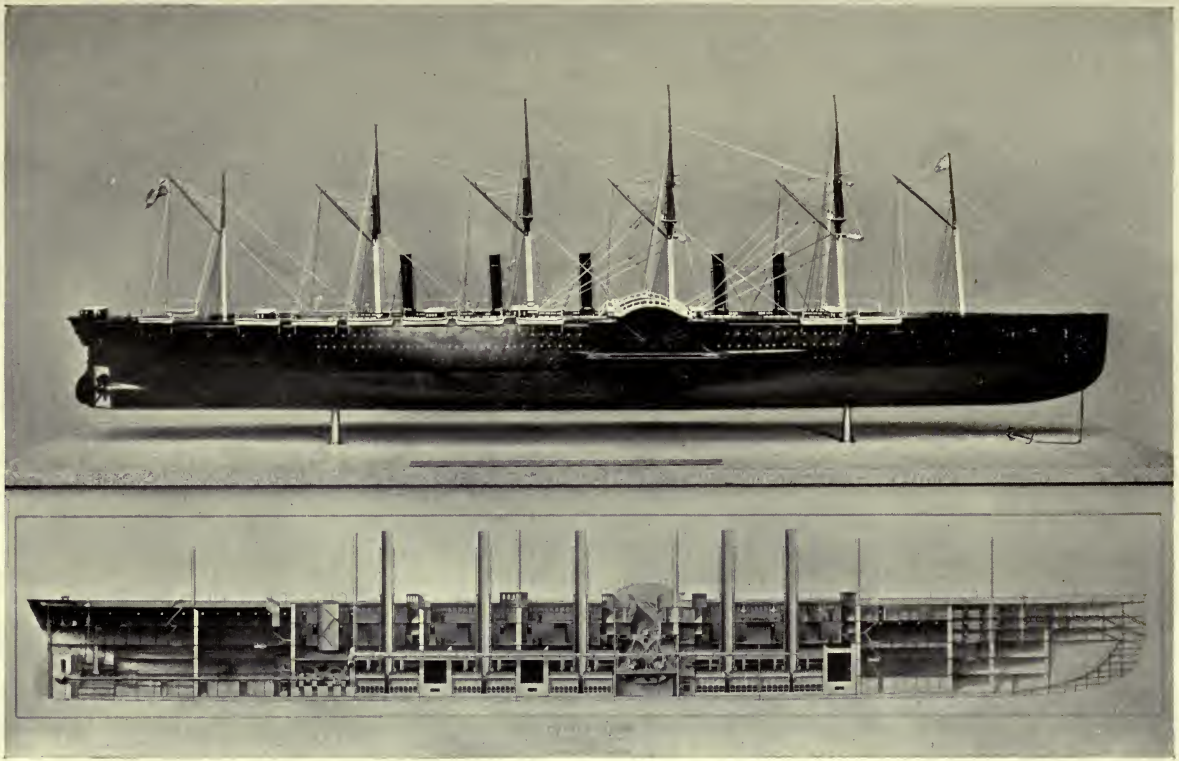
The *Scotia* was even larger than the *Persia,* for her gross tonnage was 3,871. The engines, which were of 4,950 horse-power, gave a sea speed of 13½ knots, but on her original trials she is said to have steamed 19 miles an hour. This vessel was remarkably well built, her hull being divided into seven watertight compartments, so that if one compartment was flooded the remaining six could still keep the ship afloat. She had also what is called a double bottom; that is, two skins, so she might run on a rock and damage the outer skin, while the inner one would still prevent the water entering the interior of the vessel. In 1871 this celebrated ship—for in her day she excited every bit as much attention as have the *Mauretania* and *Titanic* —was converted into a twin-screw cattle vessel, and as such was still sailing in 1896, which speaks well for the work of her original builders.

The *Scotia,* as I have said, was built in 1862, and, strictly speaking, I should have described the famous *Great Eastern* between her and the *Persia,* for this vessel was finally ready for sea in 1859. For the sake of convenience, however, I have described the two Cunarders together, and will now go on to say something about the gigantic ship whose length was not exceeded until the White Star *Oceanic* was built in 1899.

The *Great Eastern* was a vessel created out of her due season, for only forty-three years before her building was commenced in 1854, the little *Comet,* 42 feet long, had been looked upon as a marvellous invention. In spite of this, however, she exhibited to the full the almost terrific speed at which steamship building had developed since its original inception, and although financially she proved a failure, it cannot be said that she was without certain good points. The idea of her construction originated in the fertile mind of Mr. Brunel, the famous engineer, and he intended her to trade between this country and the East, while she was designed to make the passage to Australia without being under the necessity of stopping anywhere *en route* to replenish her bunkers. Her great length, coupled with the fact that she was to be driven at a speed of 15 knots by both paddle-wheels and a single screw, tempted her designers and owners to hope that she would readily command the large amount of cargo necessary to fill her capacious holds. Accommodation for a colossal number of passengers was also arranged for, as she was designed to carry 4,000—800 first-, 2,000 second-, and 1,200 third-class.

Mr. Brunel suggested the idea that such a vessel should be built to the directors of the Eastern Steam Navigation Company, and the latter entrusted the contract to the shipbuilding firm of Messrs. John Scott Russell and Co., of Millwall. Messrs. Brunel and Scott Russell conjointly designed the vessel, and she was commenced on May 1, 1854, being finally launched on January 31, 1858. The first attempt to float the enormous ship had taken place the preceding November, but had resulted in failure, while she was eventually launched into the water sideways by means of hydraulic machinery. The attempts to launch her, and the subsequent delay, cost the company £120,000, and, being unable to bear the expense, they were compelled to wind up their affairs, the *Great Eastern* as she stood being sold to a new company for £160,000. She was eventually completed for sea in 1859, and her enormous size attracted world-wide attention. She had a length of 680 feet and a breadth of 83 feet, while her gross tonnage was 18,914 and her loaded displacement 32,000 tons. She had five funnels and six masts, all of which latter, except the second and third, which carried square sails, had the usual fore and aft canvas.

Actual results showed that the *Great Eastern* could do her 15 knots with both screw and paddle working,



From the model in the Victoria and Albert Museum.

THE "GREAT EASTERN."

but the average sea speed was 13 to 14 knots. She was very strongly built, for from keel to water-line she had a double hull, while the bulkheads running fore and aft throughout the ship gave her great longitudinal strength. The vessel, however, was never given a fair chance of proving her suitability for the work for which she had been designed, for her new owners employed her in the American trade, where neither as a cargo nor a passenger vessel did she pay her way. In 1865 and the following year she did good work in laying the Atlantic telegraph cables, and in 1888 was finally handed over to the shipbreakers.

It was during the 'sixties of the nineteenth century that the screw generally began to be adopted as the means of steamship propulsion, while during the same period iron gradually superseded wood for steamship building purposes. To explain the advantage of iron over wood, take two ships, one built of wood and the other of iron, and let them be of exactly similar dimensions as regards length and breadth. We should then find that the ship built of iron would have a "displacement," or actual weight, one-third less than her wooden sister, and from this it will be seen that the iron ship could carry a greater amount of cargo and thus make a larger profit for her owners. Also, as I have said before, an iron vessel could be built stronger, and consequently longer, than one of wood.

The famous Inman Line, founded in 1850, were the first transatlantic company to build all their vessels of iron, and until 1892 they were one of the foremost competitors for the "blue ribbon" of the fastest passage across the Atlantic.

The first steamer of the White Star Line, the famous *Oceanic,* built in 1871, marks the turning-point between the old-fashioned passenger steamer and the modern ocean liner. The White Star Line had at first consisted of a fleet of sailing clippers, but in 1867 the managing owner retired, and Mr. T. H. Ismay took over the control. One of his first steps was to build the sailing clippers of iron instead of wood, and in 1869 he ordered a fleet of steamers to be built. These were to be specially constructed for the Atlantic trade, and Messrs. Harland and Wolff, the well-known Belfast firm, who still build for the White Star and many other big lines, received the contract. The first vessel to be completed was the *Oceanic,* launched in 1870, and she was something quite different to any previous type of steamer. Her extreme fineness, her length being 420 feet and her beam 42 feet, made old sailors predict that she would prove very unseaworthy in the heavy Atlantic seas; but her designer, Sir Edward Harland, knew his business far better than these old sea lawyers could teach him, and the success of the *Oceanic* amply fulfilled his expectations. Several new features besides that already mentioned were embodied in her design. The old-fashioned bulwarks round the side, which could not keep the water out, but imprisoned it to a dangerous extent owing to its not being able to flow away rapidly, gave way to iron railings, which would let the waves out as fast as they came in; while, for the first time, the first-class passengers were berthed amidships, where the jar and vibration of the propeller was least felt. The cabins, also, were fitted up far better than had previously been the case, and we are told that oil lamps superseded the old-fashioned candles for lighting purposes. The ship had a gross tonnage of 3,808, and her single screw drove her at a speed of 14¾ knots, but she was also rigged as a barque, so that her sails could help her along when the wind was fair or assist in steadying her when there was a heavy sea. The owners of the *Oceanic* soon followed up their initial success with the *Britannic* and *Germanic,* built in 1874, but these craft were slightly larger than their older sister, for they had a gross tonnage of about 5,000. Their speed, also, was somewhat greater, being 15 to 16 knots; but though for a time the *Britannic* held the blue ribbon for the transatlanic passage, she was beaten in 1875 by the Inman liner *City of Berlin,* which broke the record by doing the same trip in 7 days 14 hours. The latter vessel, it is interesting to note, was the first Atlantic liner fitted with electric light, the plant being installed in 1879.

Commencing in the same year—1879—the Guion Line, founded in 1866, accelerated the competition by the building of three ships, the *Arizona, Alaska* and *Oregon.* The *Arizona* was the first of these, and reduced the passage to 7 days 6 hours, her speed being 16½ knots. She was 450 feet long between perpendiculars, and had a gross tonnage of 5,150.

The *Alaska* and *Oregon* were both larger ships than their immediate predecessor, for their gross tonnages were 6,932 and 7,375 respectively. They were also longer and faster, for the former made 17¾, and the latter 19 knots. They were both, however, extraordinarily unlucky ships, for the *Alaska* ran full speed into an iceberg one night in mid-Atlantic. Her bows were badly damaged, and but for the strength of her watertight bulkheads she would have foundered; she was, however, successfully navigated to St. John's, Newfoundland, without further mishap. The *Oregon* was less fortunate. She had been purchased by the Cunard Company, and after reducing the cross-Atlantic passage to 6 days 9 hours 51 minutes, she was run into and sunk by a sailing ship off the American coast, the mails and passengers, however, being saved.

The *Servia,* built for the Cunard Company in 1881, was the first large passenger vessel to be built of steel, which in turn eventually took the place of iron for shipbuilding. As early as 1873 the French Government had used this material for certain parts of their warships, while in the same year the British Admiralty ordered the fast cruisers *Iris* and *Mercury*, both entirely built of the same substance. It was in 1877 that the attention of firms building vessels for the mercantile marine was drawn to the advantages of steel, and in this year alone particulars of 5,000 tons of sailing and 18,000 tons of steam vessels proposed to be built of mild steel were received at Lloyd's. Mild steel has the advantage over iron of being very ductile—i.e. it can be bent into any required shape without fear of its cracking; its tensile strength is also 25 to 30 per cent. greater than that of iron, while if a steel and an iron ship are built to the same dimensions, the former will be some 20 per cent. lighter. At first the construction of a steel ship was a more costly business than the building of an iron one, but in spite of this it was found that the new material paid, for vessels could be made lighter in the hull and with heavier, and consequently more powerful, engines, which could drive them at a greater speed. Nowadays steel is much cheaper than iron, and except in the smallest sailing craft, where wood is still used, it is employed in the building of all ships, both sailing and steam, while the same material is also utilised for the manufacture of masts, yards and standing rigging. The *Servia*, referred to above, was at the time of her launch the largest and most powerful vessel the world had ever known—except, of course, the *Great Eastern*. She had good passenger accommodation, and created a furore in the shipbuilding world, for she was 515 feet long, with a gross tonnage of 7,392, while, with her speed of 16½ to 17 knots, she lowered the Liverpool-New York record to 7 days 1 hour 38 minutes, the distance being measured from wharf to wharf.

The two famous Cunarders, *Umbria* and *Etruria*, both built of steel, were completed by Messrs. John Elder and Company, of Glasgow, in 1884 and the following year respectively. They were practically sister ships, each 501 feet long, with a gross tonnage of 8,000, and at the time of their completion they both carried sails, being barque-rigged. These were afterwards removed, however. They were driven by single screws, but were very fast, and in August, 1885, the *Etruria* crossed from Queenstown to New York in 6 days 6 hours 36 minutes, while in 1892 the *Umbria* did the same journey at an average speed of 19½ knots. As time went on they both became faster instead of slower, and the *Etruria's* record transatlantic trip was 5 days 20 hours 55 minutes, with a highest day's run of 509 nautical miles. Both these ships, which for a time, from the point of view of speed, eclipsed anything crossing the Atlantic, were finally sold out of the Cunard Company in 1909.

During the early 'eighties the rapidly increasing size of vessels, and the greater power necessary to drive them at a high speed, made it harder and harder to construct the large single-screw engines to fulfil the necessary requirements. Twin-screw ships had been built, but they had usually been small craft, and had hardly been considered so satisfactory as those driven by a single screw. As time went on, however, the mercantile shipbuilders began to look upon the innovation in a more favourable light, and the Inman and International Company were the first to place steamers of this description upon the Atlantic route. Before describing these vessels, however, it is as well to say that twin screws, or the later inventions of triple or quadruple screws, are now almost universally fitted in modern passenger steamers. They have obvious advantages, for, if one screw shaft fractures, the ship can continue her voyage with the other, whereas if she had only a single screw, she would be helpless under similar conditions. For the same reason their advent also did away with the necessity of steamers carrying sails.

The two twin-screw steamers mentioned above were the *City of New York* (now called the *New York*) and *City of Paris* (now known as the *Philadelphia*), built by Messrs. J. and G. Thomson at Clydebank in 1888. Their length was 560 feet, their gross tonnage was 10,500, while they were able to steam at a speed of over 19 knots, the *City of Paris* averaging 19.02 knots for a period of eight months. They were built with a double bottom from end to end, and were subdivided into fifteen watertight compartments, it being said that the ship would still float with three of these open to the water. It has happened that vessels have been lost through the watertight doors leading from one compartment to another being open at the time of a collision, but in these two Inman liners this was guarded against by having no openings in the transverse bulkheads or partitions below the level of the saloon deck. The *City of Paris* broke the transatlantic record by doing the outward passage of 2,788 miles in 5 days 19 hours 18 minutes, while the homeward trip of 2,784 miles she reeled off in 5 days 22 hours 50 minutes. These famous ships were both transferred to the American flag in 1893, when the Inman Company was reorganised, and they now sail from Southampton to New York.

The White Star Line were not long in accepting the challenge held out to them by the Inman Company, and in 1889 were launched the *Teutonic* and *Majestic* at Messrs. Harland and Wolff's shipyard at Belfast. These craft were 582 feet long, with a registered tonnage of 10,000, and, driven by twin screws, had a speed of slightly over 19 knots. By arrangement with the Admiralty they were built especially strong, so that they could be used as mercantile cruisers in time of war, and were fitted to mount twelve 4.7-inch guns if necessary, while half their crews consisted of men belonging to the Royal Naval Reserve. Both vessels were exceptionally fast, the *Majestic* breaking the record by crossing from Queenstown to New York in 5 days 18 hours 8 minutes, while the *Teutonic* did the same trip in 5 days 16 hours 31 minutes.

The famous Cunarders *Campania* and *Lucania,* built by the Fairfield Shipbuilding and Engineering Company of Glasgow, and launched in 1891 and 1892 respectively, showed a considerable advance in size on any previous vessels. Their length was 622 feet and their gross tonnage some 13,000, the *Campania* being slightly the larger vessel of the two. The average speed at sea was some 21½ knots in the case of the *Campania* and 20 for the *Lucania,* and both ships could accommodate 600 first-, 400 second- and 700 to 1,000 third-class passengers. They were fitted internally with the utmost luxury, and, both from the point of view of comfort and speed, were justly regarded in their time as the crack transatlantic liners. In 1897, however, there was built in Germany a vessel which wrested the record for ocean speed from Great Britain.

Although it is intended that this book should deal primarily with British nautical affairs, it is hardly possible to refrain from giving a very brief account of the rapid development of shipbuilding in Germany, for until the advent of the *Lusitania* and *Mauretania,* in 1908, the German vessels held the record for the passage across the Atlantic. Shipbuilding in modern Germany may be said to have commenced after the Franco-German war of 1870-1, and although at first no very remarkable results were achieved, many large ships were built, while several were constructed in this country. In 1897, however, the Stettin Vulcan Company turned out the well-known *Kaiser Wilhelm der Grosse* for the North German-Lloyd Company, and she was larger than the *Campania* in every respect. Although her actual horse-power was less than that of the Cunarder by 2,000, she succeeded, nevertheless, in attaining a mean speed of 22.8 knots across the Atlantic, thus breaking the previous British record.

The answer to the German vessel was the White Star *Oceanic*, built by Messrs. Harland and Wolff, and launched in 1899; and at the period when she was first set afloat she was the largest vessel that had ever been built, being 685½ feet between perpendiculars to the 625 feet of her German cousin. Her gross tonnage was also greater by 3,000, but from the point of view of speed she was still behind, for she made only 20 knots.

From this time for some considerable period both the Cunard and White Star Companies contented themselves with building ships which, although large, came nowhere near the German record as regards their speed. Some of these vessels are enumerated below:

Ship	Date	Length	Gross Tons	Speed	Company
Ivernia / *Saxonia*	1899	580	14,027	15½	Cunard
Celtic	1901	680	20,880	16	White Star
Cedric	1903	680	21,034	16	White Star
Adriatic	1906	726	25,000	17½	White Star

In 1904, however, the Germans again built a vessel whose length and tonnage exceeded that of the *Oceanic* and whose speed was greater than that of the *Kaiser Wilhelm der Grosse*. This was the North German-Lloyd liner *Kaiser Wilhelm II.*, with a length of 706½ feet over all and a gross tonnage of 20,000. This ship and the Hamburg-Amerika Company's *Deutschland*, which latter had beaten the transatlantic speed record of the *Kaiser Wilhelm der Grosse*, gave the Germans for a time the proud position of being the owners of the fastest liners in the world, for the *Kaiser Wilhelm II.* succeeded in maintaining an average speed of 23.58 knots from New York to Plymouth.

By permission of the Cunard Steamship Co.

THE CUNARD LINER "LUSITANIA."

We must now pass to a new feature in connection with the propulsion of ships which came into being during the first decade of the twentieth century. I refer to the introduction of the steam turbine. A description of engines of this type, together with an account of their advantages and disadvantages, will be found in the chapter of this book which deals with propelling machinery, so it is not necessary for me to go farther into the subject here than to say that in 1905 the Allan liners *Victorian* and *Virginian* were the first large ships fitted with turbines driving triple screws. These craft were of 12,000 tons displacement, and on their trials attained speeds of 19.2 and 19.8 knots respectively, the average sea speed, however, being about 17 knots.

In 1905, also, the Cunard Company brought out the turbine-driven liner *Carmania,* which was practically a sister vessel to the *Caronia,* except that the latter was propelled by ordinary reciprocating engines. Both these craft were 650 feet long, had a gross tonnage of 19,524, and a sea speed of 18 knots, although the trial speed was considerably more.

In 1905, too, was completed the *Baltic,* of the White Star Line, whose gross tonnage of 24,000 made her a larger vessel than either of the huge German ships previously mentioned. She is driven by reciprocating engines at a speed of 16½ knots, and has accommodation for 3,000 passengers besides her crew of 350.

We have now come to the days of the *Lusitania* and *Mauretania,* those mammoth steamers which wrested from the Germans the honour of holding the record for the fastest passage across the Atlantic. These two ships are the outcome of an agreement entered into between the British Government and the Cunard Company, and by which the latter agreed to produce two vessels capable of an average speed of 24 to 25 knots in moderate weather. The Government advanced £2,600,000 to the company to help to defray the initial cost of the vessels—some £3,500,000 for the two, it is said—and an annual subsidy of £75,000 is also granted for each vessel on condition that they are held at the disposal of the Government in the event of the necessity arising. They are both fitted to receive an armament of quick-firing guns, and with their great speed might be able to render the utmost assistance in time of war either as transports or else for the purpose of carrying grain cargoes across the Atlantic.

These gigantic vessels have a displacement of 40,000 tons, are 762 feet long, and carry, including their crews, 3,200 people. A great deal has been written at one time and another about the wonderful way in which they are fitted up internally, and little upon this subject remains to be said. They are provided with suites of apartments comprising dining-, sitting-, dressing- and bedrooms for the use of the millionaire on his journey, while even the humble third-class passenger is catered for and accommodated in a manner which a few years ago would have been considered out of the question. The accommodation for the first- and second-class passenger, with the smoking-rooms, veranda cafés, libraries, lounges, writing-rooms, orchestras, Turkish bathrooms, gymnasiums, etc., is on a scale which has never before been attempted, and the proprietor of many an expensive first-class hotel would turn green with envy at the sight of such luxury. Telephones are placed in each cabin, and by means of these communication can be effected, through a central exchange, with any other cabin throughout the ship; lifts take passengers from one deck to another, while a newspaper, supplied with news by means of the wireless telegraphy installation which is constantly in touch with either Great Britain or America, is printed every day, and so supplies the pampered passengers with all the latest information.

The *Mauretania* and *Lusitania* are fitted with turbine engines driving four propellers, and during the year 1909 the best average speed of the former was 26.6 knots, although for a time she averaged 27.47 knots, or 31.59 land miles, an hour. When we remember that it was only fifty years ago that the paddle-driven *Scotia*, with a speed of approximately 13½ knots, was regarded as a crack liner, the enormous speed of these modern leviathans appears all the more remarkable as illustrating the immense development both in shipbuilding and in the propelling machinery of steamers. The following table gives the fastest passages outward and homeward accomplished by these ships, the time being taken from the Liverpool landing stage and the Cunard pier at New York, and vice versa :

	Days	*Hours*	*Mins.*
OUTWARD			
Lusitania	5	7	0
Mauretania	5	1	30
HOMEWARD			
Lusitania	5	15	30
Mauretania	5	5	0

These two gigantic specimens owe their size not so much to their cargo-carrying capacity as to the fact that they have to steam at an enormous speed of over 25 knots for nearly 3,000 miles, while they must also carry a large amount of coal, for it is burnt at the rate of 1,000 tons a day; and, again, they must be able to pay their way by the number of passengers carried.

It seems impossible to know where the race for size is likely to stop, for the Cunarders described above were eclipsed in tonnage by the two gigantic White Star liners *Olympic* and *Titanic*. On her maiden voyage the *Titanic* collided with an iceberg and sank, over 1,600 of her passengers and crew being drowned. She was larger than the *Olympic*, but the two ships were sisters. Although bare figures give little real idea of the size of ships, it is as well to say that the *Olympic* is 882 feet 9 inches long over all, and has a gross tonnage of 45,000 and a displacement of 60,000 tons. She is driven by triple screws, and has a combination of reciprocating and turbine engines, the steam being generated in 29 boilers. Her sea speed is 21 knots, though she is capable of between 24 and 25.

The accommodation for the passengers, of whom 750 first-, 550 second- and 1,100 third-class can be carried, is on a most lavish scale, and the vessel is fitted with Turkish baths, a restaurant, besides the usual dining saloons, a veranda café, and even a swimming bath, gymnasium and squash racket court. The *Olympic* and *Titanic* have now been put in the background by the *Aquitania*, a new vessel now (1912) building for the Cunard Company. She has a gross tonnage of 60,000, is 930 feet long, and is designed for a speed of 27 knots. With this short description of these latest gigantic steamships we must close our account of the larger British transatlantic vessels. Among the steamers on the Atlantic, as I have said before, the largest in the world are found; they can be built of practically any size, so long as their draught of water will enable them to enter the harbours to which they ply; but on the other routes, and greatly owing to the limited depth of the Suez Canal, draught, and consequently size, are matters of more important consideration. We will now attempt to describe the smaller, but none the less important, mail steamers which run outside the Atlantic, and whose work helps so largely in maintaining the maritime greatness of the country to which they have the honour to belong.

One of the most famous steamship companies outside the Atlantic Ocean is the Peninsular and Oriental Steam Navigation Company, or, as it is more generally called, the "P. & O. Line." It commenced its career in 1837 by running mail packets to Lisbon and Gibraltar under

Government contract. The famous P. & O. house flag —a square flag quartered diagonally in blue, white, red and yellow—is said to owe its origin to the colours of the Portuguese and Spanish ensigns, the Peninsular countries to which the P. & O. ships first ran. Since then the company have slowly but surely extended their services, until at the present time their steamers run to India, Ceylon, China, Japan, the Philippine Islands, Australia and Tasmania.

The finest P. & O. mail steamers are the ten vessels of the "M" class: *Marmora, Moldavia, Mongolia, Macedonia, Mooltan, Malwa, Mantua, Morea, Medina* and *Maloja*. The first of these ships, the *Marmora,* was completed in 1903, while the latest, the *Maloja,* was completed in the autumn of 1911. All these ships have a speed of 18½ knots, and all are driven by twin screws, while their tonnage varies between 9,500 and 12,500. The immediate predecessors of the "M" class mail steamers were the five vessels of the "China" class: *China, India, Arabia, Egypt* and *Persia,* all completed between the years 1896 and 1900. They are single-screw ships, with a speed of some 18 knots, and the tonnage of all is approximately the same, being about 7,900 registered. The older mail steamers belong to no particular class of their own, and are all single-screw vessels. For the sake of convenience, I will enumerate them in tabular form :

Ship	Date	Tons	Speed
Arcadia . . .	1887	6,603	16.5
Oceana . . .	1887	6,610	16.5
Oriental . . .	1889	5,284	16
Himalaya . .	1892	6,929	17.5
Caledonia. . .	1894	7,572	18.5

The *Caledonia,* it is interesting to note, was the first of the P. & O. ships without sails, for all vessels previous to her had three or four masts, and were square-rigged on the fore and main. The *Caledonia* has four pole masts, but all subsequent steamers have two pole masts only.

The small mail steamers *Isis* and *Osiris,* built in 1898, are twin-screw ships of 1,800 tons, capable of a speed of 21 knots. They are used on the run with mails and passengers between Brindisi and Port Said, and are flush-decked, two-funnelled craft.

The *Salsette,* completed in 1908, is a 20-knot twin-screw steamer of 5,842 tons, designed for service between Bombay and Aden; while the *Vectis,* a single-screw steamer of 5,628 tons, is used for yachting cruises to the Mediterranean, Baltic, the Norwegian fiords, and many other interesting places. She carries only one class of passenger.

The three twin-screw vessels of the "D" class, the *Delta, Dongola* and *Devanha,* were all completed in 1905-6, and are principally used between Colombo and the Far East. They all have a registered tonnage of slightly over 8,000 gross. The loss of the *Delhi,* the fourth vessel of this class, is still fresh in the public mind. The vessels which preceded the "D" class ships on these connecting lines were the *Assaye, Plassy, Palermo, Palma, Pera, Peshawur* and *Poona.* They, too, are all twin-screw ships, built between 1899 and 1905, and have tonnages varying between 7,376 and 7,637 gross.

The intermediate P. & O. steamers of the latest type are the twin-screw vessels *Socotra, Sicilia, Somali, Soudan, Syria, Sardinia, Candia, Nore, Nyanza, Nile* and *Namur,* while two more, the *Nankin* and *Netley,* are now complete (1912). These craft all have tonnages of about 7,000, and though, of course, they are slower than the proper mail boats, they have the comfortable sea speed of about 13 to 14 knots. They afford excellent accommodation for those passengers travelling to India and the Far East to whom time is no object but to whom the extra amount payable for a mail passage is of some importance.

Besides those vessels which I have enumerated, the P. & O. Company own many other smaller intermediate steamers running through the Suez Canal to India and the Far East. They are single-screw ships of about 5,000 tons, and, although they have comfortable accommodation for a certain number of passengers, their chief *raison d'être* is the carrying of cargo. Not content with running steamers to India and the Far East through the Suez Canal, the P. & O. Company have recently acquired five ships of Lund's Blue Anchor Line, which run to Australia, round the Cape of Good Hope, touching at Cape Town and Durban. Of these ships, the *Commonwealth* and *Geelong* are twin-screw vessels of 6,600 and 7,954 tons respectively, while the *Narsung, Wakool* and *Wilcannia* are of about 5,000 tons and are driven by single screws. For this route also are now building the *Bendigo* and *Ballarat,* twin-screw vessels of 11,000 tons. After mentioning 29 steam tenders and tugs, which are stationed at various ports all over the world at which the P. & O. steamers touch, our list of the Peninsular and Oriental Company's fleet is complete. All the mail steamers are fitted with wireless telegraphy, while the *Bendigo* and *Ballarat* will also receive an installation when they are completed.

P. & O. steamers can always be distinguished by their colouring, for they have a black hull with a narrow white encircling ribbon, red water-line, buff-coloured upperworks, and black funnels, this distinctive method of painting being uniform throughout the company's fleet.

So much for this famous company, whose ships are so often met with in the Mediterranean, Red Sea, Indian Ocean and China Sea; their history is a very interesting one, and, to quote the words of Sir Thomas

Sutherland in the preface to the "P. & O. Pocket Book," "no company has ever been served by more capable and zealous officers than those who sail under the P. & O. flag."

Another British company whose ships run to Australia is the Orient Line, and this is the only other company besides the P. & O. under contract with the Commonwealth of Australia for the conveyance of mails between England and Australia. Their latest mail steamers are the *Orsova, Osterley, Otway, Orvieto* and *Otranto,* all launched in 1909. They are all practically sister ships, being of about 13,000 tons, and are driven by twin screws at a speed of 18½ knots. The other vessels of the Orient Line are the *Orient, Ormuz, Oroya, Orotava, Oruba, Ophir, Omrah, Orontes* and *Ortona,* the first of which was completed in 1879 and the latter twenty years later. They vary in size from 5,850 to 9,000 tons, and although several of them are comparatively old ships, they offer extremely comfortable accommodation to their passengers. The *Ophir,* built in 1891, was the first twin-screw vessel of the fleet, and she had a sea speed of 18 to 19 knots. She was, it will be remembered, the vessel selected to carry the present King and Queen on their tour of the British Colonies in 1901.

It is impossible, in the space at our disposal, to do more than to give the briefest description of the many important British steamship companies. It must be remembered that practically every port in the world is served by vessels flying the Blue or Red Ensigns, and, further, the frequent amalgamations and changes which are constantly being effected would render a long and detailed account practically valueless after a comparatively short time. According to Lloyd's Register Book of 1910-11 there are owned by British and Colonial firms no fewer than 9,837 steamers, with a total tonnage of 18,059,037

By permission of the Peninsular and Oriental Steam Navigation Co.

THE P. & O. LINER "MOOLTAN."

gross, and if we were to attempt to tell something of every one of them our task would indeed be a colossal one.

Ships change in type, tonnage and in many other ways very frequently, so in endeavouring to give a dissertation on the ships of the British mercantile marine, it is as well to confine oneself to a general rather than to a detailed description.

Among the more important steamer lines trading and carrying passengers to and from the Antipodes are the Aberdeen Line, the Ocean Steamship Company, the British India Line, the Federal Steam Navigation Company, the Houlder Line, the Moor Line, the New Zealand Shipping Company, the Orient and the Peninsular and Oriental Lines (which have been already mentioned), the Royal Mail Steam Packet Company, the Shaw, Savill and Albion Company, the Union Steamship Company of New Zealand, and the White Star Line.

The Aberdeen Line was founded in 1824, and long occupied a prominent place in the Australian trade with its fleet of fast-sailing clippers. The present fleet, however, consists entirely of steamers, and of these the *Themistocles* and *Demosthenes,* of 12,000 tons, are the most famous, the latter being the first turbine steamer trading between this country and Australia. The journey is made round the Cape of Good Hope, and, besides cargo, first- and third-class passengers are carried.

The Blue Funnel Line, so called because its ships have a blue funnel with a black top, is more properly known as the Ocean Steamship Company, and maintains a cargo service between Great Britain and the East, while a further series of steamers extend the service to British Columbia, to the Dutch East Indies, and Australia. Many of the vessels are fitted for the accommodation of saloon passengers, and among the largest of these are the *Aeneas, Ascanius* and *Anchises,* each over 10,000 tons. The Suez Canal is used for the passage to the East.

The British India Steam Navigation Company was founded in 1855, and now maintains services over practically the whole of the Indian Ocean and as far as Australia and Java. Its largest ship is the *Queda,* of 7,700 tons, while the 4,500-ton *Angora,* and *Alhona,* the former being a turbine vessel, are the latest additions to its fleet.

The Bucknall Steamship Lines, Limited, run vessels for passengers and cargo from London to South and East Africa, and from New York to South Africa, Australia, New Zealand, India and the Far East. They also have a large interest in the trade in the Red Sea and Persian Gulf, the majority of the steamers carrying on these services being craft of about 4,500 tons.

The Federal Steam Navigation Company's steamers —all of which, by the way, are named after English counties—convey general cargoes to Australia and New Zealand, and return to London, by way of South Africa, with wool and frozen produce of all kinds, the majority of vessels being fitted with large refrigerating chambers for this purpose.

The Houlder Line, established in 1849, also employs steamers on the same route and for the same purpose, though passengers are also carried; but, in addition, it owns vessels trading between this country and the River Plate ports and South and East Africa. The *Drayton Grange* and *Oswestry Grange* are practically sister vessels of 6,500 tons, with twin screws giving them a sea speed of about 13 knots, while the new twin-screw *Everton Grange* is of 8,100 tons.

The Moor Line of steamers trades with all parts of the world, and its fleet of thirty-one steamers is entirely composed of modern vessels.

The New Zealand Shipping Company was organised in 1873, and at first carried on business with sailing ships accommodating passengers. Of the present fleet, however, two—the *Ruahine* and *Rotorua*—are triple-screw steamers of 11,000 tons, while the *Olaki* is fitted with a combination of reciprocating and turbine engines. The ships of this company do a large trade in bringing to England the frozen produce of New Zealand, and also in carrying passengers. The passenger steamers sail from London every month, and touch at Plymouth, Teneriffe, Cape Town and Hobart, returning round Cape Horn via Montevideo and Rio de Janeiro. The passenger rates are very low, and the accommodation and food are excellent.

The Royal Mail Steam Packet Company is one of the most ubiquitous of the British steamship companies. Incorporated in 1839, the company received a payment of £240,000 a year for the carrying of the mails to and from Great Britain, the West Indies, and North and South America. The West India Mail Line was extended to Colombo in 1868, while the following year the South American Mail Line was continued to Buenos Ayres. The company now runs steamers from New York to Jamaica, and vice versa, while in 1905 it acquired a half-interest in the Australian mail services. Two years later it also acquired a half-share in the "Shire" Line, by which its services are extended to the Far East; while, still more recently, Messrs. Forwood's Line has been acquired, and vessels are now run to Gibraltar, Morocco, the Canary Islands and Madeira. In addition to this, a service of pleasure cruises to Norway were successfully inaugurated in 1909, while soon afterwards a regular service from New York to Bermuda, which was subsequently extended to Antilla, Cuba, was commenced. The company also has a large number of small vessels employed in the West Indian coastal and inter-colonial services, by which the produce from the various islands is collected and taken to Barbados or Trinidad, where it is embarked by the mail steamers; and in June, 1910, this enterprising company purchased the whole of the Pacific Steam Navigation Company's share capital, and has thus acquired control of its fleet and interests, thereby practically circumnavigating the continent of South America. The most important vessels of the Royal Mail Steam Packet Company are the mail steamers *Asturias, Avon, Araguaya, Amazon* and *Aragon*. These vessels, which are all driven by twin screws, vary in size between 12,000 and 9,500 tons. Their accommodation for passengers is amongst the most luxurious afloat, and a speciality is the number of single-berth cabins provided.

The Shaw, Savill and Albion Company is another company maintaining a regular service of fast steamers between this country and New Zealand. Passenger craft leave London every month, and call at Teneriffe, Cape Town and Hobart on the outward journey, while on the way home round Cape Horn the steamers call at Montevideo and Rio de Janeiro. All the vessels are fitted with refrigerators for the carrying home of frozen produce from New Zealand, and the fleet of twelve large vessels, many of which are twin screw, is this year (1912) being augmented by the addition of a large vessel of 10,000 tons, which is also driven by twin screws.

The Union Shipping Company of New Zealand is the most important shipping concern in the Southern Hemisphere, and its ships run from Australia to Vancouver, while the company also controls services to San Francisco via Raratonga and Tahiti. In the fleet are included three turbine steamers, the *Loongana* (2,500 tons, 20 knots), *Maori* (3,500 tons, 20 knots) and the *Maheno* (5,500 tons, 17 knots).

The famous White Star Line, besides its transatlantic services, runs large steamers to Australia and

FUNNELS AND HOUSE-FLAGS OF THE PRINCIPAL STEAMSHIP LINES.

New Zealand in connection with the Shaw, Savill and Albion Company. On the former route the twin-screw *Afric, Medic, Persic, Runic, Georgic* and *Suevic,* vessels of about 12,000 tons, with a speed of 13½ knots, are employed, as are also the smaller vessels—*Cufic, Tropic, Cevic* and *Bovic*. The voyage from Liverpool to Sydney is made via Cape Town, Albany, Adelaide and Melbourne. Passengers, all of one class, are carried, and the accommodation is very good, while the fare is only £19 for the passage of over 12,000 miles! The *Delphic, Athenic, Corinthic* and *Ionic,* vessels varying in size from 7,755 to 12,234 tons, and with speeds ranging from 11½ to 15 knots, are employed by the same company on the New Zealand service. The passage out is made via Plymouth, Teneriffe, Cape Town, Hobart, Dunedin and Lyttelton; and, home, the vessels come round Cape Horn, calling at either Rio de Janeiro or Montevideo and Teneriffe.

The Allan Line is the oldest in the Canadian service, the mail steamers having commenced running in 1856, while sailing vessels have carried on the communication since 1819. The Allan liners still carry the mails between Great Britain and Canada, while the itinerary includes Glasgow, Londonderry, London, several Canadian ports, Boston, New York, Philadelphia, and the River Plate.

This company owned the first turbine steamers on the Atlantic—the *Virginian* and *Victorian,* vessels of 12,000 tons and 17½ knots speed, and both these craft have beaten all previous records between the North of Ireland and Canada.

The Dominion Line of twelve steamers is another company whose moderate-sized vessels ply between Liverpool and Canada and the United States, carrying passengers and cargo; while the Manchester Liners, Limited, whose vessels are cargo carriers only, ply on the same routes. The Anchor Line, besides its Indian and Mediterranean services, carries on a cargo and passenger trade from the United Kingdom to New York, and the size of the steamers has developed with their trade, the *Columbia, Caledonia* and *California,* all of about 9,000 tons, being worthy of notice.

Of other lines trading across the Atlantic to the United States, West Indies, Brazil, Mexico and the River Plate may be mentioned the Lamport and Holt Line, the Leyland Line, the Harrison Line, the Houston Line, the Imperial Direct West India Mail Service Company, Limited, the Prince Line, and the Booth Line. The steamers of the Lamport and Holt Line form a mail and passenger service between Liverpool, Brazil and the River Plate. The company owns many large vessels. The twin-screw *Vandyck,* of 12,000 tons, is one of the latest of these, and she is fitted with all modern improvements, including a children's nursery, laundry, café, gymnasium, wireless telegraphy and a whole host of other conveniences for the comfort of passengers. Nearly all the Lamport and Holt steamers carry passengers, but some are fitted up to transport large numbers of sheep, horses and cattle.

The Leyland Line pays special attention to the carrying of cargo, the principal item of which is the cotton brought to this country from New Orleans. The ships, however, are also fitted to accommodate passengers.

The Imperial and Direct West India Mail Service Company, Limited, runs its ships from Bristol to Jamaica with passengers and mails. The vessels are specially fitted out for bringing home large quantities of fruit, each ship being expected to bring back 20,000 bunches of bananas on the homeward voyage.

The Prince Line runs its ships to Continental, Mediterranean, South African and Far Eastern ports, besides those already mentioned, but the vessels, though large, require no special notice.

The Booth Line possesses many fine steamers running to Brazil from Liverpool, New York, Havre, Vigo, Leixoës and Lisbon, and among these are the *Hildebrand, Anthony, Lanfranc* and *Hilary,* well-known twin-screw vessels, with a tonnage of about 7,000 and a speed of 14 knots. The company carries the royal mails to Brazil and also between New York and Brazil, while all the ships I have mentioned carry a large number of first- and third-class passengers.

One of the newest transatlantic lines, the Canadian Pacific Railway, owns some 15,225 miles of main and branch railways stretching across Canada from the Atlantic to the Pacific oceans. The successful completion of this undertaking, in 1885, was in itself a remarkable feat, but, not content with this, six years later the advent of the three steamers, *Empress of India, Empress of China* and *Empress of Japan,* moved the Western terminus of the railway across the Pacific Ocean to Hong Kong. These fine steamers, which have since been reinforced by the smaller vessels, *Athenian* and *Tartar,* are of 5,905 tons gross, and had a speed on trial of 18 knots. They carry the mails from Vancouver to Japan and Hong Kong, and average 17 knots on the journey, and I think I may safely say that they are the most beautiful liners afloat. Their white hulls and overhanging bows, together with their three masts and two large cream-coloured funnels, give them a yacht-like appearance which is absent from by far the greater number of ocean liners, and often at Hong Kong and Yokohama I have seen them steaming in at the end of their long journey looking as spick-and-span as if they had just been newly painted.

Besides these vessels in the Pacific, the Canadian Pacific Railway Company owns a large number of steamers running between Liverpool and Canada. All these craft are large modern steamers, but chief among them must be mentioned the *Empress of Britain* and the *Empress of Ireland,* vessels of 14,500 tons, driven by twin screws. They are the largest and fastest vessels plying between this country and Canada, and the latter holds the record for the passage. The Canadian Pacific Railway Company, I should also mention, run lake, river and coasting services in British Columbia and Canada.

The most important steamship company whose vessels run to South Africa is undoubtedly the Union-Castle Line. (Last April [1912], it will be remembered, this company passed into the hands of the Royal Mail Steam Packet Company and Messrs. Elder, Dempster and Co., Limited.) The mail steamers of this line leave Southampton every Saturday for Natal, calling at Madeira *en route.* The vessels carrying on this mail service are the *Saxon, Briton* and *Norman* of the old Union Line, which was amalgamated with the Castle Line in 1900, and the *Balmoral Castle, Edinburgh Castle, Kenilworth Castle, Armadale Castle, Walmer Castle, Kildonan Castle, Kinfauns Castle, Carisbrook Castle, Dunvegan Castle* and *Dunottar Castle.* The tonnage of these vessels varies considerably, being 5,625 in the case of the *Dunottar Castle,* which is a single-screw ship built in 1890, and 13,360 in the case of the *Balmoral Castle,* the newest addition to the fleet. (This latter ship, it will be remembered, conveyed their Royal Highnesses the Duke and Duchess of Connaught to South Africa in October, 1910, to open the first Parliament of the new Union.) The speed also varies, for while it is 16½ for the *Dunottar Castle,* the *Kildonan Castle,* built in 1899, can do 17½, the newer vessels being even faster than this.

The company also owns numerous intermediate steamers carrying a large amount of cargo, and a certain number of passengers, and of less speed than the mail steamers; and, after arrival at Durban, these vessels go on up the coast to Delagoa Bay and Beira,

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THE UNION CASTLE LINER "BALMORAL CASTLE."

and finally across to Mauritius. Another intermediate steamer is sent every month via Marseilles, Naples and the Suez Canal direct to Mombasa, Zanzibar, Mozambique, Chinde, Beira, Lourenço Marques and Durban; so the Union-Castle ships circumnavigate Africa. Even in these vessels the passenger accommodation is extremely comfortable, the only disadvantage being that they are slower than the proper mail boats.

Another line of steamers running to the Cape of Good Hope and Natal is the Natal Line, established in the 'fifties with a fleet of sailing clippers. The ships run to the same places as the Union-Castle Company's ships, but carry out in addition a through service from South Africa to China and Japan, while other of the vessels, under contract with the Natal Government, proceed to the East African ports, Colombo, Madras and Calcutta. The largest vessel in the fleet is the *Umona,* of 4,000 tons, launched in 1910, and she has a speed of 13½ knots.

The steamers of the Clan Line, carrying cargo only, commenced a service from the United Kingdom to South and East African ports in 1881, while twelve years later was originated a joint service from New York to South and East Africa. Vessels of the same line now carry out services to Bombay, Karachi, the Malabar coast and Chittagong. Of the forty-nine steamers in this fleet, twenty-eight are turret steamers, of which the largest is the *Clan Colquhoun,* of 5,856 tons.

The best-known steamers running to the West Coast of Africa, alike for the mail, passenger and cargo services, are those of the British and African Steam Navigation Company. The line is owned by the firm of Messrs. Elder, Dempster and Co., Limited, whose trade enterprises have been carried out on a colossal scale, and who now control six lines of steamships, comprising some 108 vessels. The larger of the vessels of the British and African Steam Navigation Company, Limited, are slightly over 4,000 tons, the largest in the fleet being the *Mendi,* of 4,230 tons.

Of the smaller lines running to India, the Bibby Line is one of the best known. Its vessels run to Rangoon and Colombo, and carry cargo and passengers, very good accommodation being provided for the latter. The ships of the fleet are all modern, the largest being the twin-screw steamer *Gloucestershire,* of 8,100 tons.

The Wilson Line is the largest private shipowning company in the world, and maintains, besides its Continental, Baltic, Mediterranean and Black Sea fleets, some of which are first-class passenger vessels fitted with wireless telegraphy, a fortnightly service to Bombay and Karachi.

The Ellerman Lines of steamers comprise the Ellerman Line, whose 25 ships trade between Liverpool and all Continental ports; the City Line, which has 28 steamers sailing from Glasgow and Liverpool to Calcutta, Bombay and Karachi; the Hall Line of 26 vessels, running a regular passenger and cargo service between Liverpool, Bombay and Karachi; the Papayanni Line, whose vessels ply principally in the Mediterranean; the Westcott and Laurance Line, trading in the same locality; and the Coverly and Westray Line, running between London and Oporto on a passenger and cargo service. The Bucknall Line is also managed by the Ellerman Lines, Limited, so this company has a total fleet of 120 steamers.

The Glen Line of nine steamers, running with passengers and cargo to the Straits Settlements, China and Japan, is one of the few privately owned lines. The largest steamers are the *Glenlogan* and *Glenroy,* of 5,838 and 4,901 tons respectively.

Last, but not least, there is the London firm known as the General Steam Navigation Company, Limited.

Services are maintained from London to Edinburgh, Continental ports, the Mediterranean, Adriatic, Levant and Black Sea, while among the vessels are steamers of about 2,700 tons.

Although I have enumerated only a few of the many British steamship companies, I think sufficient has been said to show what an enormous institution the British mercantile marine really is. From Greenland down south to the Cape of Good Hope, from Cape Horn across to Kamschatka, and from South America across the dreary, wind-swept Southern Ocean to New Zealand, you will still see the ships flying the British flag outnumbering the foreigners by more than two to one. This is, when we come to look at it, a wonderful state of affairs, and all the more credit is therefore due to the officers and men of the British merchant service who so ably carry on the work. Although they rarely become public heroes, for their gallant deeds are performed far out of the track of the journalist, their efforts none the less serve to maintain this Empire of ours upon a very firm basis—a basis which could not exist for any length of time without ships to carry on our oversea trade.

CHAPTER IX

Steam Vessels for Special Purposes

THE commonest of all the steamers seen at sea is undoubtedly the ubiquitous tramp. There is, perhaps, little romance attached to her calling, and she is far from being a thing of beauty, but in spite of this she fulfils a very important function.

A tramp steamer, as a general rule, varies in size from 1,500 to 5,000 tons, and will carry a crew of about twenty-five men at the most. Everything about her is run on the lines of the most rigid economy, and her officers and men usually receive low wages, the skipper, even, of such a vessel thinking himself lucky if he gets as much as £12 a month. The speed of the ship may be anything up to 10 knots, varying, of course, with her age, and, as she burns only 20 tons of coal a day, she is not an expensive craft to run.

The proper tramp has no recognised route like the passenger steamers and larger freight carriers, but goes about from place to place at the will of her owners or charterers. Once away from home waters, her officers and men never know where they may be going next, for in many out-of-the-way ports her owners may have no agents, and the skipper will be left to take what cargo he can, and at as an advantageous a rate for freight as possible. At some ports a cargo may not be forthcoming, so the vessel will proceed at her leisurely gait to some other place where a deal is more likely to be made.

It does not matter in the least what the cargo is:

railway material, perhaps, consisting of anything from railway metals to a 40-ton boiler; bones and hides, the most odoriferous and horrible cargo that can possibly be imagined; coal; cattle; cotton; cases of trade gin and rusty flintlocks for the West Coast of Africa—all these things may at one time or another find their way into her capacious holds, for her owners are not very particular so long as money is earned and the shareholders' dividends paid.

The ship may be abroad for years without ever coming home, a new crew being shipped periodically, and the officers returning to Great Britain on the termination of their agreements; but still the old vessel will be left running to all sorts of out-of-the-way places, earning money for her owners.

The life on a tramp steamer is far from being pleasant. In harbour, if cargo is not being taken in or unloaded, the crew may be employed in the hundred and one little jobs which are constantly cropping up even in the best-found ships; painting or keeping the vessel clean is not looked upon as a matter of vital importance, for—with coal tramps especially, who are either embarking or disembarking coal every fortnight with the utmost regularity—everything is bound to be dirty and grimy, and it is hardly worth while endeavouring to better this state of affairs.

At sea the men have plenty to do, for besides having to take their tricks at the wheel and on the look out, there are various things constantly requiring attention. Their leisure time they spend in their noisome den of a forecastle, where they are cooped up like sardines in a tin. Amusements or recreations they have none, and it is little to be wondered at that the tramp sailorman has a reputation for being a dare devil on the rare occasions when he does get ashore. The officers are more comfortably berthed amidships; but even they have a hard time, while their salaries, as a general rule, are miserably low. They have few opportunities of seeing their wives or relations, and such a thing as regular leave is practically unknown, so there is no wonder that the majority of them detest the life.

None the less, I have an intense admiration for the personnel of a tramp steamer, for they are ready to go anywhere and do anything, while the hard life breeds sailors who are as willing to face his satanic majesty himself as they are a gale of wind in the Bay of Biscay.

The oil and grain ships are quite a different type of steamer, and they are specially built for the work they have to do.

In days gone by oil was carried in barrels, and this, as may well be imagined, meant the sacrifice of a large amount of space, besides entailing a great amount of labour in stowing. Nowadays, however, oil is usually carried in bulk, being pumped in and out without much trouble. Petroleum carried in this way is naturally a dangerous cargo, for there is always the risk of fire, while the oil, being very heavy, will rush from side to side with the roll of the ship and may occasion much damage unless means are taken to check it. There is only one way of circumventing the difficulty, and this is by building special ships for the purpose, and in a number of modern oil-tank steamers the engines and boilers are placed well aft, so that they are not in close proximity to the dangerous cargo. The holds also are divided up into many oil-tight compartments by means of bulkheads running across and fore and aft the ship, and this latter device, as can be easily understood, effectively partitions off the oil into small quantities and prevents heavy masses rushing from side to side as the ship rolls.

Cargoes like rice and grain, when loaded in bulk in an ordinary vessel, are very dangerous, for there is a

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THE NORTH SEA TRAWLER "ORONTES."

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THE TURRET-SHIP "INLAND."

possibility of their shifting as the vessel rolls, and so giving her a permanent and dangerous list to one side or the other. Besides this, if rice or grain becomes damp, it will swell, and in the hold of a vessel where it is tightly packed the pressure created may be sufficient to open out the seams of the ship and cause her to founder. Mr. Keble Chatterton, in his interesting book, "Steamships and their Story," quotes a case where the sides of a vessel were actually burst outwards from this reason.

The principal danger of carrying grain, however, is due to the possibility of its shifting, and to guard against this steamers known as "turret steamers" and "trunk-deck steamers" came to be built. Vessels of the former type are frequently seen, and present a strange and unusual appearance, for it is noticeable that the sides of the ship are curved at the gunwale until they fall into a horizontal portion known as the "harbour deck." The plating then sweeps upwards again to form the sides of the so-called "turret." The top of this "turret" is decked over in the ordinary way, and forms a navigating platform, while on it are also placed the usual deck fittings and the necessary deckhouses for the accommodation of officers and men.

Any shifting of a homogeneous cargo, such as grain or coal, in the turret will not endanger the ship, while if the same thing happens to the cargo in the hold the vacant space is automatically filled up by the flow from the turret above. The cargo can also be shot in without trimming, thus saving much labour in loading. Besides having these advantages turret steamers are excellent sea boats, while their curved sides make them very strong.

Very similar to this type of vessel is the "trunk-deck" steamer for the principle upon which she is built is much the same. The harbour deck, however, instead of being curved at its outer and inner edges, has right-angled turns, and the deck thus formed is a true deck.

We must now touch briefly upon some of the British coastal services. There is hardly a port of any size in Great Britain which is not in steam communication with every other port, and the craft carrying on this coastal service, though small, so that they may enter harbours with little water, have to be well-found and good sea boats, for the weather round the British Isles is often far from pleasant.

We will deal with the steamers running in the summer only later on, and here we will confine ourselves to the discussion of such ships as those owned by the Carron Line, the Clyde Shipping Company, the General Steam Navigation Company, etc.

The first-named of these companies maintains a passenger service between London and the Firth of Forth, and extremely comfortable accommodation is provided at low fares. One of the best steamers is the *Avon,* a twin-screw steamer of 1,722 tons, with a speed of 16½ knots, and she is practically a small reproduction of an ocean liner.

The Clyde Shipping Company maintains innumerable passenger services from Glasgow, and among the ports to which their vessels ply may be mentioned Belfast, Dublin, Waterford, Cork, Plymouth, Portsmouth, Newhaven, Dover and London. Besides passenger vessels, the same company owns a number of powerful oceangoing tugs, which are ready to tow anything to any part of the world. It is with the passenger steamers, however, that we are now principally concerned, and of these the Clyde Shipping Company owns fifteen, varying in size from 920 to 1,245 tons. The sister ships, *Saltees* and *Sheerness,* are the largest in the fleet, being of the latter tonnage; they are lighted by electricity, and can accommodate ninety passengers if necessary. The saloon is aft, while a bathroom is provided and a stewardess carried, and the food being good intending passengers need have no fears that they will be badly provided for because the ships are not large. Besides passengers, all these craft carry cargo, and this is what keeps them going during winter, when passengers are unwilling to face the gales and heavy seas which are often such a bugbear to the sea voyager.

The General Steam Navigation Company, besides running vessels in the Continental trade, owns steamers which run on the coastal services on the East Coast; while in the summer they run a number of pleasure steamers between the seaside resorts in Essex, Kent, Suffolk and Norfolk.

It is impossible here to give an account of the numberless companies whose vessels are employed round about the British Isles, but those I have enumerated may be taken as good examples, and will serve to give you some idea of the ships which carry on the work.

Closely allied to the coasting vessel in the length of their journeys and the weather they experience are the cross-Channel services which are maintained between many places in these islands and various foreign ports. The shortest of these is the crossing from Dover to Calais, which is maintained by the fine fleet of steamers belonging to the South Eastern and Chatham Railway Company. Five of these vessels, the *Queen, Invicta, Onward, Empress* and *Victoria,* are turbine-driven, and have a speed of over 20 knots, and although, of course, they are comparatively small vessels they are fitted with every conceivable comfort for passengers, while wireless telegraphy has been installed.

Four of the fastest short-trip steamers in the world are the *Connaught, Leinster, Munster* and *Ulster,* employed by the City of Dublin Steam Packet Company on the run between Holyhead and Kingstown. These craft are driven by twin screws at a speed of 23½ knots, and commenced their services early in 1897. They are of about 2,185 tons displacement, and are superior to any other vessels employed on similar service about the coast of the British Isles.

Among other famous short-trip steamers we may mention the *St. David, St. George, St. Patrick* and *St. Andrew,* belonging to the Fishguard and Rosslare Rail and Harbour Company, and employed by them on the service between those two ports. They are turbine driven, and all have a speed of 20 knots or more.

The *Ben-my-Chree,* one of the fleet of fine vessels belonging to the Isle of Man Steam Packet Company, and employed on the route between Liverpool and the Isle of Man, is one of the most famous cross-Channel steamers in existence, for she is turbine-driven and has the remarkable speed of 25 knots. It is worth mentioning, in connection with this vessel, that the mean time in performing the passage from Liverpool to Douglas differed by only one minute in two successive seasons; and this fact, as illustrative of the superiority of turbines over reciprocating engines, speaks for itself. It is also interesting to note that the vessel I have just mentioned can carry no less than 2,500 passengers.

The greater number of our large railway companies have their own fleets of steamers, and among these must be mentioned the London, Brighton and South Coast Railway Company, who carry on a service between Newhaven and Dieppe. Among their vessels are the *France* (of 21½ knots), the *Sussex, Tamise* and *Manche* (of 21¼ knots), and the *Arundel, Brighton* and *Dieppe* (of 20 knots). The London and North Western and Midland Railway Companies also own fleets of steamers, and among other vessels belonging to the first-mentioned we have the *Cambria, Anglia, Hibernia, Scotia* and *Rathmore* (all of 20 knots); while the latter company owns the *Antrim, Londonderry* and *Manxman* (all of which steam 20 knots), the two last-named being turbine-driven. The London and South Western Railway Company's steamers run between Weymouth and the Channel Islands, and Southampton and the Channel Islands, besides various French ports, and the vessels keep up an uninterrupted service, carrying passengers, mails and freight, while during the summer extra ships are put on to cope with the cargoes of potatoes, fruit and flowers. The Great Eastern Railway Company run their vessels between Harwich and the Hook of Holland, and their three turbine-driven steamers, the *Munich, Copenhagen* and *St. Petersburg,* are worthy of special mention. They can all steam over 20 knots, and are equipped with wireless telegraphy, while the submarine sound-signalling apparatus is also fitted.

For obvious reasons the typical cross-Channel or short-trip steamer is limited as to size, and what she has to do must be done quickly. She must go out of harbour and develop her full speed at once, and that is the reason why turbine steamers are coming into use so rapidly. Problems of the same kind as those which beset the minds of the owners of ocean-going steamships are an equal cause of worry to the short-trip steamer owners, and they have their work cut out to keep their ships up to date; for an old ship, though she may be fast and sound, will not attract passengers to the same extent as one fitted with all the latest developments and improvements of this very progressive age.

As we have seen in the previous chapter, steamers commenced their work upon rivers and lakes long before they ventured out into the storm-tossed seas of the broad ocean. The Clyde is notable as being the first river in Great Britain on which steamboats carried out regular services, and throughout the long years that have passed between that epoch and the present time the river has not lost its reputation. Not only is it one of the most famous shipbuilding centres in Great Britain—we might say in the whole world—but it is to-day the scene of one of the finest steamboat services in existence. The three Scottish railway companies all have their own fleets of steamers running on the Clyde and the neighbouring waters, but besides these there are many private companies whose vessels are at work on the same routes. Take, for instance, the fleet belonging to Messrs. David Macbrayne, Limited, who carry out services between Glasgow and all the ports on the West Coast of Scotland, including the outlying islands in the Atlantic. The fleet consists of some thirty-four steamers of two types: the seagoing cargo vessels and the faster passenger steamers. The latter are all fast paddle-driven craft, capable of a speed of 16 to 19 knots, with a tonnage varying between 500 and 600 gross, and they form the only means of communication between the many towns and villages lying between Glasgow and Ardrishaig.

We have in these islands no great navigable river like the Volga and Danube, which are 2,200 and 1,700 miles long respectively; but on the 200-mile Thames—which, it must be remembered, is not navigable for anything like this distance—there are three well-known lines of steamers: the General Steam Navigation Company, the New Palace Steamers, and the Belle Steamers, whose vessels deserve special mention, for they are constantly at work during the summer months.

The river and coast service of the first-named company extends as far northward as Yarmouth and southward to Dover; while the *Kingfisher,* built in

1907 and driven by turbines at 21 knots, runs between Southend, Margate and Boulogne. The New Palace steamers *Royal Sovereign* and *Koh-i-noor* are also well-known craft, plying between London and various ports on the East Coast. They are driven by paddles, but are credited with a speed of about 20 knots. These vessels are fitted with telescopic funnels and a hinged mast to enable them to go under London Bridge. The Belle Steamers were established in 1890, and comprise seven vessels, named the *Clacton Belle, Yarmouth Belle,* etc. Their service also extends as far as Yarmouth and Ramsgate, but in the summer of 1911 they came as far west as Portsmouth. These craft are driven by paddles, at a speed of about 18 knots, and have a tonnage of about 525.

Between the various watering-places on the South Coast and the Isle of Wight there are also services of steamers which cater for the summer passenger traffic. These craft are, as a general rule, driven by paddles, and are of much the same type as those previously described. The paddle method of propulsion has been retained in place of the screw, to make the steamers of shallower draught, some 7 feet or so, for they enter many harbours in which a deep-draught screw steamer could not be accommodated.

Among the smaller steam-driven craft fulfilling a very important and useful purpose must be mentioned the tug. Those of you who have visited our naval or mercantile ports are probably familiar with the squat, sturdy-looking little ship whose appearance gives one such an impression of power. In congested harbours you will see her at work, pulling a great liner this way or that, or placing her well-fendered bows against the quarters of a mail steamer twenty times as big as herself, to turn the great ship in her own length. The room in which I am writing overlooks the entrance to Portsmouth Harbour, and even now, slowly passing through the narrow entrance, is the great grey bulk of the *Neptune*. Alongside her is lashed a double-funnelled paddle tug, busily churning up the water, while ahead of her steams another, ready to take a tow-rope if the occasion arises. On the other side of the battleship, although I cannot see her, is probably another, and these three small craft are compelling the great bulk of their overgrown sister to turn in the sinuous bend at the harbour mouth. Many of the Admiralty tugs are paddle-driven, for in congested harbours they are able to turn in their own length, while, as I said when referring to pleasure steamers, they can go into far shallower water than a screw vessel.

Besides these tugs used for assisting vessels in and out of harbours, there are the screw-driven ocean-going tugs, which will tow a ship to any distance. You meet them towing sailing ships down-Channel when the wind is foul, while they are often to be seen off the Lizard waiting for some homeward-bound sailing craft. Even floating docks are not too large to be tackled. As good examples of the modern type of ocean tugs we may mention the fleet of these vessels owned by the Liverpool Screw Towing and Lighterage Company. One of these vessels, the *Blackcock,* has towed all sorts and conditions of ships. She towed a dismasted barque from Fayal to Oporto, averaging 160 miles a day in spite of a heavy sea; while on another occasion the same little craft steamed from Barbadoes to Fayal without stopping anywhere for coal on the 2,600-mile run, and with a 2,000-ton German ship in tow, which she was taking the 5,000 miles from Barbados to Hamburg.

Another class of ship which fulfils an equally important function is the salvage steamer.

The salvage steamers of the present day are of many types, but for rough, all-round work nothing is so useful as a ship with a wooden hull, for she can remain alongside a wreck in weather in which it would be impossible for a steel or iron vessel to do so, for fear of having a hole knocked in her. One of the largest salvage companies in this country, the Liverpool Salvage Association, have converted old composite-built gunboats, fitted with modern engines and boilers, into salvage steamers with a marked degree of success, for their sturdy hulls will bear any amount of knocking about. Salvage steamers have to carry an immense amount of stores; huge leading blocks, chain slings, shackles, coils of rope, canvas for making pads, oakum, cement, steel plates for patching, heavy anchors, wire ropes, diving engines, and the thousand and one other items necessary for salving a wrecked vessel and for patching her up temporarily. Room has also to be found for an electric light installation, for working arc lamps and submarine diving lamps, winches and derricks to lift 40 or 50 tons, workshops fitted with lathes, rock-boring plant, air compressors, and portable steam and motor pumping engines, for there is no knowing what work the vessel may be called upon to perform. Accommodation is provided on board, also, for about a hundred officers, artisans and workmen, so it will be understood that the salvage steamer is practically self-contained, and can start off at any moment to the assistance of a stranded ship.

Telegraph ships, or steamers employed in the laying and repairing of submarine telegraph cables, are now, as a general rule, specially built for the work they have to do. In general appearance they differ little from ordinary steamers, but a closer inspection will reveal the large sheaves or rollers at the bow and the stern over which the cables are paid out or hauled in. Special grappling apparatus for hooking the end of a broken cable, winches and paying-out machinery, and brakes and friction tables for preventing the too rapid egress of the cable are fitted on deck, while the cable itself is stowed in a series of circular tanks built into the ship itself, each coil of cable being carefully whitewashed to prevent its sticking to the next. Some 3,000 to 4,000 miles of cable can be carried in the larger telegraph ships, and the *Colonia,* belonging to the Telegraph Construction and Maintenance Company, can lay an entire Atlantic cable without outside assistance beyond the help of a small vessel for laying the shore ends. The *Colonia* is the largest telegraph steamer in the world, for she has a length of 500 feet and a carrying capacity of 11,000 tons.

The *Silvertown,* belonging to the Indiarubber, Gutta-percha and Telegraph Works Company, and the *Faraday,* owned by Messrs. Siemens Brothers, are two other large vessels of this description, both having carrying capacities of about 8,000 tons. There are afloat at the present time nearly sixty telegraph steamers belonging to various countries.

The Corporation of Trinity House, who have the duty of erecting lighthouses and beacons, maintaining the lightships and buoys in efficient condition, and who are entirely responsible for the hundred and one different matters which tend to ensure the safe navigation of the coasts of England and Wales, have several steamers which are constantly employed on this work. Gas buoys, as I have said elsewhere, have to be refilled every fortnight, while at regular intervals they have to be brought ashore for repairs and painting. Moorings have to be renewed and overhauled, and on this work the Trinity House vessels are employed, while they are also kept busy taking provisions and relief crews to various outlying lighthouses and lightships. The local dock and harbour boards of our various seaports have the duty of keeping the local buoyage in efficient order for ensuring safe navigation into and out of their respective harbours or rivers, and they, too, employ their own special steamers. In naval ports like Portsmouth and Plymouth a naval officer, called the King's Harbour Master, is responsible for the same work. In Scotland and Ireland the Northern Lighthouses Commission and the Irish Lights Commission are, in conjunction with the local boards, responsible for the efficient condition of their various lighthouses, lightships, beacons, buoys, etc., so it will be seen that in the United Kingdom there are a large number of vessels which are constantly employed in keeping navigational safeguards in good order.

A vessel of great importance, again, is the dredger. The natural depth of water in many of our large ports, both naval and mercantile, is not sufficient to allow large battleships and liners drawing well over 30 feet of water to enter. Harbours and the bars across their entrances are constantly silting up, and for the purpose of deepening the water dredgers are employed. There are two different kinds of vessels of this description: the "bucket" dredger, and the "suction" dredger; but the former variety is the one most commonly seen. You are probably all familiar with her appearance, and have seen a craft of this kind at work. She is not by any means a beautiful ship to look at, covered as she is with ugly machinery, and a huge erection over which the endless chain and buckets travel, but nevertheless she has important work to do. She will moor head and stern in a channel, and start the chain of buckets moving to scoop away the sand and mud from the bottom, which will either be discharged into barges alongside or into the holds of the dredger herself. The main engines drive the buckets, and the vessel is cut in two longitudinally to allow them to work.

The suction dredger sucks the mud and sand into her holds through pipes which reach down to the river or sea bed, and the largest of them can suck up 10,000 tons of material an hour. When full, dredgers go to sea and discharge the sand and mud from their holds by the simple method of opening doors in the bottom. Though they are hardly beautiful to look at, we could not get on without them, for it is solely due to them that our principal ports and harbours are kept deep enough for the exit and entrance of large ships.

The steam trawler is another useful craft with a distinct personality of her own. She has no pretensions to beauty, but is built for hard work and heavy seas, and throughout the year, winter and summer alike, she is hard at work trawling for the fish which eventually finds its way to the markets throughout this kingdom. She is to be met with in all the waters round about these islands, but the North Sea is, perhaps, her favourite hunting-ground, and here she is to be seen out in all weathers, working either by herself or with a fleet of many others like her.

The older type of North Sea trawler was a small craft, with a length of barely over 100 feet, while her 60 horse-power engines gave her a speed of about 9 knots. Nowadays, however, the size has increased, and there are craft of this description with a length of 170 feet and a speed of 11 knots or so. A vessel of this type would be fitted both for fresh fish trawling and cod fishing, and during the cod season would carry 35 men, for the fish are gutted and salted on board. The fish hold would be kept cool by refrigerating machinery, while three different sets of lighting—electric, acetylene and ordinary oil lamps—would be installed.

Within the last few years motor-driven fishing craft have been employed with great success, for they are far more economical to work than steamers; and it appears possible that within the next decade or so the

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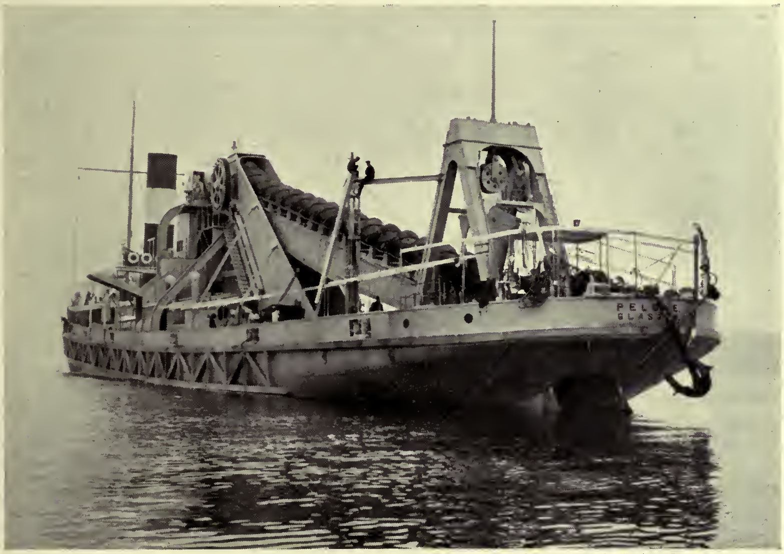
THE OCEAN TUG "BLACKCOCK."



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A BUCKET-DREDGER.

steam trawler may find a formidable rival in the shape of the internal combustion-engined vessel.

While we are discussing steam vessels built for special purposes, we must not omit to give a brief description of the steam yacht. It would be quite out of the question to keep within the limits of the subject if we referred to the many craft classed under this heading now owned in the United Kingdom, for they vary in size from the glorified steam launch to the vessel of moderate dimensions fitted internally with all the luxury of an Atlantic liner on a small scale.

The sport of steam yachting is, by reason of its costliness, a rich man's hobby. Many yachts spend the summer in England or Scotland, congregating at Cowes for the annual Cowes week, and going abroad to the Mediterranean or some other place to escape the severity of the British winter. Some, such as Lord Brassey's *Sunbeam,* go still farther afield.

The older type of steam yacht was a flush-decked craft, fitted with auxiliary sails, and rigged either as a schooner, barque, barquentine, or ship. The square-rigged craft were generally what we may call ocean-going yachts, for they depended, from reasons of economy, principally upon their sails, the engines alone being used when the wind was foul or for entering and leaving harbour.

The modern steam yacht, though her appearance varies greatly according to the ideas of her owner, is a vessel with a forecastle, quarterdeck, awning deck, bridge houses, etc. As a general rule she still has the overhanging bow and long counter, while, in some, masts carrying fore-and-aft canvas have been retained. In later craft a light signalling mast alone has been fitted. Great speed is seldom attempted, on account of its costliness, but the old single screw has given way to twin screws, while turbines are more and more coming into use, and before long yachts with internal combustion engines will be popular.

Though steam yachts are beautiful vessels, they can hardly be said to be of the same use as their humbler sisters—the cargo carriers, trawlers, etc. The fascination of steam yachting is one which is quite unknown to the greater number of the inhabitants of this country, and for that reason I have refrained from discussing pleasure craft at great length, and have confined myself so far as possible to descriptions of vessels which either have to fight for their country in time of war or earn their own living in time of peace—the ships of the Royal Navy and the Mercantile Marine.

There are, it must be remembered, many other types of steamers employed in various parts of the world. Ice-breakers and car ferry steamers are employed respectively in countries whose shores are ice-bound during some portion of the year and for conveying railway cars from one terminus to another across an intervening stretch of water; but, so far as I am aware, neither species of craft are in use in Great Britain.

CHAPTER X

Propelling Machinery

In previous chapters we have said something about the gradual development of ships, while, in referring to the steamers of different dates, we have briefly mentioned the various types of propelling agents employed. In the present chapter, however, we will go more thoroughly into the subject of the steam engine itself, and also into the methods employed in transmitting the power to the screw or other means used for driving the vessel through the water.

There are few subjects of greater importance to us British than the marine engine, for when we realise that out of the 22,008 steamers of over 100 tons in the world, 9,837 are British, it must be apparent that the satisfactory maintenance of our oversea trade depends almost entirely upon the efficiency of the engines and boilers which drive our ships.

The earliest steamers, as we have already seen, were propelled by paddle-wheels, either in pairs, one on each side of the ship, or singly at the stern, the system of both types being, however, the same. Although paddle-wheels are still employed in many vessels, such as tugs, pleasure and river steamers, their use on board large seagoing craft has long since been abandoned for various reasons. In cargo steamers, for instance, where the freeboard is constantly changing with the nature of the cargo carried, the paddles were never twice immersed to the same depth, while, if the ship rolled, one wheel would be deep in the water, and the other in the air, the consequence being that a heavy strain would be put upon the engines. Heavy seas dashing against the side of a ship would frequently damage the paddles, while the enormous boxes in which the wheels were placed increased the beam or breadth of the vessel and made it difficult for her to pass through a narrow opening, such as the entrance to a dock. In men-o'-war the boxes with the wheels inside ran a great risk of being disabled by the enemy's shot, so with all these disadvantages it was not surprising that people soon began to look round for another method of propulsion. It was not until 1836 that two people—Mr. (afterwards Sir) Francis Pettit Smith and Captain J. Ericsson, the first an Englishman and the latter a Swede —made simultaneous experiments with a form of screw propeller. Mr. Pettit Smith's appliance consisted of a screw or worm made to revolve rapidly under water in a cavity cut in the stern of a ship, but it was very unlike the screw propeller of the present day, for it had two complete turns, and was designed to bore its way through water as a screw does through wood. Figure 1 shows the propeller. A boat fitted with the new invention was soon built, and was subjected to a series of trials on the Paddington Canal in 1836 and 1837. During one of these trips the screw, which had been made of wood, came into contact with an obstruction, and had half its length torn off, but this mishap, instead of impairing the efficiency of the boat, actually increased her speed, while it showed that a screw with a single convolution, as in Figure 2, would give more satisfactory results.

In 1838 a company calling itself "The Ship Propeller Company" was formed to perfect Smith's patents, and in October, 1838, they launched the first seagoing screw steamer, the *Archimedes*. This vessel was built with the idea of satisfying the Admiralty with the efficiency of the new invention; she was of 237 tons and had a speed of 9¼ knots, which was almost double that expected. A single-threaded screw of one convolution (as shown in Figure 2) was first fitted; but this was subsequently replaced by one with a double thread, similar to that depicted in Figure 3. This propeller was then the prototype of the two-bladed screws which subsequently came into use in British men-o'-war and merchant ships.

In 1840 was built the *Mermaid,* and two years later this vessel, having attained a speed of over 12 knots, was purchased by the Admiralty and named the *Dwarf.*

As we have said in a previous chapter, the *Great Britain,* launched in 1843, was built of the comparatively new material, iron; but, not content with this, the far-sighted Mr. Brunel, her designer, fitted her with a screw propeller instead of the cumbersome paddles.

The Admiralty, too, did not waste much time in following up the new invention, for in 1843 the *Rattler* was launched at Sheerness. She was a vessel of 1,078 tons, driven by a screw, and had a speed of 9.64 knots, and within a short time she was tried with the *Alecto,* an identical vessel driven by paddles. The two ships were lashed stern to stern, and in a series of tugs of war the screw ship showed her superiority by towing her opponent stern first.

Like many other well-known inventions, the screw propeller made slow progress, and it was not until about 1850 that it can be said to have come into general use.

The number of blades utilised has varied from two to six, the majority of earlier steamers having two, but the three- or four-bladed species are by far the most common nowadays.

Screws of the modern type are hardly recognisable as a portion of a screw thread, but the propeller represents, nevertheless, sections cut out of three or four helices and arranged on a common circumference.

The shape of the blades varies a great deal, for in some cases it is practically circular, while in others it is elliptical or pear-shaped. Various different metals have been employed in the manufacture of propellers, both cast iron and steel having been used at different periods. Both these metals, however, corrode very rapidly in seawater, so that bronze—a mixture of tin, copper and zinc—is now almost universally employed. Propellers manufactured of this substance are very tough, but in salt water galvanic action is set up between the bronze screw and the iron or steel hull of the ship, the consequence being that the side of the ship in the vicinity of the propeller will be gradually eaten away. To prevent this, strips of zinc are fitted on the sides of the vessel and round the screw shaft, close to the propeller itself, and these are consumed by the galvanic action, while the hull of the ship is untouched. The strips, of course, have to be renewed from time to time, but this is a much less costly business than having to put in a complete new plate.

All large modern steamers and all men-o'-war are fitted with either twin, triple, or quadruple screws, the two latter varieties generally being found in turbine-driven vessels. The advantages of having more than one screw are obvious, for, as each is driven by a separate engine, the ship can still steam if one is damaged. The manœuvring power is also much improved, while if the rudder is damaged the ship can be steered by her screws alone. The first ships of the Royal Navy to be fitted with twin propellers were the *Penelope, Viper* and *Vixen,* launched in 1868, but in the mercantile marine their use did not become general until the last decade of the nineteenth century, and even now many of the smaller steamers have single screws for reasons of economy.

In the majority of large propellers used in ships with slow-moving engines the blades are usually movable on the boss or body of the screw, so that the pitch can be altered as necessary for varying the speed of the vessel with the various horse-powers of the engines. The "pitch," I should here say, is the distance, measured parallel to the screw shaft, the screw will travel forward if it is revolved one complete turn in a solid medium. To make my meaning clear, imagine an ordinary screw, a block of wood, and a screwdriver. Drive the screw into the wood, and the distance it advances into the wood with one complete turn of the screwdriver is what is called the "pitch."

Propellers for high-speed engines, such as turbines, are usually cast of solid bronze, and are, as a rule, far smaller than those used in reciprocating-engined ships.

The Marine Steam Engine

Although I think it is highly probable that the greater number of you know the principle upon which any ordinary steam engine works, I think it is advisable, for the sake of those who do not, to explain it with the aid of a simple sketch. The figure shows a simple type of engine with one cylinder, marked A. The piston, which travels up and down inside the cylinder is marked B, and to this is attached the piston rod C. To the end of this piston rod is hinged the connecting rod F, the end of which is again hinged to the crank G.

Now, suppose steam is admitted to the left end of the cylinder. The piston is at once pushed forward, and takes with it the piston and connecting rod, which latter is kept straight by means of the crosshead travelling between the guide rods D D. The forward motion is transmitted to the crank, which, as it is made fast to the crank shaft, can do nothing but revolve, which it accordingly does in the direction of the dotted circle marked H. This is the motion which rotates the screw or paddles to drive the ship. When the piston has travelled as far to the right as it can, the slide-valve shuts off the steam to the side A of the piston, and allows the steam which is already there to escape. At the same time it admits steam to the other side of the piston, and so drives it back towards the left, the two motions thus causing the crank G to complete the full circle round the crank shaft. It is a little difficult to understand, perhaps, but if you watch any engine at work you will be able to see what I mean.

When it is required to move the crank in the reverse direction—or, in other words, to go astern—the slide valve is so adjusted that the steam is admitted to the opposite side of the piston. The slide valve is moved by means of the eccentrics across the parts for admitting the steam into the cylinder, but its action can be more easily understood by looking at the diagram opposite.

In the sketch the engine is going ahead, or moving in the direction of the hands of a watch, and the slide valve is moving forward, and is just about to cut off the steam from the right-hand side of the piston, which is moving towards the left. When the piston has reached as far to the left as it can go, the eccentric will have turned and will have pulled the slide valve so that steam will be admitted to the left of the piston, which will then be driven to the right again. This motion will go on so long as steam is admitted to the cylinder, and the action of letting in and cutting off the supply of steam to the piston is automatically controlled by the regular motion of the slide valve.

We cannot here mention all the various improvements which have taken place in marine engines since they were first instituted, so we will confine ourselves, as far as possible, to a general description of the various types of engines found in vessels now afloat.

It was in about 1856 that Messrs. Randolph Elder and Co. first brought out the idea of compounding the engines, as it is called. The great advantage of this system lay in the fact that the consumption of coal was practically halved, and the principle involved consisted of the expansive qualities of the steam being utilised. Early compound engines usually had two cylinders, and the steam entered the smaller one at a

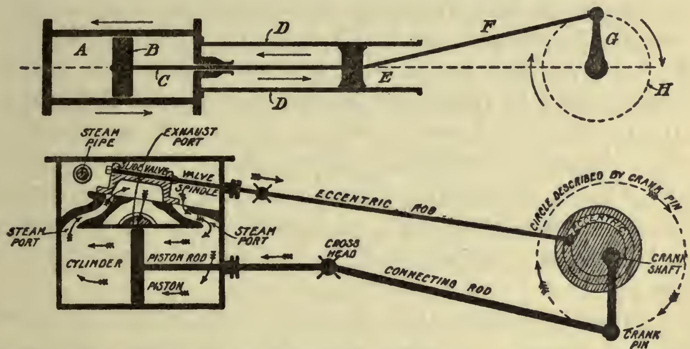


DIAGRAM SHOWING THE ACTION OF A MARINE STEAM ENGINE

high pressure, and then, after doing its work in moving the piston, escaped at a lesser pressure into the larger cylinder, where it did more work before it was passed into the condenser and converted into water again.

The modern triple-expansion engines are worked on much the same principle. The steam enters the smallest cylinder at a high pressure, and when the latter is half filled the supply of steam is automatically cut off by the slide valve, and the expansion of the steam completes the stroke of the piston. Having done its work in the small cylinder it goes on, at a lesser pressure, to work in one of larger size, where the same thing occurs. Having completed this it proceeds to a third still larger or low-pressure cylinder, and does more work, and then it is finally passed into the condenser, and thence back to the boiler. This is what is known as a "triple-expansion engine." A "quadruple-expansion engine" is one in which the steam passes into a fourth and still larger cylinder, and does still more work before entering the condenser.

I have talked about the condenser, so perhaps I had better explain what it is, in case you are not quite clear on the point. The water used in boilers is always, or ought to be, fresh, for if salt water, containing a certain proportion of solid matter is boiled, a scale will be formed inside the boiler, which will detract largely from its efficiency besides doing a lot of damage. Fresh water on board a ship is a valuable commodity, for although a distilling plant, which will make fresh water from that drawn direct from the sea, is installed in all modern steamers, it is advisable to economise as much as possible, and it is done in the following way.

When the steam has done its work in the cylinders of the engine it passes into the condenser, where it comes into contact with the outer surfaces of a number of tubes, inside which cold salt water is circulating. The steam encounters the cold surfaces and is chilled, and after falling to the bottom of the condenser in the form of water, it is pumped into a tank by means of an air pump. From here it passes through a filter to have any oil or other impurities extracted, and then goes on through what are called "feed heaters," where it is heated up to practically boiling-point by means of exhaust steam from the auxiliary engines. It finally reaches the boiler again, and thus the same water is used again and again for making into steam.

Triple or quadruple expansion engines are generally found in all modern screw steamers not fitted with turbines.

Propelling Machinery

Modern paddle vessels are usually fitted with either "oscillating" or "diagonal direct-acting" engines. The former species can be built in a very compact form, and engines of this type are well suited for working at low pressures, and at the small number of revolutions necessary for working the paddle-wheel. For the higher number of revolutions necessary for driving a screw, the oscillating type of engine is not suitable, and many examples of this type of engine take steam at a pressure of 35 lb. to the square inch, whereas triple and quadruple engines for modern screw steamers work at anything between 250 and 350 lb. to the square inch. The cylinder of an oscillating engine is usually placed below the crank shaft, and is carried on two trunnions at about the middle of its length, so that it is free to oscillate. There is no connecting rod, and the piston rod works directly on the crank, so that the cylinder moves to follow the motion of the latter. By this means space is economised, which is often a great consideration.

The "diagonal direct-acting" engine has its fixed cylinders placed diagonally at an angle to the shaft, and has connecting rods to transmit the motion of the piston rods to the cranks. It takes up more space than the oscillating engine, but is suitable for working at a higher pressure of steam than that type, the consequence being that it is largely used in modern paddle steamers.

The Turbine for Marine Purposes

It is not much more than about fifteen years ago that the now well-known Parsons turbine for propelling ships first came before the notice of the public. There are, of course, other types of turbine in existence, notably those of the Curtis, Rateau and Zoelly types, but as by far the greater number of turbine-driven craft now afloat are fitted with the Parsons turbine, we will confine ourselves to its description. It was in 1894 that the Hon. Charles A. Parsons formed a company to build the little *Turbinia,* which created such a furore at the Diamond Jubilee Review of 1897 by steaming up and down the lines of anchored men-o'-war at a speed of nearly 34 knots. She was the fastest boat in the world, and the British Admiralty were not slow to see the possibilities of the new invention, and before long ordered two torpedo-boat destroyers, which were to have turbine engines and a speed of 36 knots. Now, however, that record has been beaten, for in 1907 the turbine destroyers *Swift* and *Tartar* steamed at 38.3 and 40.2 knots respectively.

The two destroyers I have mentioned as having been ordered by the Admiralty were the *Viper* and *Cobra,* both of which craft have since been wrecked; while the first comparatively large man-o'-war to be turbine driven was the third-class cruiser *Amethyst,* launched in 1903 and completed two years later.

As regards the mercantile marine, the first turbine passenger vessel to be built was the *King Edward,* constructed in 1901. She was a small passenger craft, 250 feet long and 30 feet broad, destined for use on the Clyde, and her new-fashioned engines gave her a speed of 20.48 knots on trial. In 1902 another turbine steamer, the *Queen Alexandra,* was built. She was of much the same type as her predecessor, but with increased power, and on her trials attained a speed of 21.63 knots. The success of these Clyde vessels led to the adoption of turbines for the later Calais-Dover and other cross-Channel steamers, as well as for many yachts and other craft of comparatively small tonnage. To the Allan Line the credit is due for having first installed turbines upon the Transatlantic service, and in 1903 the *Victorian* and *Virginian* were contracted for, and commenced their career some two years later. These ships had a displacement of 12,000 tons, and with their three screws, driven by separate sets of turbines, maintained an average sea speed of 17 knots, while on their trials they did 19.2 and 19.8 knots respectively. The first turbine Cunarder was the *Carmania,* which commenced running in 1905, and she had a displacement of 30,000 tons, while her three screws, driven by three separate turbines, gave her a speed slightly over 20 knots on her trials.

The success of the first turbine-driven vessels soon proved that the new method of propulsion was suitable, and now turbines are fitted in all modern British men-o'-war, from torpedo boats up to battleships, while many of the larger vessels in the mercantile marine, such as the *Mauretania, Lusitania, Laurentic* and *Olympic,* many yachts, cross-Channel and river steamers, besides numerous new vessels now in the process of being built, are or will be driven partly or entirely by turbines.

The Parsons turbine is quite a simple contrivance, and consists of cylinders on the inside of which are fixed a series of blades known as the fixed or guide blades. On the shaft running through the cylinder are fixed another series of blades known as the rotor blades, and these project into the spaces between the guide blades. The steam comes into the cylinder, and finds itself checked by the fixed blades, labelled A in our sketch. Its direction is then, so to speak, changed until it follows the dotted line in the sketch, and it is projected on to the first row of moving or rotor blades in the shaft, and as it is at a very high pressure it follows that the rotor blades are moved to the right in the direction of the arrow seen passing through them. After impinging on the rotor blades B it is deflected on to the next ring of fixed blades marked C; from these to the next series of rotor blades, and so on until the steam finally leaves the turbine through the large exhaust port. Our sketch is, of course, a bird's-eye view, but it will enable the action of the steam to be understood. In actual turbines the blades vary in diameter, and the steam, entering at a very high pressure, first works through a series of small diameter blades; it then goes on at a reduced pressure to blades of a larger diameter, and so on, its final energy being expended on a series of very large diameter blades.

Triple or quadruple screws of comparatively small diameter are fitted to turbine-driven craft to get the best results, and though in the larger vessels each propeller shaft has its own set of engines, it is often the case, where a vessel has not to be driven at a very high speed, that the centre screw or screws are driven by a high-pressure turbine, while the two wing propellers are worked by low-pressure turbines. These low-pressure worked shafts are usually fitted with a high-pressure turbine to work the propellers astern, for, unlike an ordinary reciprocating engine, a turbine cannot be reversed.

The *Olympic* is an excellent example of a ship fitted with a successful combination of turbines and reciprocating engines. This idea spells economy, for the two outer screws are driven by ordinary engines, and the centre one by a low-pressure turbine, using the steam after it has passed through the reciprocating engines. The idea really resolves itself into a means of getting extra work out of the steam before it is passed into the condenser. The turbine, of course, only drives ahead, and when it is desired to go astern the steam supply to the latter is cut off, and the reciprocating engines drive the wing screws astern in the ordinary way.

To round off our description of the turbine it may be interesting to give a few particulars of the enormous low-pressure turbines of the *Olympic*. The rotor itself is 12 feet in diameter and nearly 14 feet long, while it has a weight of about 130 tons, the turbine complete weighing 420 tons. The propeller driven by the turbine is solid, built of manganese bronze with four blades, and has a diameter of 16½ feet. It is designed to run at 165 revolutions a minute with 16,000 shaft horse-power, but in high-pressure turbines, fitted in very fast craft such as torpedo-boat destroyers, the propeller revolves far more rapidly.

The turbine has the following advantages over the reciprocating engine. It is more economical, for a greater speed can be obtained with the same horse-power; it is smaller, lighter, less liable to breakdown, causes far less vibration, and can be kept lower down in the vessel's hold than a reciprocating engine, and thus at the present time it is undoubtedly the best method of propelling a ship, either man-o'-war or merchant vessel. Truthfully, it may be said that the turbine has been one of the most marvellous engineering triumphs of the present epoch.

Internal Combustion Engines

A chapter on propelling machinery would hardly be complete without a mention of the internal combustion engine as applied to the propulsion of ships, both large and small, men-o'-war and merchantmen.

During the last few years the application of this method of driving vessels of moderate size and power has met with a marked degree of success, and before long we shall probably have both large liners and men-o'-war propelled in this way. Engines of the internal combustion variety have many advantages over others, the most important of which—in men-o'-war, at any rate—is that boilers and funnels are not necessary.

The internal combustion engine is also said to be far more economical in the consumption of fuel, and consequently it is not surprising that marine engineers are of the opinion that a great future lies before the new method of propulsion. Even now there are comparatively large vessels successfully propelled by internal combustion engines, the Danish ship *Selandia* being a very good example. Also, as we all know, many yachts and small vessels are motor driven, while auxiliary motor lifeboats, sailing yachts, fishing boats, etc., are by no means rare. All the submarines in the British Navy have internal combustion engines, and it is said that the Admiralty have actually ordered a torpedo-boat destroyer driven in the same way. Even within the last few years what are commonly called "motor boats" have greatly increased in number, and these are all driven by comparatively small internal combustion engines, and have, for their size, remarkable speeds.

An attempt to forecast the future is not, as a general rule, a very profitable undertaking, but without a doubt the internal combustion engine for marine purposes has come to stay.

Let us now turn our attention to the boiler and the fuel used in it, which, with a striking similarity to the rhyme of "The House that Jack built," makes the steam in the boiler, which supplies the engines, which transmit the power in rotary form to the screws or paddles, which drive the ship to any place in this world where she may be required to go.

Marine Boilers

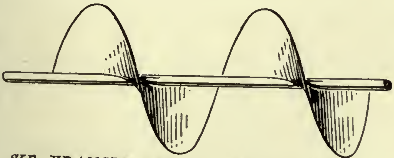
The first marine boiler to be built—a good example being that fitted in the *Comet*—was nothing more or less than an ordinary iron tank filled with water, and set in brickwork. The fire for boiling the water was outside, while the steam pressure was about 15 lb. to the square inch. It was soon found that with the fire outside it took a very long time to raise sufficient steam to drive the engine, and before long the furnace was fitted inside the boiler, with the advantage that the latter had the water all round it, which therefore boiled far more quickly. This was what was known as a "box" boiler, for it was rectangular in shape, and it continued in use until about 1845 or so. The greatest steam pressure it could stand, however, was between 35 and 40 lb. to the square inch; and soon afterwards the idea of utilising tubular boilers for marine purposes suggested itself. Before this time locomotive boilers had been fitted with tubes, but there was, at first, rather a strong feeling against high-pressure boilers on board ships, for they were considered dangerous.

However, in time the steam pressures gradually increased with the speed of steamers, but it was not until about 1870 that the "Scotch" cylindrical boiler was introduced. This type has survived until the present day, and even the *Mauretania* and *Lusitania* are fitted with them. The boiler of this type is cylindrical in shape, and may be as much as 18 feet in diameter and 20 feet long. It may be either single- or double-ended—that is, fixed from one end or both ends—and the number of furnaces may be two, three or four for a single- or four, six or eight for a double-ended boiler.

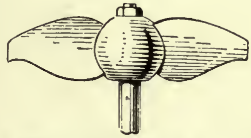
We give a sectional sketch of an ordinary cylindrical Scotch boiler, which will help you to realise how it works. The furnace, as you will see, is a corrugated cylinder inside the boiler itself; and it is corrugated for two reasons—firstly, for strength, and, secondly, to increase the heating surface. Inside the furnace is the grate or fire bars, on which the fire is laid. This grate is terminated at its inner end by the bridge, while at the back of the boiler is the combustion chamber, in which takes place the combustion of the gases given off by the burning fuel. The fire in the furnace is laid upon the fire bars, and the ashes fall through into the ashpit, from where they can be removed as necessary. From the ashpit, also, a current of air passes up into the fuel through the spaces between the fire bars, and thus makes the coal burn better. From the combustion chamber the heated gases pass through the tubes seen in the sketch into the uptake, and thence to the funnel. It will thus be seen that there is an enormous heating surface, for the grate, combustion chamber and tubes are all in contact with the water, which in our sketch is shown shaded. The *Mauretania,* in her twenty-three double-ended boilers, has no fewer than 159,000 square feet of heating surface, and it will be understood that the water is converted into steam very rapidly, and that there is a great pressure in the boilers—something like 220 lb. to the square inch. The steam collects in the top above the water, and from here it is drawn off to the engines by means of a valve.

The double-ended cylindrical boiler is really one large boiler containing two single-ended ones placed back to back, the principle, however, being exactly the same as in that just described. The combustion chambers are variously arranged, for some boilers have one into which all the furnaces lead, while in others each separate furnace has its own combustion chamber. We must not omit to mention another class of boiler which, though rarely used in vessels of the mercantile marine, is found in practically all the modern vessels of the Royal Navy. I refer to the water-tube type.

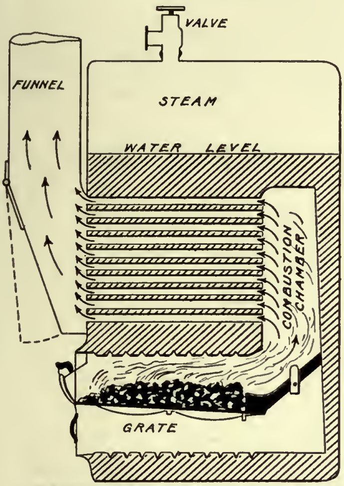
A boiler of this kind, as its name implies, has the water in the tubes instead of outside them, and has the property of being able to generate steam far more rapidly than one of the Scotch type. In the latter it takes from six to nine hours to raise steam, whereas



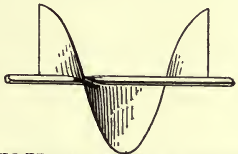
SIR FRANCIS PETTIT SMITH'S FIRST SCREW PROPELLER.



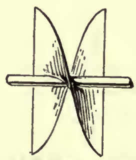
A TWO-BLADED PROPELLER OF THE OLDER TYPE.



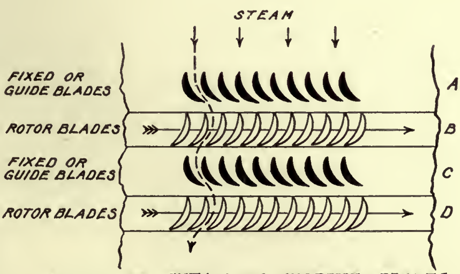
ROUGH SKETCH OF SINGLE ENDED SCOTCH BOILER.



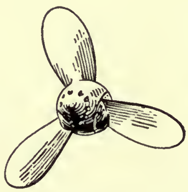
SCREW PROPELLER WITH SINGLE CONVOLUTION AS FIRST FITTED TO 'ARCHIMEDES'.



DOUBLE THREADED SCREW PROPELLER AS SUBSEQUENTLY FITTED IN 'ARCHIMEDES'.



ACTION OF STEAM ON TURBINE BLADES.



A MODERN PROPELLER.

PROPELLING MACHINERY.

in water-tube boilers two hours, or even less, will suffice for this purpose. A water-tube boiler can also withstand a higher pressure, and is much lighter, for it does not contain the large amount of water the Scotch boiler does. It has its disadvantages, however, for it is said to require far more care in management, while there is an idea—whether it is correct or not we cannot say—that the water-tube boiler is not quite so reliable as the older type for regular long-distance running. For these reasons few of the vessels of the British mercantile marine carry the boiler of this type, but in the French Messageries Maritimes it has been installed in many ships.

The celebrated Belleville boiler was the first of the water-tube type to come into existence, for in 1879 it was adopted in some of the French men-o'-war, while since that date, and commencing in 1893, it has been fitted in many British war vessels. On its introduction into our service there was a great deal of discussion as to its suitability, and in 1900 a special committee was appointed with the idea of arriving at some decision as to the best boiler for British men-o'-war. After carrying out a series of exhaustive trials and experiments lasting till 1904, the members of the committee satisfied themselves that the water-tube boiler was satisfactory, and recommended the Yarrow and the Babcock and Wilcox boilers of this type as being the most suitable for the large ships of the Royal Navy.

The consequence is that practically all large vessels of the navy are fitted with boilers of the two species mentioned, while some others have those of the Niclausse or Dürr type. For torpedo-boat destroyers and other small, fast craft there are a number of varieties of other boilers of the water-tube kind in use, and among these may be mentioned the Thornycroft, Reed, White and Normand types. The system of all water-tube boilers is very similar, and instead of the heat from the furnaces passing into the combustion chamber and thence through tubes to the funnel, the water itself is inside the tubes, while the heat and flame is all round them.

The Yarrow boiler is constructed in triangular form, the base being formed by two large drums, which contain the water to be converted into steam. Between these drums come the furnaces, while stretching from the drums into what is technically known as a "steam drum," forming the apex of the triangle, so to speak, are large numbers of tubes. The flame has free access to the outer surfaces of these, and there is then a very large heating surface which generates steam very rapidly. In the Babcock and Wilcox water-tube boiler the straight, sloping water-tubes connect a number of water boxes of square section and sinuous outline, which are in turn connected to a cylindrical upper drum half-filled with water and half with steam. The furnaces, as in the case of other boilers, are fitted below the tubes.

Before concluding the subject of modern marine boilers, there is another matter we should mention, and that is the method of creating the necessary draught to make the fires in the furnaces give off the requisite heat. There are various methods of doing this. Sometimes the boiler-room is airtight, and what is known as "forced draught" is employed. This consists in pumping air into the stokehold by means of fans until the pressure there is greater than that in the outside air. The air under pressure naturally seeks to escape, and does so by rushing in through the ash-pits of the boilers, through the fires, which it fans into great heat, until it finally passes through the boiler and up through the funnel. Forced draught is especially valuable in the navy, for it permits of great power and high speed being obtained in cases of emergency with comparatively small and light engines suitable for lower speeds under ordinary draught.

Sometimes the furnace and ashpit are closed in, air being forced in under pressure; while another system, which consists of heating the air before it enters the furnace, is largely used in the vessels of the mercantile marine. Another plan is to pull air through the furnace by means of an appliance in the base of the funnel, but all these different schemes have the same object in view.

As regards the fuel for marine boilers, coal is, of course, the principal substance used. The employment of liquid fuel, however—a species of crude petroleum—is becoming more common day by day; but its one disadvantage lies in the fact that it is more expensive than coal. It is largely used in the navy, however, and many of our destroyers and torpedo boats burn nothing but oil fuel in their furnaces, while various larger vessels can also use it. It has one great advantage in that the shovelling of the coal into the furnaces is done away with, for the oil, after being heated, is sprayed into the boiler from a series of jets which are lighted in the ordinary way.

CHAPTER XI

Shipbuilding and Launching

The building of a ship, unlike that of a house ashore, is always imbued with a certain romance which it is very difficult to define. A vessel is always regarded by sailors as a living being, with a distinct personality of her own, and not as a mere steel or wooden shell fitted with engines or sails to drive her to any part of the world. The mere fact of a ship invariably being referred to as "she" is a proof that this is so.

A house, on the other hand, is never referred to except as "it," and of a truth there is certainly little romance in the building of a modern semi-detached suburban villa, though a true romance does exist in every ship which sails the sea, be she ancient or modern, cheap or expensive.

It is a wonderful thing to see a vessel in the process of construction, and to visit her day by day and to note the progress made. For the first few months the structure bears little resemblance to the craft she will eventually be, but as the work progresses, and the skeleton is clothed in its steel covering, the hull begins to assume its definite shape. It is marvellous to think that the enormous masses of steel which go towards the building of a ship are fashioned and put together by men's hands, but it is still more wonderful to realise that this same structure will, in the course of time, be able to go to any part of the world and that her strength will be pitted against the terrific might of the limitless ocean.

Shipbuilding and Launching

Before a ship is built there are many things to be considered. Her size, speed and cargo capacity have to be decided upon, according to the work for which she is intended, and all the various strains and stresses she will have to withstand at sea have to be calculated as nearly as possible and allowed for. When all this has been done, detailed plans or drawings are prepared by the staff of draughtsmen attached to the shipbuilding yard, and in these drawings are shown the structural arrangements of the proposed vessel, with the thickness, distance apart, etc., of all the various plates and frames clearly set down. If the vessel is to be "classed" at Lloyd's, the plans are sent to the registry, where, after taking into consideration the work for which the vessel is intended, the structural arrangements are closely scrutinised and checked to make sure that the ship will have an ample margin of strength. You have probably all heard of the expression: "A1 at Lloyd's," but beyond knowing that a ship classed as A1 is a good and seaworthy vessel, you do not, perhaps, fully realise what it means.

Ships are built for innumerable purposes, and you will understand that it would be absurd to build a cross-Channel passenger steamer, for instance, which has to carry nothing but mails, passengers and luggage, with the strength necessary for a vessel intended to carry 3,000 tons of cargo. What is done, therefore, is to ensure that each ship is strong enough to do her own particular work, and that she shall not be loaded down beyond a certain limit which would make her dangerous.

Ships are built which are not classed by Lloyd's, but it by no means follows that unclassed craft are badly built or unseaworthy. It is usual, however, for shipowners to have vessels built to the highest possible class in their respective types, but a ship may not always remain in the same class. Every four years Lloyd's require vessels classed with them to be subjected to special surveys, and if a ship is found to have deteriorated, she is put in a lower class, which simply means that she is not allowed to carry the same amount of cargo as she did when new.

After the plans of the new ship have been inspected, they are sent back to the builders with any alterations which may be considered necessary, and from this time onwards Lloyd's surveyors are constantly watching the vessel as she is in the process of construction. The steel of her hull and frames must be of a certain quality; the surveyors will satisfy themselves that all the frames, plates, etc., are of the correct dimensions, and, in fact, they exercise a general supervision to see that the workmanship is satisfactory. At the same time as the ship is being built the engines and boilers are under construction, and these are examined in the same way. Other fittings, such as masts, wire rigging, anchors, cables, etc., all have to be of a certain strength as laid down by Lloyd's, and when the vessel is finally completed all the watertight compartments, bulkheads, decks, etc., are well tested. The person owning the vessel is then given a certificate of registry, on which is written the class in which the ship is entered and various other details, such as the number of passengers, amount of cargo, etc., allowed to be carried.

Before the passing of the Load Line Act in 1890 the overloading of ships was a great source of danger, and many vessels and lives were lost through this cause. In all vessels of the present time the Board of Trade ensure that a maximum load line shall be fixed for each vessel strictly in accordance with her strength, and the limit to which she may be immersed under varying conditions will be found painted on the side of practically every British ship afloat except men-o'-war; this mark is what is generally called the "Plimsoll Mark." A shipowner who has a vessel built under these conditions, then, has a guarantee that everything is as it

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ON THE STOCKS—THE STERN OF THE "MAURETANIA."

should be, and as the ship is periodically inspected, he knows whether or not she is deteriorating as time goes on. The majority of vessels, as you all probably know, are insured when they go to sea, and the class she is in gives the underwriters—or insurers—the only guarantee that she has the necessary strength for the work she has to perform.

Now as to the actual building of the ship herself. The original plans are drawn, as a rule, to a scale of a quarter of an inch to the foot, and after having been worked out on paper, they are "laid off," as it is called, by being drawn upon the floor of a large building known as the "mould loft." When laid off, the various frames, beams, decks, etc., represented in the transverse section of the vessel are reproduced the full size in which they will eventually be embodied in the ship. What is known as a "scrieve board" is then prepared, and this consists of a rectangular wooden area built up of planks and large enough to take a full-sized representation of the 'midship section of the ship being built. The section of every transverse frame of the vessel as drawn on the mould loft floor is then transferred to the scrieve board, where its exact shape is cut into the wood. The scrieve board is then taken to pieces, and is transported and re-erected in the shop in the building yard, where the frames, floor plates, etc., are to be prepared, and the workmen can ascertain what particular bend there has to be in each bar of steel which goes towards making the framework of the ship.

In the mould loft, also, are prepared full-sized wooden templates, or patterns, of all large forgings or castings, such as the stem post, stern frame, rudder frame, etc., and these patterns are then sent out to the manufacturers of the various parts, so that they, too, may proceed with the work. It may be of interest to mention that the stern frames of the *Olympic* and *Titanic* were the largest and heaviest that had ever been made.

They were constructed of mild cast steel by the Darlington Forge Company, the total weight of the casting being 190 tons, the stern frame being 70 tons, the side propeller brackets 73¼ tons, and the forward boss arms 45 tons. The height of the stern frame was just over 67 feet. The rudders of the *Olympic* and *Titanic* were also constructed by the Darlington Forge Company, and were of solid cast steel built up in five sections. The total weight is 101¼ tons, while they are 78 feet 8 inches long, and 15 feet 3 inches wide. The illustrations, which have been kindly supplied by the owners of these ships, Messrs. Ismay, Imrie and Co., will give a good idea of the enormous size of the castings necessary for these very large modern vessels.

As soon as the laying off is well in hand, and the material begins to arrive, the blocks on which the vessel will be built are put in place. These blocks are of very tough timber some four to six feet long, and are placed in piles at varying distances apart, according to the weight of the ship being built. They must be high enough to allow men to work underneath the ship's bottom, and their tops slope towards the water's edge in a gradient of half an inch in one foot, so that the ship may be easily launched when the time comes.

In the building of a ship, the first part of her to be laid is the keel. This, in the case of men-o'-war and large merchant vessels, consists of wide, horizontal plates running along the centre line of the bottom and throughout the whole length of the ship from bow to stern. These flat keel-plates are then joined together, and form one continuous bar. Immediately on top of the flat keel-plates, and in the centre of the vessel, is fitted the vertical girder known as the keelson, which runs throughout the whole length of the ship. The keelson is secured to the keel-plates below and to the plating forming the inside of the double bottom above, and the building of the cellular double bottom, intended for carrying water ballast at sea, is then commenced. All large steamers have double bottoms, or two skins on the bottom of the ship, for besides being available for the carrying of water ballast, the double skin forms an additional safeguard if the ship runs ashore, for the outer surface may be pierced without damaging the inner bottom, water thus being precluded from entering the ship.

The frames or ribs, which have been bent as already described, are now brought to the building slip and erected, and the beams joining the opposite ribs are then hoisted into place and secured. These beams support the steel deck-plating, which, like the top of a box, gives extra strength to the ship. Before the deck-plating is put on, however, the bulkheads, or partitions dividing the ship off into various compartments, are placed in position.

The heavy stem post and stern frame are secured as soon as possible. The stem post is the cast-steel bar extending from the keel up to the highest deck, and to this the shell plating forming the outer skin of the ship is attached at its forward end. The stern frame is at the after end of the ship, and in it are the supports for the screw shafts and the connections for the rudder, which is, as a rule, not fitted until later on. The shell plating is secured to the stern frame in the same way as it is to the stem post.

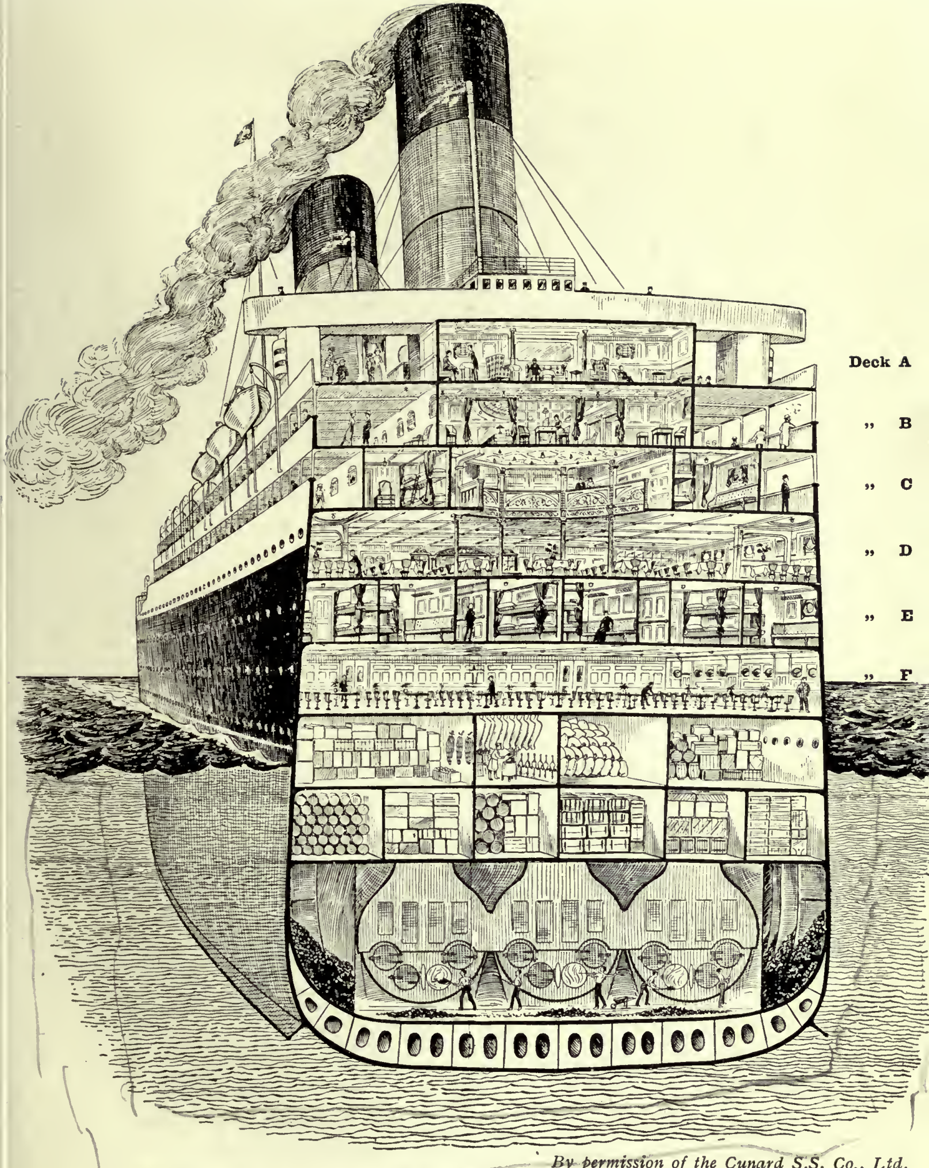
When the framing of the ship has made sufficient progress, the outside, or shell-plating, is riveted in place. The steel plates are sometimes as long as 48 feet and weigh as much as 5 tons, and these are riveted to the frames and to each other. It is interesting to note that no less than 4,000,000 rivets, weighing almost 800 tons, were used in the construction of the *Mauretania*.

After the plates have been riveted their edges are caulked to make them watertight, and when this has been done the interior woodwork, bulkheads, decks, etc., is put in place, and various deck fittings, such as steam winches, etc., are fitted. The ship is then thoroughly cleaned and painted inside and out, and when this is done she is ready for launching.

During her building, as I said before, the ship has been resting on the keel blocks, but as the day of her launching approaches an army of workmen has been busy building the launching ways, or wooden slides, extending from the bow of the ship for some distance into the water. These launching ways are really long wooden slides to guide and support the ship while she travels down the slope into the water. Attached to either side of the bow and stern of the ship are wooden "cradles," and the lower surfaces of these rest on the launching ways or slides, and they are fitted to support the fine ends of the ship where her bilge, or bottom, is not more or less flat.

On the day of the launch the weight of the ship is transferred from the blocks upon which she has been built to the launching ways, and this is done by a host of men who drive in wedges to lift the great mass bodily off the stocks. The ways, or slides, are then scraped clean and anointed with a liberal coating of tallow and soft soap to lessen friction, and the ship is now ready to be launched, for she is only held in place by a number of props known as "dog shores."

The launch of a ship is always a splendid sight, and thousands of people congregate to see the vessel take the water. A launching platform is erected near the bows of the vessel, and here are assembled the christening party with the lady who is going to name the ship. In the case of a man-o'-war built at a Royal dockyard a religious service is always held, and when this is over the lady of the launch breaks a gaily decorated bottle of wine across the massive steel stem,



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TRANSVERSE SECTION OF THE CUNARD LINER "CARMANIA."

Deck A—Promenades and Lounge.
,, B—Promenades, Drawing Room and State Rooms *en suite.*
,, C—Promenades, State Rooms, and Dome of Saloon.
,, D—Dining Saloon.
,, E—Second Class State Rooms.
,, F—Third Class Accommodation.

and at the same time christens the ship and wishes success to her and all who sail in her. An electric button is then pressed, or a rope cut with a chisel, and this brings into operation some mechanical means for freeing the dog shores to release the ship. Once free, the great mass seems to hang for a second or two as if unwilling to leave the place of her birth; but she soon starts moving slowly down the well-greased ways. The speed quickens rapidly, and amid the cheers of the assembled crowd and the blowing of the steam whistles of all the ships in the harbour the new ship glides into the water.

The launching weight of a modern battleship is from 8,000 to 10,000 tons, for she has none of her guns, armour or fittings on board, but the launching weight of the great Cunarder, the *Mauretania,* was 16,800 tons.

As may be imagined, a huge mass of this weight gathers a great momentum in travelling down the ways, but the ship is brought to rest after being launched either by the dropping of anchors or by a series of wire hawsers made fast to the ship and secured to weights or anchors embedded ashore.

When once safely afloat the ship is taken charge of by tugs, and is taken to the berth where she will be completed, for there is still an immense amount of work to be done before she is ready for sea. Engines, boilers, masts, funnels, and a thousand and one other things have to be fitted in place, and it may take a full year before this is done. After this come the plumbers, joiners and electricians to do their work, and they are succeeded by the decorators, painters, upholsterers and cleaners, until finally the ship is ready to make a trial trip at sea. During her trials she is tested on the measured mile to ascertain her speed, and exhaustive experiments are carried out to ascertain the number of revolutions and the horse-power necessary for certain speeds, and the different amounts of coal burnt for the various horse-powers obtained. Finally, when these trials have been satisfactorily concluded, the ship is handed over to her owners, and before long will start off on her maiden trip across the ocean.

Such, in a brief form, is the way in which a vessel is built and launched, and the next time you see a large battleship or liner I hope you will be able to realise, to a certain extent, what a vast amount of work she really represents and what an immense amount of care, forethought and ingenuity has been bestowed upon her construction.

The building of a ship is, I think, one of man's most marvellous achievements, and the work which goes on every day in the many British shipyards and dockyards is such as I have described. Without these shipbuilding facilities the Royal Navy and Mercantile Marine of this great empire could not hold the premier position they now do, and when it is realised that we not only build for ourselves, but also for foreign countries, it will be understood that the British shipyards are a very valuable asset, and contribute largely both to the safety and welfare of our country in so far as regards our maritime preponderance of power.

CHAPTER XII

Equipment of a Modern Vessel

Ships built of steel or iron are classed by Lloyd's Register as A1, with a numeral prefix, such as 100 A1, 90 A1, 85 A1, etc. Vessels are also classed A1 without a numeral for special trades, and these latter retain their character so long as, on being annually surveyed, they are found to be in a fit state to carry dry and perishable cargoes. Every ship is specially surveyed every four years, or oftener in some cases. Wooden vessels are classed as A1 (the highest class) for a certain number of years, subject to annual surveys. They are also, however, classed A1 in red, and this is a class of vessel suitable for the safe conveyance of dry and perishable goods. Wooden ships used for conveying dry and perishable goods on shorter voyages are classed AE1.

Load-Line Marks

By the Merchant Shipping Act of 1894 all British vessels of over 80 tons register, except fishing boats and yachts, must be marked with certain load-lines. These "Plimsoll marks," as they are sometimes called, after the name of their originator, consist of a circle with a horizontal line running through the centre. In addition to this, there are, in some cases, a number of lines running at right angles to a perpendicular, which indicate the depth to which the vessel may be loaded for different seasons of the year in various localities and in fresh water. In these load-line marks, F.W. means "Fresh Water," I.S. "Indian Summer," S. "Summer," W. "Winter," and W.N.A. "Winter North Atlantic."

Fig. 1 shows the symbol on the starboard side of a sailing ship employed in the coasting trade, while Fig. 2 shows that on the starboard side of a seagoing sailing vessel. Fig. 3 shows the markings on the starboard side of an ordinary steamer.

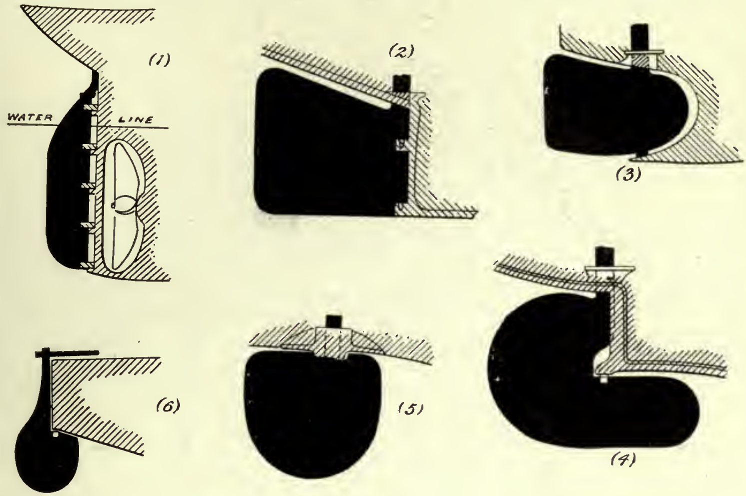
In all these symbols the line running through the circle shows the limit to which the vessel should be loaded under ordinary conditions, while the perpendicular line with its horizontal markings shows the load-line under special conditions. It will thus be seen that if a steamer is going on a winter voyage across the North Atlantic she has more freeboard (that is, she carries less cargo) than if she is going on an ordinary summer passage where calm weather might reasonably be expected.

Submarine Sound-Signalling

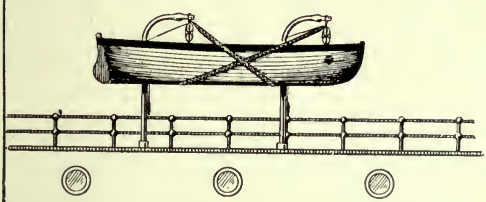
Water, as is well known, carries sound four times more rapidly than air, and as long ago as 1826 a scientist experimented with an under-water bell on Lake Geneva. He achieved, however, no practical results, and the great efficiency of water as a sound-carrying medium was not fully utilised until some ten years ago.

There are various kinds of submarine bells now in use, but they are all fitted for one purpose, and that is for warning vessels in time of fog of their approach to danger.

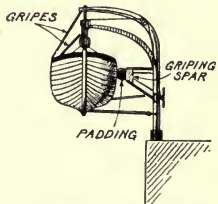
The bell may be suspended from a buoy worked by the water, or it may be hung from a tripod



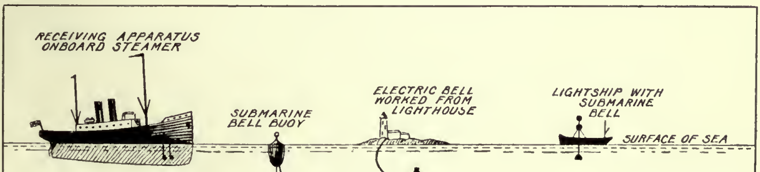
RUDDERS.



A BOAT HOISTED AT DAVITS.



SKETCH SHOWING HOW BOAT IS SECURED AT SEA.



DIFFERENT TYPES OF SUBMARINE SIGNALS.

EQUIPMENT OF A MODERN SHIP—I.

placed on the bed of the sea and worked by electricity from a lighthouse or station ashore. The bell may again be suspended under water from the side of a lightship or other vessel, and is operated by means of compressed air apparatus, which will ring it a certain number of times at regular intervals. One station or lightship will give, perhaps, two rings every ten seconds, another four rings every fifteen seconds, and in this manner an infinite number of variations can be made.

The most wonderful part of the invention, however, is the receiving apparatus fitted aboard many modern vessels to enable the ringing of the submarine bells to be heard. The appliance consists of two tanks about 22 inches square filled with sea water and fastened securely to the inside skin of the ship well below the water-line, one tank being on the starboard and the other on the port bow. Inside these boxes are delicate instruments known as microphones, capable of detecting the slightest sound, and these are connected to the navigating bridge by means of telephone wires, with two sets of ear-pieces attached to their ends. Two officers on the bridge can thus place the ear-pieces to their ears and listen for the submarine signal, and when once they have heard it the turning of a switch will tell whether the sound is coming from port, starboard or right ahead.

It has been proved in actual practice that a submarine bell can be heard in a ship travelling at a high speed and 15 miles off the source of sound, a distance at which the most powerful steam whistle or syren would be inaudible. The invention is a thoroughly practical one, and, moreover, the apparatus is so simple that it came into use very rapidly, and at the present time many lightships, lighthouses, etc., work submarine bells, while the majority of large vessels are fitted with the receiving apparatus.

Rudders

The rudder is perhaps the most important fitting in a vessel, for upon its skilful use the safety of the ship, crew and passengers often depends. Two general types of rudders, known as "ordinary" and "balanced," are fitted to present-day steam vessels. Ordinary rudders have the whole of their area abaft their axes, and Fig. 1 shows an ordinary rudder as fitted in a single-screw steamer, and Fig. 2 that fitted in many of the older battleships and cruisers of the Royal Navy.

In the sketches the rudder is shown in black. In Fig. 1 it will be noticed that a certain portion of the rudder is above the water-line, and this fact renders the use of a rudder of this sort impossible in a man-o'-war, for it might be damaged by the enemy's shot. Ordinary rudders fitted in warships, therefore, are usually shaped like that shown in Fig. 2, which is entirely under water.

Many large merchant steamers still have ordinary rudders, but all men-o'-war built at the present time have those of the balanced type, in which about one-third of the total area is fitted before the axis. This makes the rudder much easier to move, for the water rushing past the side of the ship as she moves ahead tends to help it over, and the consequence is that the steering engines need not have so much power.

Figs. 3, 4, 5 and 6 show different varieties of balanced rudders. Fig. 3 shows that fitted in many of the older cruisers, Fig. 4 the shape of the rudder fitted in later cruisers and in the battleships of the "Lord Nelson" class, while Fig. 5 is that fitted in all the latest men-o'-war. Fig. 6 shows the sort of balanced rudder fitted in torpedo boats and destroyers. Many merchant vessels are fitted with balanced rudders, two well-known instances being the *Mauretania* and *Lusitania*.

Equipment of a Modern Vessel

Steering Gear

One of the most irksome and monotonous duties of the modern sailor is the steering of the ship, or taking a "trick at the wheel," as it is usually called. In all large vessels special men, called quartermasters, do this duty, and in the Royal Navy the spells at the wheel last four hours, though in many of the large liners the men are relieved every two hours. Whilst steering the ship the man's whole attention must be concentrated on his work, and he must do his best to keep the "lubber's line" on the compass bowl—representing the ship's head—in line with the exact degree on the compass card which it is desired to steer.

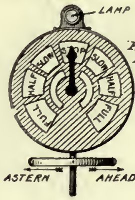
You have probably noticed the man at the wheel in some ship or another, and you will have seen how he twirls the wheel to port or starboard to keep the vessel on her course. In old-fashioned steamers and present-day sailing ships the steering was and is done by hand, and in the latter craft in bad weather it is no unusual thing for four men to be necessary for working the wheel to keep the ship on her course. All modern steamers, however, are fitted with steam-steering engines, and the helmsman, when he moves his wheel, works an engine down below which supplies the power to move the rudder from side to side. On the bridge there is a tell-tale or arrow head moving across an arc graduated in degrees, which shows to what angle the rudder is over, so the present-day quartermaster has an easy job compared with his predecessor of half a century ago, for all he has to do is to work the wheel while the engine below does the rest.

Still, steering a large ship is by no means the easy matter some people imagine, and it takes a very good man to keep a steamer steady when there is a heavy sea running on the quarter which tends to throw her off her proper course. Here is a good place to explain the orders "Starboard!" and "Port!" as applied to the steering of a ship. If the captain or officer on watch says "Starboard!" he means that he wishes the ship's head to go to port—i.e. that the wheel is to be put to port, for the vessel's head travels the same way as the wheel is put—which will put the tiller to starboard and so turn the vessel to the left. If he says "Port!" exactly the opposite takes place. These seemingly contrary orders are peculiar, but nevertheless they are always heard in British ships. In France, however, if a pilot says "Port!" he means he wants the vessel's head to go to the left, or port; and it is well to remember this, for in the two countries the same orders mean exactly opposite.

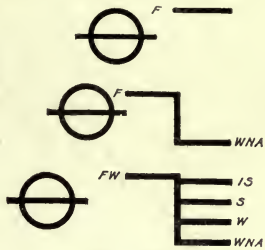
Watertight Doors

In another chapter we have said something about the watertight compartments into which a modern man-o'-war or liner is subdivided, so that the risk of losing the ship by collision or grounding is lessened; and we have shown how ships are so well thought out with regard to their watertight subdivision as to be almost unsinkable. Modern battleships, as we have said elsewhere, have their transverse bulkheads carried up well above the water-line, and as these have no openings of any kind in them, people going from one compartment to another have to go on deck and then down again. In earlier men-o'-war watertight doors gave access to the different compartments, but in various accidents these were found to be unsatisfactory, so the system of continuous transverse bulkheads was adopted.

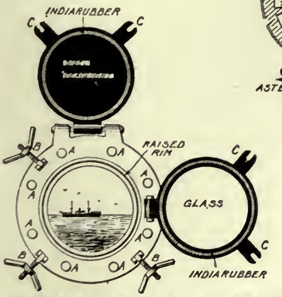
The watertight doors fitted in a modern liner are most ingenious and extremely interesting. By the sinking of the *Titanic,* which was believed to be



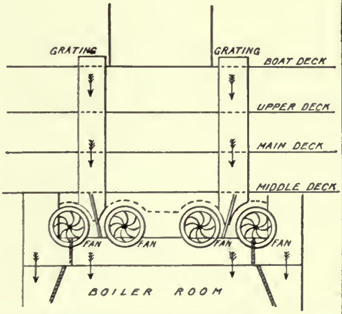
FACE OF ENGINE-ROOM TELEGRAPH.



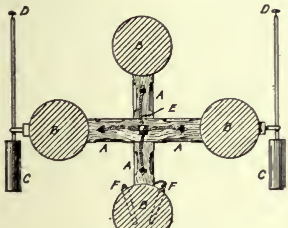
LOAD LINES.



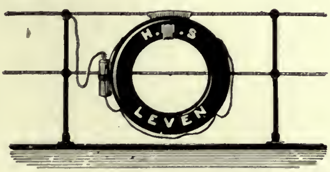
SKETCH SHOWING HOW A SCUTTLE OR PORTHOLE IS MADE WATERTIGHT.



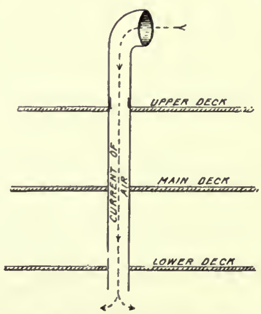
SKETCH SHOWING THE METHOD OF VENTILATING A BOILER ROOM.



NIGHT LIFEBUOY.



AN ORDINARY LIFEBUOY FITTED WITH HOLMES' LIGHT.



ORDINARY VENTILATING COWL.

EQUIPMENT OF A MODERN SHIP—II.

unsinkable, public attention was forcibly attracted to the subject, and the value of these watertight doors has been questioned. As an example, therefore, we will describe those giving communication between the various engine and boiler rooms of the White Star liners *Olympic* and *Titanic*. They are fitted on the drop system. When open, each door is held in place by a friction arrangement, which can instantly be released by means of a powerful electric magnet controlled from the navigating bridge. In the event of an accident, therefore, the captain or officer of the watch can instantly close every watertight door in the ship by turning an electric switch, the doors themselves being fitted with oil cataracts, which govern the closing speed. In addition to the above, each door can be closed from below by means of a lever fitted in connection with the friction clutch, and, as a further precaution, floats are fitted below the floor level, which, in case of water accidentally entering any of the compartments, automatically lift and thus close the doors opening into the compartment.

To prevent men being imprisoned below through the closing of the watertight doors, ladders or escapes are fitted in each boiler room, engine room and other watertight compartment, while another device causes electric bells fitted near each watertight door to ring before they are closed, thus giving warning to those below.

Although no ship can be said to be actually unsinkable, there is no doubt that in the most modern vessels the danger of immediate foundering after collision or grounding is largely minimised, thanks to the excellent system by which they are partitioned off into watertight compartments. The unfortunate *Titanic* had a great portion of her side torn away in her collision with the berg, but even then the watertight compartments served to keep her afloat for some time.

Scuttles

It may sometimes have occurred to you to ask how the scuttles or portholes in the side of a ship are made watertight in bad weather when they can no longer be left open.

The scuttle consists of a cast steel ring bolted to the inside skin of the ship, and this ring is fitted with a raised rim, shown in the sketch, and the use of which will be explained presently. On one side is a brass frame with a glass in it, fitted with a hinge, and this can be swung across the opening and secured in place by fitting the butterfly nuts marked B into the clips marked C and then screwing them up. The act of screwing forces the raised rim against the india-rubber ring on the brass frame and thus makes a watertight connection.

In men-o'-war what is called a "deadlight" is usually fitted above the scuttle itself. This is for preventing light from showing outside the ship, as well as for preventing damage being done when the heavy guns on board are fired. The deadlight consists of a hinged steel disc fitted with clips, and it can be screwed down over the frame with the glass in it, the watertight joint being made by an indiarubber ring being forced up against a raised rim fitted on the frame with the glass in it.

Bilge Keels

What are known as "bilge keels"—that is, keels fitted on either side of the vessel below the water-line—are found in practically all men-o'-war except those of the very smallest type. In the mercantile marine, however, they are not so extensively used, for at one time it was thought the fitting of bilge keels reduced speed, while they were also liable to damage during docking.

Several large liners are fitted with bilge keels, however, and among them may be mentioned the *Campania, Lucania, Mauretania* and *Lusitania*.

Bilge keels, as their name implies, are fitted on the bottom of the vessel at the turn of the bilge, and vary in width from 9 to 42 inches, while they vary in length from one-third to one-half the length of the ship. They prevent excessive rolling by the resistance offered to the water when the ship heels over, and their use in warships was brought about to procure a steady gun platform. In experiments carried out some years ago in the battleship *Revenge*, the 13.5-inch guns were trained alternately from side to side, and before bilge keels were fitted produced a roll of 13 degrees; after bilge keels had been fitted it required the training of the 13.5-inch guns and the moving to and fro across the ship of 400 men to obtain a roll of 8 degrees, so it will be seen that bilge keels have a great effect in checking rolling.

Ventilation

The question of efficiently ventilating a large vessel is necessarily a matter of vital importance, for fresh air, besides being necessary for the crew and passengers down below, must also have free access to provision rooms, cargo holds, etc. In older ships you will probably have noticed the ventilating "cowls," as they are called, which scoop up the air and pass it below. Some of these cowls, more particularly those leading to the boiler rooms, had electric or steam-driven fans at their bases to suck down the air from above, but in other places the large hollow head of the cowl was turned towards the wind and scooped up enough air for the purpose of ventilation. In modern ships the ventilation is done almost entirely by means of large centrifugal fans driven by electricity or steam, and which, working in shafts, keep up a constant circulation of air throughout the whole vessel. In the stokeholds, where the air is pumped in under pressure to create forced draught, the system is rather complicated, but the large fans suck the air through a shaft and pump it into the boiler room. The large ventilating cowls noticeable in earlier vessels have gone, and their place has been taken by the outwardly invisible and more effective electric and steam-driven fans.

Loading and Unloading Cargo

All large steamers have either derricks or cranes which, in conjunction with steam or electric winches, are used for loading or unloading cargo. In the *Olympic* there are three cargo hatches forward and three aft. Two of the foremost hatches are served by steam winches, while the third is served by two electric cranes capable of lifting 2½ tons. The first hatch in the after part of the ship is served by electric cranes designed to lift 1½ tons, while the two aftermost ones have 2½-ton electric cranes for working their cargoes. The lifting speed at full load is 160 feet a minute in the case of the 2½-ton cranes and 200 feet a minute in the case of those lifting 1½ tons. In addition to the electric cranes, there are four 3-ton electric cargo winches at the various hatches, also four 15-cwt. electric boat and baggage winches.

The majority of ordinary steam tramps do not, of course, have the same facilities for working cargo as do the larger cargo vessels, for they are usually fitted with steam instead of electric winches. Fig. 1 shows one method of hoisting cargo out of the hold of a tramp by means of derricks and steam winches. The derricks are strong wooden spars hinged to the foot of the mast, and they are topped up by means of the topping lift until the head of the derrick is directly over the hatchway leading to the hold. The whip (of strong, flexible wire rope) is rove, as seen in the sketch, and on the winch being hove round, the bale is hoisted until it is clear of the edge of the hatch. The guy marked A is then slackened off, and that marked B hauled in, the consequence being that the hinged derrick travels round until it reaches over the side of the ship, when the bale is lowered into the lighter or on to the wharf alongside. In some cases guys are done away with, for they require either men or winches to work them, and the derrick can be made to work automatically by reeving the whip as shown in Fig. 2. The bale is hoisted right up to the derrick head, and then, as it can go no farther, the wire rope, acting through the block on the ship's side, pulls the derrick round until the bale is hung over the side of the ship. The bale is then lowered in the ordinary manner, and on the weight being released the derrick automatically returns to its original position over the hatch.

Still another method of working cargo with two derricks is shown in Fig. 3. One derrick is topped up over the hatch and the other reaches over the side of the ship. The bale is hove up by the derrick over the hatch, and when it is high enough a man takes a turn on the winch drum with the whip led through the block at the head of the derrick swung out over the side, and the original one is slacked away until the bale is in the position marked in the sketch with dotted lines. It is then lowered into the lighter or on to the wharf in the usual manner.

There are many different ways of working cargo, and in the case of coal or grain the cargo is poured into the hold through a sort of funnel. Grain is also unloaded by means of a suction apparatus. When a ship, however, has a cargo of grain made up in bales or cases, the methods described above are very frequently seen in use.

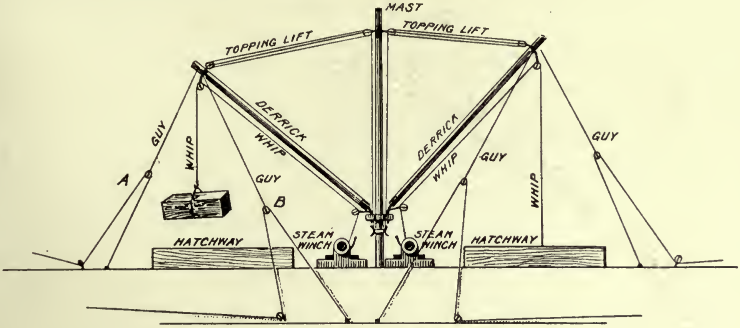
Boats

The Merchant Shipping Act of 1894 provides that the Board of Trade may make all the necessary rules with regard to the number of lifeboats that must be carried by British ships. This, of course, varies according to the nature of the voyage and the number of passengers accommodation is provided for; but the rules are rigidly enforced, and the master of every vessel is further charged that he must satisfy himself that the boats and other life-saving appliances are in efficient condition and that they are kept ready for instant use.

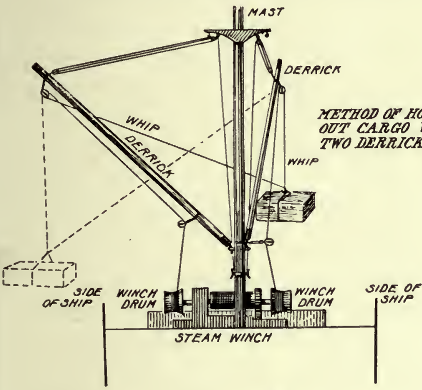
In the well-known steamship lines, such as the Peninsular and Oriental, Cunard, White Star and many others too numerous to mention, boat drill is carried out at frequent intervals, when all the boats are manned —and, if possible, lowered into the water—while their equipment, such as oars, masts, sails, lowering falls, etc., is examined. The *Titanic* disaster, however, showed that still further legislation was necessary, for previous to that lamentable occurrence large liners were frequently not supplied with enough boats to carry the whole of their passengers and crew.

In spite of the Board of Trade regulations, moreover, the boats in many coasting and other small vessels are very often in anything but an efficient condition. How often do we see boats in these sorts of craft turned inboard and lashed, or else filled with odds and ends of rope, etc., which it would take a long time to clear out if the worst came to the worst?

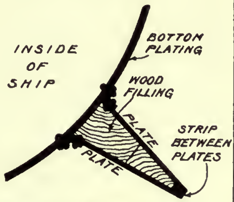
As a case in point, a small sailing ship was once loading in the West India Docks, and she had two boats



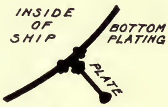
SKETCH SHOWING HOW CARGO IS HOISTED OUT WITH DERRICKS USING GUYS.



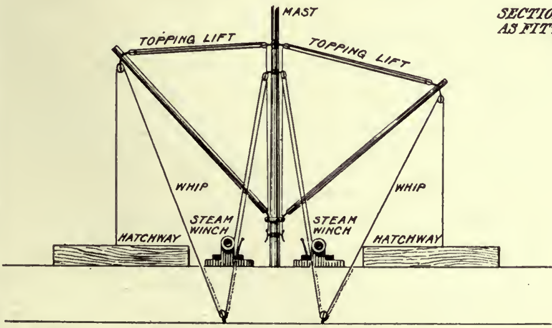
METHOD OF HOISTING OUT CARGO WITH TWO DERRICKS.



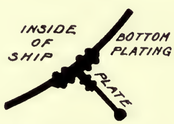
SECTION OF BILGE KEEL AS FITTED IN A LARGE WARSHIP.



SECTION OF BILGE KEEL AS FITTED IN A SMALL WARSHIP.



SKETCH SHOWING HOW CARGO IS HOISTED OUT WITH DERRICKS WITHOUT USING GUYS.



SECTION OF BILGE KEEL AS FITTED IN A MERCHANTMAN.

EQUIPMENT OF A MODERN SHIP—III.

—a lifeboat stowed inboard on chocks amidships and a small gig in davits on the quarter. The lifeboat was full of odds and ends of ropes, spare sails, etc., put in her to be out of the way, and when the Board of Trade inspector visited the vessel he told the master that davits would have to be provided for the lifeboat. The skipper objected, saying he did not want two boats in davits; but the inspector informed him that if the orders were not carried into effect the vessel would not be allowed to put to sea.

The skipper therefore had the necessary alterations made, and in due course the ship went to sea. She was scarcely out of sight of land, however, when the carpenter was set to work to replace the boats in their original positions, and the old tub went serenely on her way with the lifeboat full of rubbish and quite useless for the purpose of saving life if the vessel happened to be wrecked.

In the majority of large vessels boats are hung from davits, the upper parts of which are curved so that the boats overhang the water. The davits themselves are pivoted so that the boats can be turned in or out as necessary. In all men-o'-war and large steamers one boat on either side is always kept turned out in case anybody falls overboard; and when in this position the boat is secured by means of gripes. These gripes are usually bands of canvas which stretch from the head of one davit to the foot of the other, and, one being hauled taut, they keep the boat tight against the padded "griping spar"—a spar running between the davits of an outrigger —and so keep her from knocking about with the motion of the ship. There have been cases where ships have been wrecked, and the lives of the passengers and crew have been saved by the boats, so it will be understood what an important matter their efficiency is.

Lifebuoys

The most common type of lifebuoy is that with which you are probably all familiar, the small, circular "Kisbie" lifebuoy. These buoys are distributed round the upper decks of ships and are hung in conspicuous places ready to be used at a moment's notice in case of necessity. The older buoys are filled with cork, and are consequently rather heavy; but now a new substance called "Kapok" has been introduced, and the buoys filled with this are far lighter and easier to throw, while there is less chance of a man in the water being injured if one is dropped on top of him.

When buoys of this kind are required to be used at night, a cylinder containing calcium, or Holmes' light, is lashed to one side of it, as shown in Fig. 1. Into the top of this cylinder is secured a brass eye, to which is attached one end of a strong line, the other end being made fast to a stanchion. The buoy is thrown in the ordinary way, and the line pulls the brass eye out of the top of the cylinder, the preparation inside thus coming into contact with the water. The action of the water causes the calcium to create a gas, which bursts into flame on reaching the air, and thus the whereabouts of the buoy can be seen at night, whilst in the daytime the dense smoke created denotes its position.

The night lifebuoy as supplied to all large men-o'-war consists of a large copper replica of the Kisbie buoy, or one of the type shown in Fig. 2. It is suspended in a sort of frame placed somewhere in the after part of the vessel, and is let go by pulling a metal knob which releases a trigger and allows the buoy to slide off into the water. When the buoy falls, the extracting rods remain behind and tear the sockets out of the calcium light cylinders, and this allows the water to enter and ignite the calcium lights, which show the position of the buoy. In one of the copper globes there is a whistle, for attracting attention, and some spirits for a man in the water to sustain himself with.

Engine-Room Telegraphs

In all vessels the navigating bridge is always connected to the engine-room by means of telephones or voice pipes, but in addition to these there are the engine-room telegraphs by which the orders to the engineers are given. The telegraph on the bridge—there are two if the vessel is driven by twin screws—consists of a brass pedestal, on the top of which there is a dial graduated as shown in the sketch. At the side there is a wheel with a handle, and for each revolution of the wheel the position on the telegraph moves one order in the same direction as that in which the wheel is revolved. The motion of the pointer is transmitted to a similar pointer and dial in the engine-room by means of shafting and cogwheels, so that those working the engines get the orders. The different orders, "Full," "Half," "Slow," etc., are let into the brass face in white letters on a red glass ground for the port telegraph, and on blue glass for the starboard telegraph, and this enables them to be used at night, for a lamp shines up through the coloured glass and shows the position of the pointer.

In some merchant ships there are similar telegraphs connecting the navigating bridge with the forecastle and stern of the vessel; but, instead of "Full," "Half," "Slow," etc., the orders are "Heave," "Slack," "Let go," etc. These telegraphs are for the benefit of the officers working the hawsers forward and aft when the vessel is anchoring or leaving or going alongside a wharf, and their use does away with a great deal of noise, for the orders are transmitted without shouting.

CHAPTER XIII

Docks and Dockyards

DRY docks, or places where ships can lie free of the water for repair or for the examination of the underwater portions of their hulls, are undoubtedly of great antiquity, and in the first instance probably consisted of holes sufficiently large to hold the ship dug in a convenient mudbank. The hole would be open towards the sea, and at high water the vessel would be floated in and moored. When the tide fell, the water would run out, leaving the ship high and dry, and a wall or dam could then be built across the entrance to prevent the water coming in when the tide again rose. When the repairs had been finished, the wall would be demolished and the ship floated out. Mud docks of this description are still frequently used in some parts of the world, but the digging of them necessarily entails a great deal of labour and is a costly and lengthy proceeding.

At the present time there are various kinds of docks, but they all come under two general headings:

(*a*) Docks in which ships can lie to embark and discharge their cargo.

(*b*) Docks in which ships are cleaned and repaired.

Docks coming under the heading (*a*) can be again divided into groups: wet docks and tidal docks.

The former are basins or docks with a small opening, the water being kept at a constant level by means of a watertight obstruction, such as a gate or "caisson" placed across the opening. Docks of this kind are used in places where there is a great rise and fall of the tide. The illustration shows this, for it will be seen that the water is imprisoned inside the dock by means of the watertight caisson across the entrance, while outside the entrance the water will not be of the same depth. A caisson, which, by the way, is pronounced "casoon," consists of a boat-shaped structure made of steel. The diagram shows a caisson in position across the mouth of a dock; it is fitted with watertight decks, and has compartments full of air, which give the whole structure its necessary buoyancy. Into other compartments water is pumped to sink the caisson to its required depth. The structure is first floated into place with no water in this space, and when it is in its correct position the water is pumped in until it reaches its proper level. The keel then fits into a groove at the bottom of the dock. When the water is pumped out of the dock, the pressure of the outside water forces the edge of the keel against one side of the groove, while the projections at the side take up against angles on the dock walls, and in this position it is practically watertight, the slight leakage being negligible.

A tidal dock is the same as a wet dock except that it is used in a place where the rise and fall of the tide is comparatively small and there is no caisson across the entrance. The ships in it, therefore, rise and fall with the state of the tide.

Docks in which ships are cleaned and repaired are usually known as "dry" or "graving" docks, and these are cut out of the earth and are lined with masonry. There are also other kinds of docks, known as "floating" docks, but these will be described presently.

The sides of a dry dock are sloped to allow of the docking of ships, and are cut into steps. On the bottom, at short intervals apart, are wooden blocks, on which the vessel eventually rests. What happens when a ship is to be docked is as follows: The gates are opened or the caisson removed, and the vessel enters and is placed over the blocks. The caisson is then put in place, and the water pumped out of the dock, and as it subsides the ship settles on the blocks at the bottom, while she is kept upright by long spars called "shores," the end one of which are placed in the steps in the side of the dock, and the other against the vessel's hull. Very powerful pumps are used to eject the water, and in the case of some of the largest docks in Portsmouth Dockyard they can be pumped dry in less than two hours.

Messrs. Swan, Hunter and Wigham Richardson have kindly placed at our disposal an excellent photograph of a typical graving dock with a ship in it. In the bottom are the powerful blocks on which the weight of the vessel is taken, while the sides are cut into steps, into which are fitted the shores or spars used to keep the ship upright. The general plan is similar to that of the floating dock shown on the plate at page 216, only, instead of being built of steel, it has been cut out of the land and lined with stone.

In most of the large dockyards communication with dry docks is effected as follows: The ship first goes into the tidal dock, the water in which, you will remember, rises and falls with the tide. In the entrance to the wet dock (see plate) there is a caisson, and when the tide has risen high enough to make the water level in the tidal dock the same as that in the wet dock this caisson is removed, the ship taken into the wet dock, and the caisson once more put in place. As the water in the wet dock always remains at the same level, the ships in it can be moved about independently of the state of the tide outside in the tidal dock, and they can thus be taken into the dry dock at any time.

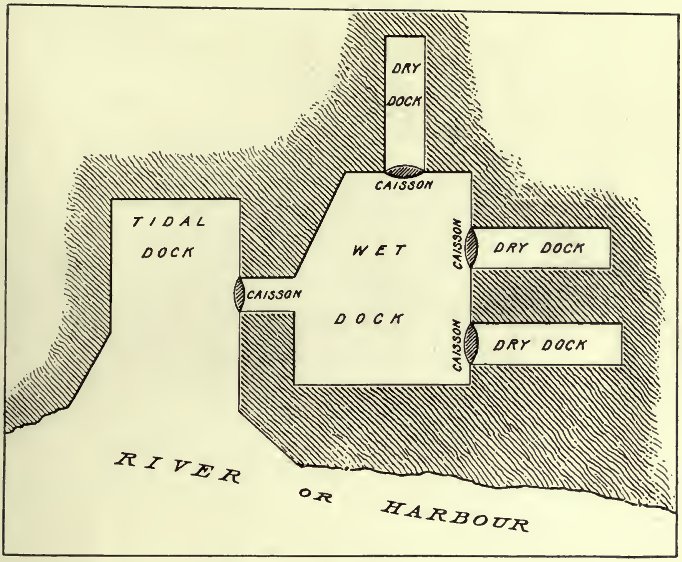


DIAGRAM OF A DOCK.

By permission of the Great Western Railway Co.

A PASSENGER TENDER.

Docks and Dockyards

Floating Docks

Until the latter half of the nineteenth century little progress had been made in the design of floating docks, the earliest type used being merely an old hulk with the decks and beams removed and a gate fitted at the stern end. At the present time, however, there are large numbers of floating docks in use.

Floating docks may be generally divided into two classes, those which are self-docking and those which are not. The latter are those in which the side walls cannot be detached from the pontoon or floor, nor can they be taken apart in any way. If it is necessary, therefore, to repair or scrape the under-water portions of docks of this kind, the entire structure must be treated like a ship and placed in an ordinary graving dock, which is a great disadvantage.

A "self-docking" dock is one which is divided into sections, any one of which can be lifted on to the remaining portion of the dock for painting or repairs. There are three different types, all of which I will describe separately:

The "Havana" type is so called from the dock built by Messrs. Swan, Hunter and Wigham Richardson for use by the Spanish Government in Cuba. In this species of floating dock the two side walls are continuous, but the bottom is divided into three portions, which are attached to the walls by means of bolts. The famous Bermuda Dock, built for the British Admiralty, has an extreme length of 545 feet and a breadth of 126 feet, and has a lifting capacity of no less than 17,000 tons. Water, of course, is pumped into the pontoons and hollow side walls until the whole structure is nearly submerged, only the tops of the U just appearing above the surface. The ship is then floated in and placed on the blocks seen running along the bottom of the dock, and the water is gradually ejected, the ship and dock rising as the water is pumped out, the vessel, of course, being shored up during the process.

Another class of self-docking floating dock is the "sectional pontoon" type, and this, as its name implies, consists of two continuous side walls, which rest on and are bolted to a number of separate pontoons lying transversely to the length of the dock. The length of each pontoon is so arranged that when it is detached it may be passed endwise into the remainder of the dock, and so lifted for repairs like an ordinary ship A "bolted sectional dock" is the latest improvement, and this is also of the self-docking type.

Still another important kind of floating dock is the "off shore" type. This is one whose transverse section is L-shaped. It is connected to the shore by hinged booms to give it the necessary stability. A dock of this type is divided into two parts, and, having only one wall, one-half can be lifted in the lap of the other, so to speak.

Floating docks have many advantages over ordinary graving docks, for in the former width does not matter, whereas in a graving dock the entrance has to be made as small as possible in order that the caisson or gate shall not be too large and unwieldy. A floating dock, also, can take a ship of any draught, whereas in a graving dock the depth of water at the entrance limits the size of the ship to be taken in according to her draught. Ships of a greater length than the dock itself can be lifted, a feat which is obviously impossible in a graving dock, and a floating dock 174 feet long has lifted a ship with a length of 334 feet. When a small ship is placed in a dock built of masonry, the whole dock has to be pumped dry so that the vessel may be allowed to enter. In a floating dock, however, the structure need only be submerged to a sufficient depth for a small ship to enter, and this lessens the amount

By permission of Messrs. Swan & Hunter, Ltd., Wallsend-on-Tyne

FLOATING DOCK.

of water which it is necessary to pump out. Another great advantage of floating docks is their mobility, for they can be towed to any part of the world. The Bermuda floating dock, for instance, was towed 3,900 miles to its destination; while another one built by Messrs. Swan, Hunter and Wigham Richardson was towed 8,000 miles to Durban in Natal. Others have been towed to Egypt, the West Indies, West Africa, the west coast of South America, etc.; while, if it is impossible to tow them to their destinations in a completed state, they can be transported in sections and erected on arrival.

Floating docks can be constructed in an incredibly short time, whereas graving docks have taken as long as seven years to complete. To give an example of this, a German firm at Stettin required, at short notice, a dock 510 feet long to lift 11,000 tons. Messrs. Swan, Hunter and Wigham Richardson undertook the contract, and within fifteen days the drawings had been completed and the dock commenced. The completed structure, with all machinery on board, was launched within seven and a half months, and within eight and a half months of the subject first having been mentioned the dock had been towed across the North Sea and had arrived at its destination. Small docks have been completed within a shorter time, and the same firm constructed two 230-feet docks within thirteen weeks of the first plate being laid.

There is practically no limit to the size of floating docks, and the enterprising Messrs. Swan, Hunter and Wigham Richardson have built enormous floating docks of the box type for the Admiralty. These gigantic structures are 680 feet long, 144 feet broad, with a lifting capacity of no less than 32,000 tons. This enormous structure will be able to take the largest and heaviest men-o'-war now afloat with a more than ample margin of safety.

Naval Dockyards

The three great naval dockyards of the United Kingdom are situated at Portsmouth, Chatham and Devonport, while there are smaller establishments at Pembroke Dock, Portland, Haulbowline and Dover. Another dockyard is also in process of being built at Rosyth, on the Firth of Forth. At many places abroad—Gibraltar, Malta, Bermuda, the Cape of Good Hope, Ascension, Hong Kong, Sydney, Wei-hai-wei, etc.—there are also dockyards, or smaller depots, or coaling stations.

All these dockyards and depots are provided for the repair and maintenance of His Majesty's men-o'-war alone, while, in addition, warships are built at the home yards. It does not necessarily follow, however, that every man-o'-war is built in a royal dockyard, for there are various large shipbuilding firms, situated on the Thames, Clyde, Tyne and other places, who are always at work building warships of the largest type, while other firms are employed in the construction of torpedo craft and other small vessels for the Royal Navy.

The engines, boilers, guns and armour of dockyard-built vessels are usually supplied by private firms, and they are sent to and put into the ship at the place where she is built.

The dockyard at Portsmouth is the oldest in existence in this country, for it was established by King John early in the thirteenth century. It was more fully developed by Henry VII., while the first dry dock was constructed in 1495, and was capable of taking the largest man-o'-war then afloat. At that time Portsmouth was practically the only royal dockyard, and the majority of the King's ships, including galleys, pinnaces and row-barges, were stationed there.

During the seventeenth and eighteenth centuries further developments were carried out, and since those days the yard has been getting larger and larger to cope with the increased number of vessels in the Royal Navy and their greater tonnage. Dockyards at Woolwich and Deptford were founded by Henry VIII., and many famous vessels were built there. These yards, however, are now no longer used, and that at Deptford is utilised as a victualling depot. Queen Elizabeth founded the dockyard at Chatham, and Charles II. extended it to Sheerness, while in the latter part of the seventeenth century the dockyard at Devonport was commenced. Pembroke Dock started shipbuilding in 1815, while Haulbowline yard was created in 1778, and enlarged in 1865. It cannot, however, be said to have been a proper dockyard until 1885, for in that year the first dry dock was constructed.

In addition to the dockyards, there are gun and ammunition depots at Portsmouth, Devonport and Chatham, and these are responsible for the issue of the weapons and their ammunition to the ships of the fleet as they require them.

Naval hospitals are situated at the three great naval ports, and also at Portland, Haulbowline and various other places at home and abroad, and these minister solely to the officers and men of the Royal Navy. There is also a lunatic asylum for naval cases exclusively at Yarmouth.

At Deptford, as said before, is situated the principal victualling yard, and here is manufactured much of the biscuit, cocoa and other provisions ultimately issued to the ships of the fleet through the local victualling establishments. Such of the provisions as are supplied by contract are sent to Deptford, where they are carefully tested and examined before being served out for use.

The importance of the good and efficient work done by the personnel of the royal dockyards can never be over-estimated. Practically all the repairs to the men-o'-war of the Navy are done at Portsmouth, Chatham, Devonport and at various places abroad, and they are invariably carried out with the least possible delay. The vast amount of organisation required can be imagined, but our British dockyards, when put to the test, have never yet failed to do what was required of them, and we may well congratulate ourselves that the finest navy in the world is kept in an efficient condition by the ministrations of the best and most complete dockyards ever known.

CHAPTER XIV

Wrecks and Salvage

THE two most frequent causes of disaster at sea are undoubtedly collision and grounding, although, of course, there are other ways in which a ship can be lost, such as by leak, capsizing or fire. Nowadays, however, modern science has provided safeguards against the risk of a vessel being destroyed by the last three causes, so they are, happily, not nearly so frequent as they used to be.

Capsizing, however, is by no means unknown, particularly in sailing ships, while among steamers we have the recent case of the *Waratah,* which went to sea and was never heard of again. There are many ways in which she may have been lost, but public opinion usually supposes her to have capsized.

Fire at sea is still a danger which cannot be sufficiently guarded against, and it can originate in many different ways. Cotton and wool are very dangerous cargoes—even more so, perhaps, than oil and gunpowder—and if they are stored damp, and subsequently become heated, they are liable to take fire from spontaneous combustion, in the same way as hayricks often do ashore.

A case in point is a fire which broke out on board the White Star liner *Celtic* towards the end of 1909. The ship was in mid-Atlantic when it was discovered that the bales of cotton in one of her holds were alight. Steps were instantly taken to prevent the flames from spreading, and the hold was tightly closed to exclude all air, while steam was admitted to drown the flames which were eating their way through the inflammable cotton. The crew were set to work strengthening bulkheads and getting ready to cope with the fire should it extend still farther; but, luckily, it was kept under, and the great liner arrived at Liverpool, where the fire was speedily extinguished by shore appliances. The most remarkable thing about the whole affair, after the prompt and effective measures taken for confining it, was the fact that not one of the passengers knew until afterwards that it had occurred, for the captain and his officers, in spite of their terrible anxiety, went about among the passengers as if nothing unusual had taken place.

In September, 1909, also, a fire broke out on board the Cunarder *Lucania,* which was lying in dock at Liverpool. The fire brigade soon arrived on the scene, and it was found that the first-class saloon was alight from end to end. Fire engines and mains were soon pouring in water, but, in spite of the fact that 20,000 gallons per minute were being pumped into the burning ship, the flames spread rapidly, and, working forward, consumed every particle of woodwork. It was eventually decided to let water into the dock as the only way of saving the vessel, and, on this being done, the great ship heeled over and seriously damaged her funnels as she did so. She was eventually righted, and the fire successfully extinguished, but the vessel was so badly damaged, both by the flames and water, that the Cunard Company were forced to sell her out of their service. This instance only shows that a fire, if it is once allowed to gain the upper hand, can cause an enormous amount of damage even to a vessel with a steel hull.

The gas formed by coal is another fairly frequent source of fire. A case in point was the loss of the coal and iron ore tramp steamer *Tregartha* in 1909. One of her stokers went into a half-empty coal bunker with a naked light, and there was instantly a terrific explosion which started a fire. This eventually caused the total loss of the vessel, in spite of the efforts of the officers and crew to cope with it. Bunker explosions of this kind are by no means rare, for if the coal has been stowed wet, and afterwards becomes heated, it will give off a highly explosive gas.

Undoubtedly, however, the most frequent cause of disaster at sea is either collision or grounding; and fog, that terrible enemy of the sailor, has been responsible for many accidents of both kinds. The rule of the road, designed for preventing collision at sea, has been described in another chapter, and, as will be seen, its strict observance should, theoretically, make such a thing as a collision impossible. Accidents will happen, however, even in the best-regulated families, and frequent collisions only show how very necessary it is that the rule of the road should be most strictly obeyed. Under some circumstances, and more particularly in crowded or narrow waters, it is by no means as easy to obey the strict letter of the law as may be imagined. People are apt to say that, as collisions are comparatively rare in streets, they should be so at sea; but they forget that the heaviest road vehicle weighs practically nothing compared with a ship.

Comparatively recently there have been two serious collisions between liners and men-o'-war, both of which, by a curious coincidence, occurred in the Solent. We all remember the awful collision between the second-class cruiser *Gladiator* and the American liner *St. Paul,* which took place on April 25, 1908, off Yarmouth, Isle of Wight. The *St. Paul* was outward bound, and ran into the *Gladiator* during a snow blizzard. The sharp bows of the liner penetrated the side of the cruiser as far as the centre of the deck, and the stricken warship, in a sinking condition and heeling over, was run ashore in shallow water, where she turned over and settled down on her side. One officer and twenty-six men were drowned or reported as missing. The recent collision between the *Hawke* and *Olympic* took place only some ten miles to the eastward of the scene of the *Gladiato*r disaster, and though, happily, no lives were lost, great damage was done to both vessels. Collisions between men-o'-war, although they always cruise in close formation and often without lights, are, fortunately, of rare occurrence, but when they do take place they are usually serious. Take the well-known case of the battleship *Victoria,* which sank on June 23, 1893, after having been accidentally rammed by the *Camperdown*. The former sank, taking with her Admiral Sir George Tryon and all but 255 of her officers and men, while the latter was seriously injured, and for a time it was thought that she also would be lost.

The awful circumstances attending the loss of the *Titanic* are still fresh in the public mind, and many have asked whether, after all, the watertight compartments are of any use. This question was effectually answered by the behaviour of the *Olympic* after she was rammed by the *Hawke*. Her watertight compartments kept her from sinking, and those of the *Titanic* enabled that ship to float for two hours after she struck.

In spite of all the latest improvements and devices which tend to make navigation far safer than it was even a quarter of a century ago, there is still a need for the lifeboats round our coasts, and many lives have been saved by them. I have before me as I write a chart of the British Isles on which all the wrecks that have taken place in one year are marked by black dots. Along the east coasts of England and Scotland these dots are thickly clustered, and though in other localities they are not quite so frequent, they are very numerous; and I read that in the year in question there were no fewer than 3,863 vessels lost or damaged round the coasts of Great Britain. As far as could be ascertained, about 318 persons were drowned, while in the same year 486 were saved by lifeboats, so it will be seen that the Royal National Life-Boat Institution does a very important and valuable work.

There are several different kinds of lifeboat in use at the present time, but the one most frequently seen is the "self-righting" type. This craft is very strongly built, and has a large watertight air case at either end to give the necessary buoyancy, while further air cases are fitted on the inside of the gunwale of the boat above the deck. The deck is almost level with the water-line, and underneath this, in the centre of the boat, are fitted a series of "ballast tanks," which are filled with water. Valves for automatically freeing the boat of any water that may come in are also fitted in the bottom, while there is also a drop keel, or two drop keels, for sailing. On the keel on the outside of the boat is more iron ballast. It will thus be seen that all the weight is low down, while the air boxes are higher up, and so, if the boat capsizes, the conditions are reversed, and she rights herself. The tests which have to be undergone by a self-righting boat before she is passed into use are very severe. She must "right" with her masts up and sails set (everything being made fast except the fore sheet), with all her gear on board, with her crew represented by 11-stone weights in place on the thwarts, and with the water ballast tanks both full and empty. There are 182 boats of this kind in use on our coasts.

Non-self-righting boats are generally used in places where they will probably have to go far out to sea, and, broadly speaking, it may be said that it is better, if a boat is to work under these conditions, to lay aside the self-righting principle and to endeavour to attain great buoyancy, stability and speed. A boat of this type is fitted in much the same way as the one previously described, but she has smaller ballast tanks, and, in addition to the air boxes mentioned, has others along her sides inside each gunwale. Her beam is also greater, the ends lower, and her iron keel ballast lighter than those in a self-righting boat; but she is a very fast craft under sail, and over 90 non-self-righting boats are in use, of which the "Watson" type is the most prominent.

A sailing life-boat is fitted with two masts, on which are set a couple of lugsails and a jib made of strong canvas. Five or six oars a side can also be used, however, in case the wind is foul. On the outside of a life-boat, and running right round the hull, will be noted a thick cushion or "wale" of cork enclosed in painted canvas, and this acts as a fender and prevents damage to the boat on her going alongside anything. Below this "wale," and fastened to the hull, is a looped rope, and the loops are for the crew to hold on to if the boat capsizes or for a drowning man to clutch as he is swept alongside.

The Royal National Life-Boat Institution possess four steam life-boats, which are stationed at Holyhead, New Brighton, Milford Haven and Harwich, and in addition there is stationed at Padstow a steam tug which is employed to tow life-boats or to render assistance to vessels in distress who have no chance of getting private tugs. The steam life-boats are very useful at the carefully selected stations where they have been placed, but they are more than twice as heavy as a sailing life-boat, and must therefore lie afloat in harbours not far distant from scenes of frequent wrecks. They are also expensive to maintain. The first two of these craft are propelled by what is called a water turbine, the water being sucked in by a scoop amidships and driven out aft on either side of the hull, thus forcing the boat ahead; if it is required to go astern, the water is driven out of the bows. The idea of having this method of propulsion instead of the screw propeller was that the latter stands a very good chance of being disabled by wreckage or weed, but in the case of the two newer steam life-boats which are driven by screws this possibility is guarded against by placing the propeller in a tunnel some distance forward of the stern, where it is protected. These steam life-boats are built very strongly of steel, and do not lose their stability until they reach an angle of 110 degrees from the perpendicular, while they are divided into watertight compartments and are fitted with the usual automatic valves for freeing the interior of the boat from water. Motor life-boats have now been instituted, and these are said to be a great success, and they are far more economical than the steam craft.

Every life-boat carries a strong anchor and cable to enable her to veer down to a ship wrecked on a lee shore, while a compass, rope of the best quality, grappling irons, life-buoys, lamp, signal lights, an axe, two hatchets and other tools, and an airtight case containing chocolate, biscuits and a bottle of spirits, are also provided. Each member of the crew also wears a life-belt, which is either made of cork or the new substance called "Kapok." This latter is procured from a plant which grows in the Malay States; it is something like cotton, and is far more buoyant than cork and retains its buoyancy longer, while the life-belt filled with it is far warmer and more comfortable to wear than the old-fashioned cork one.

It is impossible here to enter into a description as to how life-boats are launched in different places, for many methods, varying with the local conditions, are employed. In some places they are pushed over greased skids placed on the beach, while sometimes they have to be mounted on a carriage, which is drawn into the sea by horses until the water is deep enough for the boat to be launched. Sometimes, too, regular slipways have to be constructed, from which the life-boat can be slid into deep water.

The Royal National Life-Boat Institution is supported entirely by voluntary contributions, and it behoves us, the inhabitants of the greatest maritime country the world has ever known, to see that the good work is not allowed to suffer through lack of funds.

Besides life-boats, many life-saving stations are maintained round the coasts of the United Kingdom by the Board of Trade. The more important of these stations, of which there are 310, are those at which a complete rocket apparatus is kept; but at innumerable other places are what are usually called "Life-line and Belt Stations." The life-belt is of ordinary pattern, and a 20-fathom line is attached to the man wearing it, the other end of which is held by an assistant. This enables the man in the life-belt to wade out into the water, clamber over rocks, or descend a cliff to the assistance of anyone in danger.

The rocket apparatus is stowed in a wagon or two-wheeled cart kept in a specially built house or shed. It is kept ready for instant use, and frequent exercises take place to ensure all the gear being in good condition. A rocket company consists of 25 men, either coastguard men or "volunteers" enrolled by the Board of Trade, and no men who are in any way connected with a life-boat are allowed to belong to it, the idea being that the rocket apparatus and life-boat will be required at the same time. They are paid at the rate of 2s. 6d. for every exercise, while the Board of Trade gives a "Life Prize" of £1 for every life saved by the apparatus.

Briefly described, the contrivance consists of a rocket machine, from which the rocket is fired; the rocket line, a flexible rope 250 fathoms long (three of these being carried), which is made fast to the rocket stick; a whip, a hawser, an iron tripod, an anchor, a breeches buoy, a cliff ladder, and a heaving cane, besides various signalling lights and tools.

Suppose a wreck has taken place. The rocket company are assembled by the firing of a gun, and proceed with the cart or wagon to the neighbourhood of the ship in distress. When all the gear has been unloaded, the rocket is fired with the line attached so that it will fall across the deck of the vessel. The shore end of the line is then made fast to the tail block of the whip, and the people on board the wreck haul in the rocket line until the whip block is on board. To this whip block is attached a tallyboard, on which is printed in English, French, German and Norwegian: "Fasten tail block to lower mast well up. If masts gone, then to best place handy. Cast off rocket line; see rope in block runs free. Show signal to shore." When the tail block has been made fast on board the wreck, the signal is shown to those ashore, and the whip is then bent on to the hawser and the end is hauled off to those in the vessel. An instruction board on its end tells those on board the ship to make the end of the hawser fast two feet above the whip block, to unbend the whip from the hawser, to see that the rope runs clear in the block, and to show a signal to the shore. The rocket company ashore thereupon place the hawser through a block under the head of an iron-legged tripod and haul it taut. The whip is then made fast to the traveller block on the hawser, to which the breeches buoy is attached, and the latter is hauled off to the wreck.

The people in the wreck then get into the breeches buoy one at a time, and are hauled ashore by the rocket company. The whole arrangement is very simple and effective, the initial difficulty being to effect communication with the vessel by means of the rocket line; and nearly 11,000 lives have been saved by the life-saving stations of the United Kingdom since 1855.

Salvage

It is quite impossible to lay down hard-and-fast rules on the subject of salving ships, for so much depends upon the resourcefulness of the officers in charge of the operations and on their quickness in improvising and adapting the material and appliances at their command to achieve the best results. Bad weather has to be faced, and a hundred and one other complications may crop up, all of which will tend to delay matters, and the ultimate success of the undertaking depends primarily upon the courage, perseverance and coolness of the officers and men employed.

In salvage operations the diver is, perhaps, the most important factor to be considered, for success in raising and floating the ship depends greatly—and, in fact, almost entirely—upon his work under water. His function differs largely from that of the ordinary diver in that he must be skilled in such important things as discharging cargo from a sunken vessel, fitting watertight patches under water for sealing up holes caused by collision or grounding, building up bulkheads, etc. He must also know how to use powerful explosives to their best advantage, and must have a thorough knowledge of pneumatic tools, while he will frequently have to place lifting wires underneath a wreck, and will be called upon to destroy rocks, etc., which may be in the way.

I will endeavour to give a short account of what actually goes on in the process of raising a wreck.

First, let us consider what the salvage diver has to do. The most frequent work he is called upon to perform is that of patching fractures in the bottom or side of a ship. These holes are, of course, under water, and it is first necessary that any projecting plating shall be cut away. This is usually done by exploding small and carefully placed charges of dynamite or gelignite. A canvas pad, filled with oakum, is placed vertically on the side plating either side of the hole, and the diver, working from a suspended stage, then commences to close up the fracture by fitting in position, one at a time, a series of planks of some hard wood, about 12 inches wide, 4½ inches thick, and of a sufficient length to allow the ends to project over the canvas bolsters on either side. The planks are secured in place by means of specially made hooked bolts, screwed up from the outside, and when they have all been secured the whole patch is covered over with canvas and has battens of wood nailed over the seam. The canvas bolsters at the sides prevent the water coming in there, and when the patch is quite watertight the compartment inside the ship is pumped free of water, the wooden cover being shored up from the inside to prevent its being thrown over by the water pressure outside. If pneumatic tools are available, fractures can be closed in a more substantial manner by drilling holes in the plating either side of the damage and bolting on steel plates.

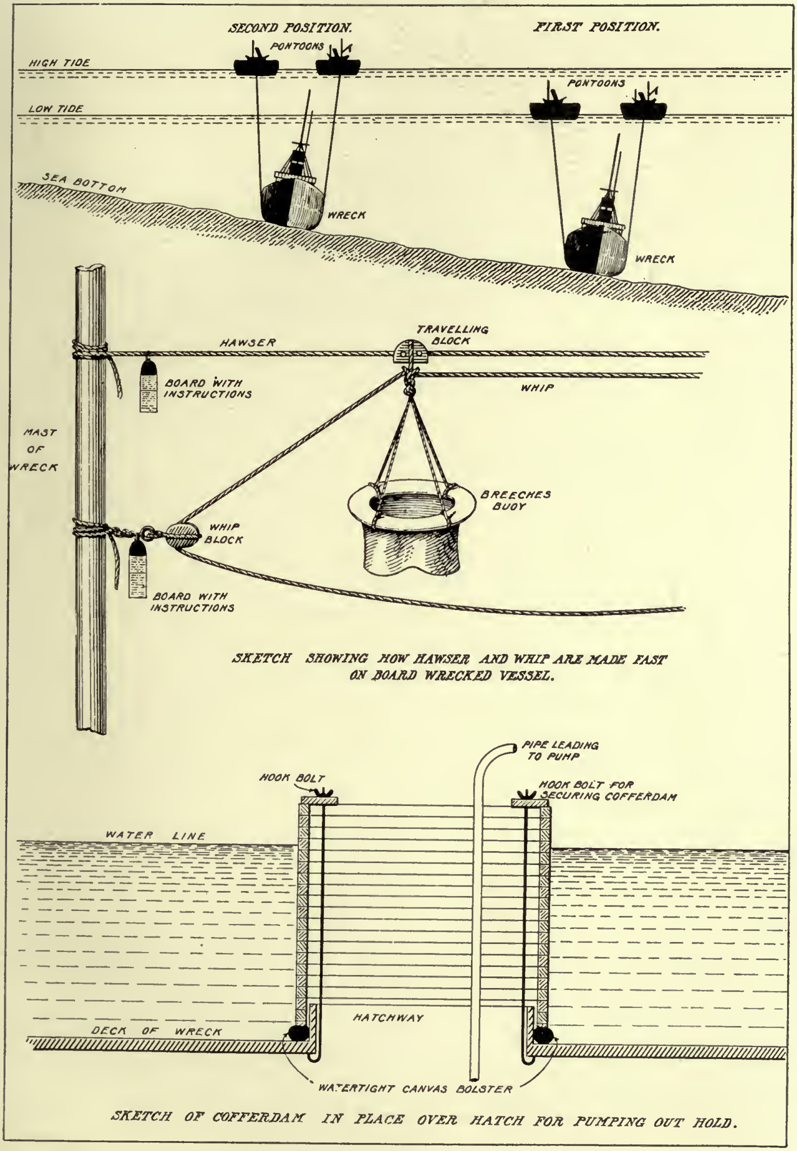
We will now go briefly into the usual method employed in floating a sunken ship. Suppose a vessel has foundered in 60 feet of water and is resting on a sandy bottom, with both bow and stern fairly clear. A series of wires are carried round underneath the ship, and the ends are taken on board pontoons, one of which is placed on either side of the wreck. These pontoons are specially constructed vessels with a central well similar to a dredger, through which the wires are operated. They are divided up into watertight compartments, and are fitted with the necessary steam winches and capstans for heaving in the wire ropes.

The ordinary lifting capacity of a pontoon is about 400 tons, while the lifting wires are 9 inches in circumference and have a breaking strain of about 280 tons. As said above, the wires are first rove underneath the wreck, and at low water they are hauled taut and made fast on board the pontoons. As the tide rises the pontoons lift, and the wreck, being attached to them, is also lifted off the bottom to a height equal to that of the rise of tide. The wreck and pontoons are then towed inshore until the former grounds once more, and the operation is repeated again and again at each low tide until the vessel's decks are above water. The holes in the wreck are patched, and she is finally pumped out and floated.

When there is no rise and fall of tide the lifting becomes rather more complicated, for the tanks in the pontoons are partially filled with water, the wires then being hauled taut and made fast. The water is now expelled from the pontoons, and the wreck lifted, pontoons and vessel being towed inshore as before until the latter grounds, the process being repeated time after time until the decks of the wreck are above water.

When a vessel is sunk in shallow water with her deck a short distance below the surface, the damage to the hull is first repaired by divers, who then close from the inside all openings such as hatches, ventilators, skylights, etc. If the weight of water is too much for the decks to bear they are shored up from the inside with balks of strong timber, and wooden erections known as coffer-dams are built up round large openings such as hatchways.

This structure is nothing more nor less than a box with no lid or bottom, whose lower edges rest on canvas bolsters placed on the deck round the hatch coamings to ensure watertightness. The box is built up plank by plank by divers, and is made as watertight as possible, while it is kept in place by a series



SKETCH SHOWING HOW HAWSER AND WHIP ARE MADE FAST ON BOARD WRECKED VESSEL.

SKETCH OF COFFERDAM IN PLACE OVER HATCH FOR PUMPING OUT HOLD.

SALVAGE.

of hook bolts. It will be seen that with this structure reaching well above the water it is a comparatively easy matter to pump out the hold to which the hatch leads.

The method described above is much used in salvage work, and small vessels have been raised by having coffer-dams built completely round them, the structure being attached to the bulwarks, and the ship being then pumped out and floated in the ordinary way.

The floating off of a vessel which is partially submerged is a matter of some difficulty, and the first thing to be done is to place powerful pumps on board the wreck. Heavy anchors are also laid out to prevent the ship from being driven farther ashore if the sea should get up, but the most important work is done by the diver. It often happens that the ship is set so fast on the rocks or sand that he is unable to get at the fractures. Blasting the rock away may succeed in some cases, but if it does not all the diver can do is to push quantities of oakum and straw under the bottom of the ship through any openings there may be in the rocks. Captain F. W. Young, the chief surveyor to the famous Liverpool Salvage Association, states that in many cases where the injuries could not be reached by divers the leakage could not be kept down in spite of the most powerful pumps being continually at work, but that continual perseverance for some days in feeding straw and oakum under by the divers eventually resulted in the pumps being able to control the water, and secured the floating of the vessel.

When a ship has been driven ashore on sand, and has been subsequently lightened, there is always a possibility, if she is in an exposed position, of her being driven farther on if bad weather springs up. She is therefore anchored by having holes cut in the hull at either end, and the weight of the water which will enter will effectually keep her in position, while the holes can easily be sealed up afterwards. Ships ashore on sand or rock, with heavy cargoes at either end, often break in half as the tide falls. The two portions are then salved separately, bulkheads being built at the ends of the two parts to allow them to be floated off.

Many other ways of floating vessels besides those I have mentioned have been adopted with success. Where the ship is small she may be filled with empty watertight casks, the lifting power of which will often be sufficient to raise her. Air bags or large watertight drums attached to the outside of the vessel have also been utilised, but, as said before, no hard-and-fast rule can be laid down as to the best method of floating a vessel, for so much depends upon the circumstances of the case.

When we recollect that no less than £9,000,000 worth of ships and cargoes are wrecked every year on our coasts, it will be seen that salvage work is very important, and the number of successful operations in wreck raising which have been accomplished speaks very highly for the efficiency of our salvage associations and companies.

CHAPTER XV

Flags at Sea

FROM time immemorial flags and banners have been used by bodies of troops fighting on shore to denote to which side they belonged, and the eagles of the Romans, who invaded and conquered this island in the eleventh century have their direct counterparts in our regimental standards of to-day, though, of course, the latter are no longer carried in action. Our Navy, before the days of King Henry VII., did not consist of regular ships of war, neither was there any highly trained regular body of men like the men manning the vessels of our Navy to-day. On the outbreak of war, if it was required to convey troops across the sea, proclamations were issued to the authorities of the various seaports directing them to collect a certain number of ships, and men to man them, to act as transports, which for the time were under the orders of the military officers. The seamen belonging to the ships were only responsible for the navigation, and were in no sense organised fighting men, although we may assume that in an action they were not backward in helping their soldier comrades. A flotilla of transports of this kind would sometimes meet a hostile fleet employed on the same function, and on coming into contact, a naval engagement would take place under the direction of the military officers commanding the expeditionary force. The battle of Sluys, fought between ourselves and the French in A.D. 1340, is a case in point.

The military officer, on embarking, would transfer the single-tail pennon he bore on his lance to the masthead of his ship, and this is said to be the origin of the long whiplash pennant flown by all men-o'-war other than flagships at the present time. In larger vessels the military commander was a knight who carried a swallow-tailed banner at the masthead, and from this the present "commodore's" flag now in use in the Navy was derived. On more important occasions a knight banneret went afloat in charge of the fleet, and he flew a square flag which has been handed down to posterity in our admiral's flags of the present day.

In the time of the Crusades the English men-at-arms wore over their armour a white garment bearing on it a red cross. This was the famous St. George's cross of England, which was speedily adopted as the national flag of our country, and which is still to be found in all our national ensigns.

The red St. George's cross on a white ground remained the banner of England until 1606, three years after the accession of James I., at which time it was incorporated with the Scottish flag, a white diagonal cross on a blue ground. This combined banner was known as the "Union Jack." The origin of this rather peculiar name is somewhat uncertain, and by some the word "Jack" is said to be a corruption of the name of the reigning monarch—James, Jacobus, or Jacques. Other authorities, however, affirm that the word originated from the leather surcoat, or "jack," worn over the hauberk of our men-at-arms between the fourteenth and seventeenth centuries, and which was emblazoned with the St. George's cross. "Jack" is also said to be a contraction of "Jazerine," or "Ghiazerine," meaning a clinker-built boat, or one constructed of overlapping planks, which bore some resemblance to the jack worn by the soldiers, which was made of overlapping plates of metal or leather.

In 1660 the Duke of York, afterwards James II., gave an order that the Union flag should only be flown by the king's ships, while in 1707 the red St. George's cross of England was superimposed on the white St. Andrew's cross of Scotland. In 1801, after the union with Ireland, the Irish banner of St. Patrick—white, with a red diagonal cross—was added to the design, and the Union Jack then appeared as shown in the colour plate of flags. This is the form in which it is still used as our national flag.

In men-o'-war this flag is flown on the jackstaff, a small staff on the bowsprit or forepart of a ship, and it is also the distinguishing flag of an Admiral of the Fleet when flown at the masthead.

The correct heraldic description of the flag is as follows: "The Union flag is azure, the crosses saltires of St. Andrew and St. Patrick, quarterly per saltire, countercharged argent and gules; the latter fimbriated of the second, surmounted by the cross of St. George of the third fimbriated as the saltire." In heraldic language, it may be said, azure is blue, argent is silver, or white, and gules is red.

An authenticated instance where distinctive flags were flown by the admirals in command of squadrons occurred in 1596, during the expedition to Cadiz. The fleet consisted of 128 sail (18 of which were Queen's ships, or men-o'-war), 68 merchant vessels, 18 hoys or flyboats, and 24 vessels of the Flemish squadron. Six thousand eight hundred soldiers were carried in the ships, and the expedition, which had for its purpose "the annoyance of the King of Spain," was under the joint command of Lord Howard of Effingham and the Earl of Essex.

The vessels were divided into five squadrons under the command of Lord Howard, the Earl of Essex, Lord Thomas Howard, Sir Walter Raleigh, and Jan van Duyvenvoord, the latter being the Dutch admiral in command of the Flemish squadron. Of the flags and ensigns carried by these latter ships we know nothing, but a description of the banners flown by the various English vessels has been handed down to posterity by a contemporary author.

Lord Howard of Effingham, as Lord Admiral of the Fleet and admiral commanding the First Squadron, flew at the foremasthead of his flagship the *Ark Royall,* a plain white flag bearing the red St. George's cross of England. At the mainmasthead he displayed the Royal Standard, consisting at that time of a banner quartered in red and blue, bearing the three lions of England in gold on each of the red quarters, and *fleurs-de-lis* in gold on each of the blue quarters. A shield, or perhaps another flag, bearing this same device, was shown over the stern of the *Ark Royall,* and from this the system of flying the national flag from the ensign staff in the stern appears to have been originated.

The vice-admiral of the First Squadron, Sir Robert Southwell, in the *Lyon,* flew at his foremasthead a flag divided horizontally into seven equal-sized stripes of crimson, white and blue. The St. George's cross figured in the upper canton, but the origin of the introduction of the crimson in the body of the flag is unknown. It may possibly have had some connection with the private colours of the admiral who bore it.

The rear-admiral of the First Squadron, Captain Alexander Clifford, in the *Dreadnought,* flew at the mizen a somewhat similar flag to that described above. The number of stripes was the same, but the white field bearing the St. George's cross was somewhat smaller.

The Earl of Essex, as joint Admiral of the Fleet, and as admiral commanding the Second Squadron, displayed at the mainmasthead of his ship, the *Due Repulse,* a white flag bearing the red St. George's cross, while a shield, or flag, bearing the same device was exhibited from the stern.

The vice-admiral of the Second Squadron, Sir Francis Vere, in the *Raynbow,* had at the foremast a flag with eight horizontal stripes of white and blue, the whole surcharged by the scarlet St. George's cross; while the rear-admiral, Sir John Wingfield, flew a similar flag from the mizenmast of the *Vanguard.*

Lord Thomas Howard, in command of the Third Squadron, and vice-admiral of the fleet, was in the *Merhonour,* and flew at the foremasthead of this vessel the usual white flag with a red St. George's cross. At the main he exhibited a flag having eight horizontal stripes of white and green, and bearing the St. George's cross on a white ground in the upper corner next the mast. The vice- and rear-admirals of the Third Squadron, Captain Robert Dudley in the *Nonpareil* and Captain Robert Maxwell in the *Crane,* flew somewhat similar flags from their fore- and mizen-mastheads respectively, the arrangement of the stripes being varied.

Sir Walter Raleigh, the Rear-Admiral of the Fleet, and the admiral commanding the Fourth Squadron, flew at the mainmasthead of his flagship, the *Warspight,* a plain white flag bearing no device. From the mizen-masthead he displayed the usual banner of St. George. The vice-admiral of this squadron, Captain Robert Crosse, in the *Swiftsure,* flew the plain white flag mentioned above at the fore, while the rear-admiral, Captain George Gifford, in the *Quittance,* flew the same flag at the mizen.

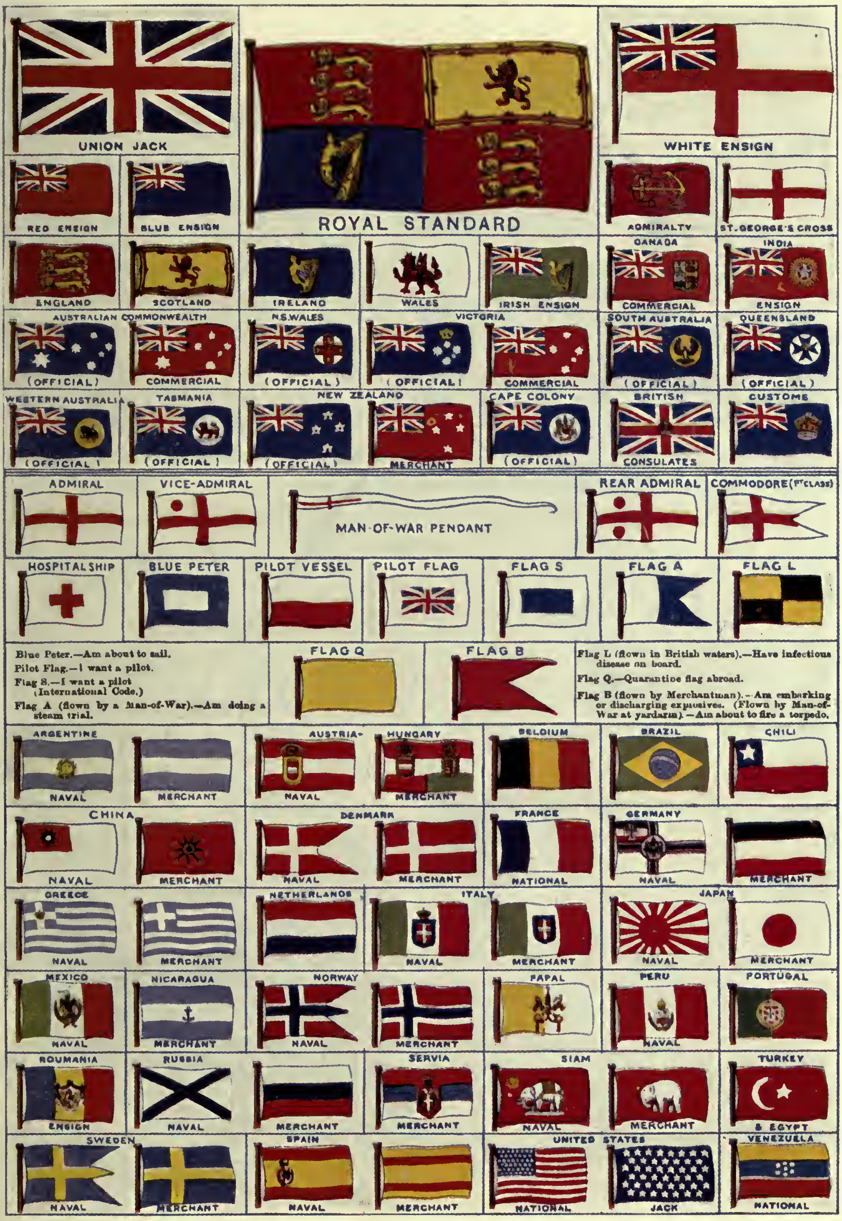
The origin of the strange colouring of some of these flags is not known, while the green in the banner of the Third Squadron is strange. It may, however, be accounted for by the fact that green and white were the Tudor colours. The devices and colours of the flags at this period depended largely upon the individual taste of the officers in command of the various fleets, for at this time no definite instructions upon the subject had been laid down. The emblem of England, however, the red St. George's cross, is common to all in one form or another.

One of the first known instances where admirals of the red, white and blue flew their flags is said to have been in Blake's squadron in 1653. All the admirals flew the usual St. George's flag, a full admiral exhibiting his at the main, a vice-admiral at the fore, and a rear-admiral at the mizen. Each rank was again subdivided into three grades—red, white and blue—the first-named being the senior, the second next, and the third junior. As a means of distinguishing between the various squadrons the red, white and blue ensigns were flown. The red and blue ensigns were similar to those now flown, except that the St. George's cross alone appeared in the top left corner.

There is some uncertainty as to the white ensign, for in some old prints the ships of the white squadron are shown flying a flag similar to the red ensign, while in others they fly a white flag with the usual red St. George's cross—exactly similar, in fact, to the admiral's flag. It was thus possible, by noting the mast at which an admiral flew his flag, and the colour of the ensign flown by his flagship, to know what squadron he actually commanded and what his rank was.

Present-Day Flags

The Royal Standard is the personal flag of the Sovereign, and is only hoisted on board a ship when the Sovereign is actually present or when any member of the Royal Family is present representing the Sovereign. Whenever the Sovereign is on board a



FLAGS OF THE CHIEF MARITIME NATIONS.

ship of war the Royal Standard is hoisted at the main, the Admiralty flag at the fore, and the Union Jack at the mizen.

When Her Majesty the Queen is embarked on board a ship the Royal Standard is hoisted at the main. The Prince of Wales, the Duke of Connaught, Prince Arthur of Connaught, and other members of the Royal Family all have their distinctive flags, which are very similar to the Royal Standard.

The white ensign is the flag flown by all His Majesty's men-o'-war, and is displayed by no other ships of any kind except those belonging to the Royal Yacht Squadron. The latter vessels can always be distinguished by their burgee, which is a small white triangular flag, with a red St. George's cross, and a crown in the centre, always flown at the masthead.

The blue ensign is flown by mail steamers and merchant ships which are commanded by officers of the Royal Naval Reserve, and which carry ten or more persons belonging to the same force. A warrant is issued to the captain of the ship entitling him to fly this flag, and a list of vessels so entitled will be found in the quarterly Navy List issued by the Lords Commissioners of the Admiralty.

Any man-o'-war meeting a merchant vessel flying the blue ensign is authorised to ascertain whether the latter is legally entitled to do so. If the officer to whom the warrant was issued is not actually in command, or if the number of persons on board belonging to the Royal Naval Reserve falls below ten, the blue ensign is not to be flown. If, also, a ship is found to be flying this ensign without an Admiralty warrant, the flag is to be confiscated and the matter reported to the Admiralty.

This flag, with the addition of a device in the fly —that part of the flag away from the mast—is used by all other Government vessels, such as victualling yard craft, ammunition ships, transports, War Department steamers, etc. The device itself varies with the department to which the vessel flying the flag belongs, but in the case of all dockyard craft belonging to the Admiralty, hired transports, hospital ships and victualling yard craft it consists of a yellow anchor.

Many yacht clubs are also entitled to fly the blue ensign, and in this case it will usually be found to bear an extra device of some kind, such as the club crest.

The red ensign is the British mercantile flag, and as such is flown by all vessels not entitled to fly the white or blue ensigns. With the addition of a device it is also used by many yacht clubs.

The Admiralty flag is flown by any ship in which the Lords Commissioners of the Admiralty may be afloat in their official capacity.

The distinguishing flags used in the navy for flag officers are as follows: An admiral of the fleet, the highest rank to which a naval officer can attain, flies the Union Jack at the masthead; an officer of this rank is but rarely employed at sea, and the Union Jack is seldom used for this purpose. In dockyard ports a man-o'-war going in or out of harbour displays this flag at the masthead, so it must not be thought that every ship flying the Union Jack has an admiral of the fleet on board.

An admiral flies a white flag with a red St. George's cross at the masthead; and in the case of vice- and rear-admirals the flag is the same except for the addition, in the case of the former, of a ball in the upper quarter nearest the mast, and, in the case of the latter, a ball in each of the quarters nearest the mast.

A commodore is what is known as an acting rank, or, in other words, he is a captain who has been made a commodore for the time being. Commodores are of two classes, first and second, and the former flies the white swallow-tailed flag with the red St. George's cross shown in the plate. A commodore of the second class flies a similar flag with the addition of a ball in the upper quarter nearest the mast. On the arrival of a captain who is senior to the commodore, the latter may be required to haul down his "broad pennant," as it is called, while the captain will hoist a small "senior officer's flag"—similar to the first-class commodore's flag, but much smaller—at the yardarm of his ship to show that he is the senior naval officer present.

Every man-o'-war which does not fly an admiral's flag or a commodore's broad pennant flies at her mast-head the long, narrow man-o'-war pennant. It is white, with the red St. George's cross nearest the mast, and, as has been said before, it originated in the days when a ship-o'-war was commanded by a soldier who bore on his lance a single-tail pennon, which he transferred to the mast of his ship when he went afloat.

What is know in the Navy as a "paying-off pennant" consists of an extraordinarily long pennant, which is flown by a man-o'-war when she is paying off after a term of foreign service or on paying off after having completed a commission at home. A pennant of this kind is usually many hundreds of feet long, while the end, which usually trails in the water, is ornamented with a gilded bladder. How the custom of flying these long pennants arose it is quite impossible to say, but the old tradition is kept up even now.

"House flags" are private flags of the various steamship and railway companies, and are merely used for indicating to which particular line a vessel belongs. The accompanying colour plate shows the funnels and flags of some of our more important steamship companies. The selection of the colouring of these flags is entirely in the hands of the owners, but most of them have a history. The well-known flag of the Peninsular and Oriental Company, for instance, is blue and white, red and yellow, and it may be noticed that these are the component colours of the old Portuguese flag—the one in use before the late revolution—and the Spanish ensign respectively. When the P. & O. line of steamers was started, in the early part of the nineteenth century, their ships took over from the Government the work of delivering the mails to the Peninsula—Spain and Portugal—and it is said that they adopted the colouring of the flags of these two countries in designing their house flag.

It is customary in many steamships to hoist the flag of the country to which they are sailing at the foremasthead, and this accounts for, perhaps, an American flag at the masthead of a steamer flying the British red ensign.

Another well-known flag is the "Blue Peter." This is a square blue flag with a white centre, and is the signal for all persons belonging to the vessel hoisting it to repair on board at once, as she is about to proceed to sea.

A vessel in British waters requiring a pilot hoists at her masthead a Union Jack having round it a white border, the latter being one-fifth of the breadth of the flag itself. There are various other signals which can be used for the same purpose, but this is the most common. The international signal for a pilot is flag S of the International Code. Section 612 (c) of the Merchant Shipping Act provides that every British pilot boat, when afloat, shall fly at her masthead a large flag of two colours, the upper horizontal half being white and the lower horizontal half red.

Flag L of the International Code—see Chapter XVI—is required to be flown by every ship infected with cholera, yellow fever or plague, when she is within three miles of the coasts of England, Wales, Scotland, Ireland, the Channel Islands, or the Isle of Man.

Abroad a square yellow flag, similar to flag Q of the International Code, is generally used to denote a vessel liable to quarantine.

Vessels which are used as hospital ships fly at the masthead a white flag bearing a red cross. This is the flag of the Genéva Convention, at which the rules and regulations concerning hospital ships in war-time were evolved.

Flag B of the International Code is always to be hoisted by a vessel when she is taking in or discharging gunpowder or any other explosive. In the Royal Navy a similar flag is known as the "Red Burgee," and, hoisted at the yardarm, denotes that the ship hoisting it is about to fire a Whitehead torpedo for practice. The flag is "dipped," or smartly hauled down for a few feet, when the torpedo is fired, and is kept in this position until it is recovered. In peace-time, of course, torpedoes are invariably picked up after having been fired.

Flag A of the International Code hoisted by a man-o'-war in British waters means that the vessel hoisting it is doing a steam trial at full speed. It is known as the "Steam Cornet," and is a signal for other vessels to keep clear.

The flags mentioned in this chapter by no means exhaust those in use at sea, for all the navies of the world have their own special codes. To mention these all in detail, however, would be an impossibility, and those described are the ones most frequently used.

CHAPTER XVI

Signals

SIGNALS between ships have been in use ever since squadrons of vessels acting in unison were formed, and in early days these signals consisted of flags shown by day and lights or the firing of a certain number of guns at night. I propose for the purposes of this chapter to deal with flags and lights first, and to leave the mechanical methods of signalling, such as the semaphore, until later.

Flags, as stated in a previous chapter, have been in use from the earliest times, and we may assume that the same flags flown from various parts of the ship all had their meanings, even so far back as the fifteenth century. By the time of the battle of Trafalgar, in 1805, a naval code of flag-signalling had been adopted, with different flags for practically all the different numbers up to ten. The several groups of numbers had each a separate meaning, and a combination of two or three flags—and it will be seen that many combinations were possible—meant a word, the more frequently used signals being tabulated in vocabulary form and included in a signal-book issued to all the ships concerned.

The famous signal made by Lord Nelson at Trafalgar clearly shows this. "His lordship," says Captain John Pasco, who as a lieutenant was the officer in charge of signals in the *Victory*, "came to me on the poop, and, after ordering certain signals to be made, he said, 'Mr. Pasco, I wish to say to the fleet,

"ENGLAND CONFIDES THAT EVERY MAN WILL DO HIS DUTY."' I replied: 'If your lordship will permit me to substitute the *expects* for *confides*, the signal will soon be completed, because the word *expects* is in the vocabulary and *confides* must be spelt.' His lordship replied in haste, and with seeming satisfaction: 'That will do, Pasco; make it directly.' When it had been answered by a few ships in the van, he ordered me to make the signal for 'Close Action,' and to keep it up. Accordingly, I hoisted No. 16 at the topgallant mast-head, and there it remained until shot away."

This is how the famous signal "England expects that every man will do his duty" was made. It is interesting to note that on every anniversary of the battle (October 21) the famous old *Victory*, lying in Portsmouth harbour, still hoists this signal and keeps it flying all day. The flags, it must be remembered, are of exactly the same colours as those used at Trafalgar, not their more modern counterparts.

The flags in use at the present day for signalling purposes include what is generally known as the "International Code of Signals." This was first brought out in 1857, and, being subsequently revised, forms the code now used by all merchant vessels. There is a flag for every letter of the alphabet, and combinations of these letters mean different things. In order to lessen the risk of a mistake being made, few of these combinations consist of more than three flags, while many urgent and important signals can be made with two flags alone. Thus D B means "Send immediate assistance"; N O, "I am sinking (or on fire); send all available boats to save passengers and crew," etc. Some of the three-flag hoists represent the principal forms of money in use throughout the world; thus A V B means "a shilling," while others mean points of the compass, measures and weights, decimals and fractions, auxiliary phrases, etc. Thus A O B means "N. 50° W."; A W B, "a furlong"; B D O "$\frac{5}{16}$ths"; B E W, "We are."

A general vocabulary which is very complete, for there is hardly a word which cannot be found, can also be used with the aid of three-flag hoists: thus E U K means "Archipelago," while F X K reads "The barometer is rising." Names of places and ships are made by hoists of four flags: thus Portsmouth is A E L S; H.M. torpedo-boat destroyer *Leven* is G S K N; the *Mauretania* is H L T Q, etc. By this it will be seen that any signal, no matter how complicated it may be, can be made. This code forms a ready means of communication between ships at sea and between ships and shore signal stations, and as it has been translated into various foreign languages, messages can also be sent from British to foreign vessels.

A system something similar to the above is used in the British and foreign royal navies; the flags, however, are in some cases different in colour, while in our Navy, besides many special flags, there is a flag for every letter of the alphabet and a flag and a pendant for every numeral from 0 to 9 inclusive.

Signals for use at night, in olden days, consisted, as I have said before, of guns or lights. In a dispatch written by Lord Nelson on the eve of Trafalgar, and intended for the frigate shadowing the enemy's fleet, occurs the following: "If the enemy are standing to the southward or towards the Straits, burn two blue lights together, every hour, in order to make the greater blaze. If the enemy are standing to the westward, three guns, quick, every hour."

Although the use of guns and lights of this kind is not obsolete, for the former method is still employed in fogs by the ships of the British Navy, while the latter are burnt by pilot vessels, etc., and on special occasions, the usual form of night signalling now in use is what is known as the "Morse Code." In this the letters are spelt out by dots and dashes made on a lamp, and the following list shows the code used. Thus a short flash, followed by a short pause, and then a long flash means A, and so on.

THE MORSE CODE

A	– ——	N	—— –
B	—— – – –	O	—— —— ——
C	—— – —— –	P	– —— —— –
D	—— – –	Q	—— —— – ——
E	–	R	– —— –
F	– – —— –	S	– – –
G	—— —— –	T	——
H	– – – –	U	– – ——
I	– –	V	– – – ——
J	– —— —— ——	W	– —— ——
K	—— – ——	X	—— – – ——
L	– —— – –	Y	—— – —— ——
M	—— ——	Z	—— —— – –

NUMBERS

1	– —— —— —— ——	6	—— – – – –
2	– – —— —— ——	7	—— —— – – –
3	– – – —— ——	8	—— —— —— – –
4	– – – – ——	9	—— —— —— —— –
5	– – – – –	0	—— —— —— —— ——

SPECIAL SIGNS

Repeat (IMI) – – —— – –
General Call – – – – – – – – – – etc.
General Stop —— —— —— —— etc.
Erase – —— – —— – —— etc.
Spelling (FF) – – —— – – – – —— –
Full Stop – —— – —— – ——
Affirmative (AF) – —— – – —— –
Negative (NO) —— – —— —— ——

This method can also be used in the daytime by waving a flag through short and long arcs to represent dots and dashes, by short and long blasts on a whistle or fog-horn; while in the telegraph office at home you have probably heard the operator spelling out a message on a telegraphic key. The system is quite the same, although the method of making the signal may vary, and often whilst in a post office I have, involuntarily and without thinking, found myself taking in messages not intended for my ears.

The Morse Code is extremely useful, and I strongly advise you to learn it, for you never know when it may not be of assistance. It may appear difficult at first, but persevere and you will succeed. First take the symbols in alphabetical order, and learn a few—say half a dozen at a time. When you know them, go on to the next six, and when you have mastered them thoroughly practise the first twelve together, and so on. Never make use of an aid to memory such as learning the different letters in the sequence of the symbols in which they are made, like E -, I - -, S - - -, H - - - -, T —, M — —, O — — —, for if you do you will often notice that you will have to start from the beginning before you can readily recognise the letter made, and the delay thus caused is fatal, for it means another letter will probably be made while you are *still thinking* about the first.

The first form of mechanical signalling was probably what was known as the "Telegraph," which must not be confounded with the modern electric system bearing that name. An ingenious French gentleman, Monsieur Chappe, first invented and perfected the system in 1792, and four years later two of these telegraphs were erected over the Admiralty Office in London, and, by means of a chain of the instruments erected on hills, signals could be passed from London to all the naval ports. I have an old engraving of one of these telegraphs, erected in 1796, which shows that the different letters were formed by the opening or closing of a number of ports by means of shutters. Another system of telegraph enabled 400 previously concerted sentences to be transmitted from ship to ship by varying the combination of two revolving crosses.*

Semaphores, in which the letters were formed by the different positions of movable arms pivoted on a central staff, were instituted at the Admiralty in 1816, and this system was similar to that now in use. The two arms of the present-day semaphore are pivoted together at the top of the central pole, while lower down an indicator is fitted to denote from which side the signal is being made. By this I mean that A, for instance, might be confounded with G if A was not on the same side as the indicator. The great advantage of the semaphore method of signalling is that no special apparatus is necessary, for the arms can be used for making the different signs. When using the system in this way, however, no indicator is utilised, and care must be taken to face the direction in which you are making the signal.

The best way of learning the alphabet and other signs is by circles, thus:

First circle.—A to G (single signs).
Second circle.—H to N (omitting J).
Third circle.—O to S.
Fourth circle.—T, U, Y, and annul.
Fifth circle.—"Numeral" J (or alphabetical) and V.
Sixth circle.—W and X.
Seventh circle.—Z.

In the first circle A to C inclusive are made with the right arm; D with either, whichever is most convenient, and E to G with the left. In the second circle the right arm should be kept at letter A, and the left used for completing the sign. Thus letter H is made with the right arm at A and the left at B. Similarly with the other circles, the right arm is kept at the

* "Haydn's Dictionary of Dates."

standing position belonging to the particular circle, while the left completes the sign. Thus P is made with the right arm at B and the left at D, while U is made with the right at C and the left at E.

In signalling with the arms in this way great care should be taken to make the signs very carefully. The elbows should not be bent, and, in changing from one sign to another, the arms should be kept perfectly straight. Always choose a background which will enable your signs to be read distinctly, and do not stand with your back to a house or a bush unless you are dressed in light clothes. The sky line, of course, enables the signs to be read very clearly, but this is not always available. Bear in mind, however, that the question of background is an important one.

The Morse Code, as I have said before, can be spelt out by the waving of a flag, and special flags mounted on sticks are supplied for the purpose. They are of two colours, as a general rule—dark blue and white with a narrow blue horizontal stripe—so that the one which is most likely to show up best can be selected.

In making the Morse Code with a flag the normal position of the flag is at A. To make a short or dot, wave the flag to B, and then back to A; and to make a long or dash, wave it to C, and then back to A. When signalling a letter, the dots and dashes representing it should be made without any pause: thus A is made by waving the flag from A to B (a dot), from B to A, from A to C (a dash), and from there back again to A without stopping. A pause with the flag at A, and equal to the length of a dash, is made between each letter of a word, and when the word is complete the flag should be lowered in line with the body and gathered in with the left hand, so that no part of it can be seen by the person to whom the signal is being made.

CHAPTER XVII

Wireless Telegraphy

It was in the year 1867 that the discovery of wireless telegraphy was first foretold by Professor Clerk Maxwell. In a series of complicated mathematical calculations he proved that the discovery of electric waves would be achieved before very long, and he further said that these waves would be of the same nature as those of heat and light. His prophecy has been fulfilled in a most wonderful manner, and we now know that the electric waves used in wireless telegraphy differ only from those of light and heat in their frequency—that is, in the number of complete waves which pass any one point in one second.

Light waves consist of vibrations of the ether at the rate of between 4,000 and 8,000 billions per second, and although this enormous number is hard to realise, the human eye is capable of detecting vibrations between these limits. Vibrations between 1,000 and 2,000 billions per second produce heat which we can feel, while the Hertzian waves, or those used in wireless telegraphy, lie between 50,000 and 4,000,000 vibrations a second, and they require some special form of receiver to detect them.

If we set up a wire in the air and in it produce currents of electricity which move to and fro with great rapidity, the electric, or Hertzian, waves will radiate in circles from this wire in a similar manner to which ripples radiate from the point of impact when a stone is thrown into still water. Any other wire in the air within the range of these emanating waves will have electric currents generated in it by the waves, and these can be detected by a suitable apparatus. Therefore, if we make a collection of these waves to correspond to the longs and shorts of the Morse alphabet, we can send messages from place to place without connecting wires.

In 1889 Hertz first discovered the existence of these waves, but his apparatus was only fit for use in a laboratory. Marconi and Sir Oliver Lodge were the real pioneers of the wireless telegraphy which is now in use all over the world, and by means of which messages can be sent across the Atlantic or from one ship to another over a distance of perhaps 1,800 miles.

In 1896 forty yards was the greatest distance which had been covered, but the subsequent progress was so rapid that by 1901 signals sent from Poldhu, in Cornwall, were being received in Newfoundland.

It is now perhaps as well to explain the nature of these currents of electricity which surge to and fro in our aerial, for this is the name by which the wire put up in the air is invariably known. The currents are called "oscillatory," for they oscillate to and fro with great speed, which is known and can be worked out.

Imagine two iron cans joined by a large pipe stopped up by a thin sheet of rubber stretched across it. Air is now pumped into one can until the pressure is so great that the rubber breaks and the air then rushes through the pipe to fill up the empty can. Owing, however, to the weight of the air it will not stop flowing immediately the can is full, but will overshoot the mark, so to speak, and will then rush back again, the movement becoming smaller each time until the air is finally at rest.

Instead of the two cans take an aerial wire and the earth, separated by a small gap which takes the place of the pipe, the air in the gap being similar to the rubber disc which breaks. If instead of pumping air into the can, electricity is pumped into the aerial, then directly the pressure in the latter becomes too much for the air resistance in the gap it will be broken down and all the electricity will rush out of the aerial. In the same way as the air between the two cans overshot the mark, the electricity will do the same thing in the aerial, and it will rush back again, and to and fro, until finally the pressure in the aerial and earth are the same.

The electricity is pumped into the aerial wire as the sending key is pressed, and the currents rushing in and out of the aerial make the waves which radiate and affect the receiver. Owing to the fact that the hole caused in the air by the electricity jumping the gap is sealed up again as soon as the oscillations have died away, the process can be repeated as often as we like. The whole proceeding only takes an infinitesimal portion of a second, and by repeating this about a hundred times in quick succession—with one pressure of the key—a long of the Morse Code is formed. A short is formed by the process being repeated thirty times—that is, a shorter pressure of the sending key. In this way any message can be dispatched through the air by spelling out each word in the Morse Code.

To receive the signals at the other ship or station we must put up an aerial wire of the same description as that at the transmitting ship or station, and the waves radiating into space from the sending aerial set up very minute currents of electricity in this, and by having most sensitive detectors the signals can be heard in a pair of telephone receivers which the operator clips over his head. Whenever the key is pressed at the transmitting ship or station, the operator at the receiving station will hear a buzz or scratching noise in the telephone receivers, and so the longs and shorts can be distinguished and the message written down.

The same aerial wires are generally used for transmitting or receiving messages, either apparatus being connected up to it by means of a "change-over switch" manipulated by the operator. By means of what is known as "tuning," also, matters can be so arranged that a ship or station need only hear the signals sent out on the same tune as she is actually on, even though a ship quite close may be sending out a message on a different tune. In this way it is possible for British men-o'-war, for instance, to talk to each other without the probability of their messages being taken in by outsiders. The details of tuning, however, are too complicated to be mentioned here.

It is possible, by the use of suitable apparatus, to transmit speech through space by what is usually called "Wireless Telephony." As yet, however, no very great distances have been achieved, and specially trained operators are necessary to work the apparatus, but there is no doubt that in the course of time telephones without connecting wires will be in general use. In time to come, perhaps, it will not even be necessary to have wires for the electric lighting of houses, and each residence may have its own aerial wire on the roof catching the waves from big central stations and turning them into light, power and heat.

It is not difficult to realise how wireless telegraphy has revolutionised naval warfare. All battleships, cruisers, scouts, and the latest destroyers in the British Navy carry installations, and whereas in olden days an admiral commanding a fleet was hampered through not knowing what was going on out of his sight, nowadays he is constantly receiving reports and messages from vessels a hundred, two hundred, or even five hundred miles away, and by reference to a chart he can see what is going on just as easily as if it was happening before his own eyes.

The use of wireless telegraphy is not only confined to men-o'-war, for practically all the large liners and many cross-Channel steamers, tugs, yachts and other small craft are fitted with installations. Lightships also, in many cases, are supplied with it, so that they can communicate with the shore in the event of a wreck taking place; and not infrequently a life-boat has been called out to the assistance of a vessel in distress, although the lightship sending the summons has been out of sight in fog.

In the transatlantic services wireless telegraphy plays a very important part, for at a distance of 2,000 miles from Liverpool wireless communication can be maintained between a ship and the shore, while passing vessels many miles apart are able to talk to one another. On many occasions the wireless installation has been an invaluable aid to a ship fitted with it, and not so very long ago the rescue of the passengers and crew of the White Star liner *Republic,* who, when on the verge of foundering, was able to call another vessel to her assistance by means of her wireless, naturally stimulated the use of the new invention at sea.

I must give two more instances where it has been invaluable. In April, 1910, the Allan liner *Carthaginian,* bound from Liverpool to St. John's, Newfoundland, was disabled at sea due to the fracturing of a piston rod. She was able by means of her wireless telegraphy to inform the *Hesperian,* belonging to the same line, of what had happened, the latter vessel being at the time one hundred miles west of Malin Head. The *Hesperian* at once went to her sister's assistance, and towed the *Carthaginian,* with her eight hundred emigrants on board, to the Clyde. Before the days of wireless the *Carthaginian* would have drifted about in a helpless condition until some ship had sighted her and towed her home, when a heavy sum for salvage would have had to be paid, but as it was she was enabled to summon a ship belonging to the same owners, and the mishap cost the latter practically nothing. More thrilling still is the account of the rescue of the crew of the *Kentucky* by the *Alamo* in February, 1909.

The following statement is taken from a daily newspaper of the time, and needs no enlargement: "Early on Friday morning, during a heavy storm, the engineer informed Mr. Maginnis, the operator in the *Kentucky,* that the ship was doomed. An hour later Mr. Maginnis got into wireless communication with the *Alamo,* then about ninety miles away, but not until noon was it possible for the captain to get an exact observation of his position.

"'Half an hour before that,' says Mr. Maginnis, 'the electrician came to me and said that the water was creeping up, and that the dynamo power would soon be lost. All hands were then directed to abandon all other work, and devote themselves to keeping the water away from the dynamo. The turbine engine and dynamo were wrapped in canvas, and power was thus preserved until the vital message was dispatched.'

"When the *Alamo* at 3.30 p.m. reached the *Kentucky,* the deck of the sinking vessel was almost awash. The crew, despite the high seas, were rescued by the boats without mishap, and when they had clambered on board the *Alamo,* they immediately gave three cheers for Mr. Maginnis."

The part that wireless telegraphy played in the wreck of the *Titanic* is sufficiently well known to all of us not to need recapitulation here. Had the disaster happened before the installation of wireless telegraphy became general among large transatlantic vessels, the loss of life would have been greater. It would be an ideal state of affairs if every ship could be supplied with an installation of this wonderful apparatus.

CHAPTER XVIII

Something About the Compass

THAT invaluable instrument the mariner's compass is said to have been known to the Chinese as early as 1115 B.C., and to have been brought to Europe in 1260 A.D. by the well-known Venetian navigator, Marco Polo. Other accounts, however, state that the invention of the compass was due to Flavio Gioja, a Neapolitan, who discovered it in 1310 A.D. Whatever may have been its origin, it is tolerably certain that the first knowledge of magnetism arose among the ancients, who discovered that certain iron ores possessed the property of attracting and holding small particles of iron. This magnetic ore, which is found in large quantities in various parts of the world, is commonly known as the lodestone (leading stone) or natural magnet. Natural magnets have certain properties; if, for instance, they are dipped in steel or iron filings, tufts of the filings will be found sticking to the ends on their being withdrawn. If dipped in copper or brass filings, however, no such thing takes place.

If a natural magnet is hung from its centre by a string, one end will always point nearly towards the geographical north, and if it is turned round to point in another direction it will invariably return to its original position on being released. The end of the magnet which points to the north is known as the "north-seeking end," while the other extremity is known as the "south-seeking end."

If a piece of hard iron or steel is rubbed with a natural magnet, it will be found that it has acquired the same properties as a natural magnet—i.e. one end will point to the geographical north. This is what is known as an "artificial magnet," and in the present case is our compass needle. The earth itself is one huge magnet, possessing the attractive and repelling qualities of other magnets, so that its action on another freely suspended magnet causes one end to point to the north and the other to the south. Thus we have our compass, which consists of a card left free to revolve, and fitted with one or more magnets on its under side. The compass is therefore an instrument which indicates direction, and by its use the sailor can steer his ship on any course, and ascertain the bearing of any visible object, such as the sun, a distant ship, or a point of land. The compass card itself is divided into four quarters, each quarter being again subdivided into eight points. Each of these points has a distinctive name, and there are thirty-two of them.

Each point is again divided into half and quarter points, also distinguished by separate names. It will thus be seen that there are 32 points, 32 half points, and 64 quarter points in the whole compass card. The outer rim of the card is marked off into 360 degrees (90 degrees in each quadrant), marked from the north and south points, which are 0, to 90 degrees at east and west.

In the centre of the card is fitted a small sapphire cap, slightly hollowed out on its underneath side, and this supports the card by resting on a sharp-pointed pivot, the point of which is made of iridium, the hardest known metal. In this manner friction is reduced to a minimum, and the card is free to maintain its direction, no matter in which direction the ship is turned. The pivot itself is fixed to the centre of a hemispherical copper or brass bowl, known as the "compass bowl," and this is weighted at its lowest part by means of a lead weight, or a receptacle filled with castor oil, the object of this being to prevent it from swinging about.

The bowl is covered by a glass plate to protect the card from the effects of damp, and to prevent it being blown about by the wind. On its inside surface is painted a thin vertical black line, called the "lubber's point," or "lubber's line," which indicates the ship's head. This line should be in such a position that the line joining it to the pivot of the compass is in line with the keel of the ship.

The binnacle to which the compass bowl is attached is secured to, and is therefore part of, the vessel, so it follows that the lubber's point moves with every movement of the ship's head. To ascertain the direction in which the ship is heading, therefore, the man at the wheel has only to notice the particular degree or point on the card which coincides with the lubber's line.

The binnacle, or stand in which the compass is placed, is usually made of polished wood with brass fittings. Inside the binnacle arrangements are made for placing various horizontal and vertical magnets, while outside it are two brackets, one on either side, to which are secured hollow soft-iron spheres. In front of the binnacle is a vertical brass case, in which a bar of soft iron can be placed when necessary.

These magnets and soft-iron fittings are the correctors used in adjusting the compass.

The hood of the binnacle is constructed of brass, and is so fitted that it can be turned round in any required direction, and by means of doors or windows the card can be looked at without removing the hood.

The compass bowl itself is secured to the binnacle by a ring, which is so fitted that when the ship rolls or pitches the compass remains horizontal.

A compass needle does not point to the true north, but to a point known as the magnetic north pole, and the difference between this direction and the direction of the true north is known as the "variation of the compass." The amount of this at different places all over the world is known. On board a steel or iron ship the compass rarely points to the magnetic north, for it is influenced by the magnetism of the iron in the ship. This difference between the magnetic north and the direction of north as shown by the compass is called the "deviation," and has to be frequently ascertained and allowed for, as it is constantly changing. In Lord Kelvin's compasses (of which there are a large number in use) the cards are made as light as possible, and consist of an aluminium ring at the outer edge. This ring is connected to a central aluminium boss by means of silk threads, and in the boss is the sapphire cap in which the pivot fits. The graduations of the card are printed on thin but very tough paper, gummed to the outer ring.

The needles, six or eight in number, consist of fine steel wires, and the card is attached to them by silk threads, and the complete card weighs 190 grains only.

It was found, after some time, that these compasses were particularly sensitive to shock, such as is experienced in firing heavy guns, or to vibration when the ship is steaming at a high speed. This disturbs the card from its true direction, and makes it difficult to steer by, so in 1906 it was superseded in the ships of the Royal Navy by an improved liquid compass. Lord Kelvin's compass, however, is still to be found in the greater number of liners and merchant vessels where there are no guns, and which always steam at a comparatively regular speed.

The liquid compass is so called because the bowl is filled with liquid which prevents the card from being so readily disturbed by external shock, while devices are fitted which maintain an equal pressure on the liquid when it expands or contracts on account of heat or cold. The bowl is, of course, perfectly air and watertight, and is fitted with a glass top and bottom, the object of the latter being to enable the compass to be illuminated at night by means of an electric light placed underneath the bowl.

The compass card is made of mica, on which the graduations are painted, and the needles, four in number, are round bar magnets. To reduce the weight of the card, by giving it a certain amount of buoyancy, a hollow copper float is attached to the under side of the card, and this reduces the amount of friction between the pivot and the sapphire cap.

The liquid with which the bowl is filled consists of a mixture of one part of alcohol to two parts of water, the former being added to prevent the liquid from freezing in very cold weather.

The principal compass in a ship, which is always placed in a position from which a good, all-round view can be obtained, is always known as the "standard compass." The other compasses at the steering positions are called "steering compasses."

In standard compasses there is an instrument known as an "azimuth mirror," which rests on top of the compass bowl. It can be turned round in any direction, and is used for reading off the direction of any object from the compass card.

This direction of any object, as read off from the card, is always known as the "bearing."

Hints on Learning the Compass

The compass must not be looked upon as something to be learnt like a parrot, but on common-sense lines.

You have all seen a weathercock, and know that there are four points : north, south, east and west. You also know that if you face north, east is on your right hand, west on your left, and south behind you. These four points are called the cardinal points.

Midway between these cardinal points lie what are

LORD KELVIN'S COMPASS CARD.

known as the "half cardinal points"—i.e. north-east, south-east, south-west, and north-west.

Half-way between the cardinal and half cardinal points lie the intermediate, or three-letter, points. There are eight of them; north-north-east, east-north-east, east-south-east, south-south-east, south-south-west, west-south-west, west-north-west, north-north-west. As a rule, they are written N.N.E., E.N.E., etc.

Something About the Compass

Now, we already know the four cardinal, the four half cardinal, and the eight intermediate points; sixteen altogether out of the thirty-two points of the compass. These remaining sixteen are those midway between the cardinal and intermediate points, and midway between the intermediate and half cardinal points. They are known as "By points," as they all have the word "By" in them. They are as follows: North by east, north-east by north, north-east by east, east by north, and so on right round the compass.

What is known as "boxing the compass" is merely saying in their proper order all the points, half-points, or quarter-points, as the case may be.

Thus to box the compass in points from north to south, passing through west, you proceed to say as follows:—north, north by west, north-north-west, north-west by north, north-west, north-west by west, west-north-west, west by north, west, west by south, west-south-west, south-west by west, south-west, south-west by south, south-south-west, south by west; south.

As has been said before, each point is again subdivided into half and quarter points, and there is a little more difficulty in boxing the compass in quarter points than in points. Never read from a point which begins and ends with the same letter (W.S.W., E.N.E., etc.), but read from each side of every cardinal and half cardinal, and do not read more than once from any one point. When the point that you read from is behind you, commence with a quarter point; when it is in front of you commence with a three-quarter point.

All these instructions sound very confusing, but the accompanying diagram will help you to understand it.

The outer rim of the compass card, as said before, is divided up into 360 parts, called degrees, and written 360°. There are 90° in each quadrant, as you will see by the figure below, and to read the compass in degrees, read from north or south to east or west; thus north-east is north 45° east.

Whilst speaking about compasses, it is interesting to note that a new device has been invented which will, if successful, rival the magnetic compass. This is what is called the "gyro compass," and works on the principle of the gyroscope. The device has an ordinary compass card, and is placed in the binnacle in the same way as an ordinary magnetic compass. A heavy disc is mounted inside the machine in a framework floating on mercury in such a way that the disc is kept absolutely vertical with its axis horizontal. It is driven at 20,000 revolutions a minute by a small electric motor. With this instrument the true and not the magnetic north is indicated, while, moreover, it is not affected by the metal in the ship, as in the case of the ordinary compass.

The gyro compass is a German invention, and it is said that the trials proved it to be so reliable that it is being introduced into some of the ships of the German Navy. It has also been tested in this country, and some of our men-o'-war are supplied with it.

The one weak point is the rotation of the disc, for if this falls below a certain speed, it becomes unreliable in operation. Dependence upon the electric motor might also arouse misgivings, and for these reasons it appears improbable that the new contrivance will ever wholly supplant our present compass, which for so many centuries has been the mariner's guide, philosopher and friend.

CHAPTER XIX

The Lead and Log

SOUNDING, or the ascertaining of the depth of water, naturally plays a very important part in navigation, for upon it depends, to a great extent, the safety of the ship. In olden days two methods of taking soundings were used, one of which was by using the "hand lead," and the other the "deep-sea lead."

The hand lead, which is still employed in shallow water, both by vessels of the Royal Navy and the mercantile marine, consists of a leaden weight of about 14 lb., made fast to the end of a tough, thin line. The latter, commencing from the base of the lead, is marked as follows; and, in case you may have forgotten it, let me remind you that a fathom is six feet:

2	fathoms	A piece of leather with 2 stripes.
3	,,	Ditto with 3 stripes.
5	,,	A piece of white cloth or bunting.
7	,,	A piece of red cloth or bunting.
10	,,	A piece of leather with a hole in it.
13	,,	A piece of blue cloth or bunting.
15	,,	A piece of white cloth or bunting
17	,,	A piece of red cloth or bunting.
20	,,	A piece of yarn with two knots in it spliced into the line.

All the above fathoms are known as "marks," while those not marked—that is, 1, 4, 6, 8, 9, 11, 12, 14, 16, 18, and 19, are what are called "deeps."

Ships are usually fitted with "chains," or small platforms projecting from the side of the vessel, and in these the men heaving the lead take up their position. In sailing ships the chains were often in one of the boats, hung on davits and projecting over the side, but in all cases the method of sounding is the same. The leadsman, after satisfying himself that everything is secure, eases the lead down towards the water until about 2 or 2¼ fathoms of the line are out. With the coil of line in the other hand, he then commences to swing the lead to and fro, like an ordinary pendulum, to obtain impetus, and having obtained sufficient, draws back his arm sharply as the lead comes horizontal. This motion causes the lead to fly round his head in a circle, and after two or three of these are completed he lets it go just before the lead becomes horizontal. This causes it to fly forward, taking the line with it. When the latter has finished running out it is drawn in with both hands, and when it becomes up and down under the leadsman he endeavours to obtain the necessary sounding by noting, when the lead is on the bottom, how much line is out. If the depth of water corresponds with one of the "marks" given above, he calls out "By the mark five!" or "By the mark thirteen!" etc., as the case may be, but if it corresponds with a "deep," he calls "By the deep four!" "By the deep nine!" etc. If the depth is a quarter or half a fathom *more* than any particular mark or deep, he calls "And a quarter seven!" "And a half nine!" etc.; but if it is a quarter of a fathom *less* than a mark or deep, he says, "And a quarter less seven!" "And a quarter less nine!" etc.

It will be readily understood that this form of sounding can only be used in shallow water, for the line is only marked to 20 fathoms. To take the depth, therefore, where the water is deeper, a longer line and a heavier lead was originally used, and is still supplied to many ships in case the sounding machine—to be described later—breaks down. The deep-sea lead weighs some 30 lb., and the line to which it is attached is 100 fathoms long. Up to 20 fathoms it is marked in the same way as the hand lead-line, but after this it has one knot at each five fathoms—i.e. 25, 35, 45, etc.; while at 30, 40, 50, 60, etc., it has three, four, five, six, etc., knots respectively.

In sounding with the deep-sea lead, the vessel is stopped or hove-to, and the lead-line is taken forward, outside everything, from right aft to the forecastle, where it is made fast to the lead. A number of men are stationed along the side of the ship, each one having a small coil of the line in his hand. When everything is ready, the lead is let go from forward, and, as each man tending the line feels it tauten, he throws his coil overboard and passes the word to the next man abaft him by saying, "Watch, there, watch!" The man who feels the lead touch bottom notes the amount of line out, and the depth of water is thus obtained.

Leads, both deep-sea and hand, and also those used with sounding machines, are hollowed out at the bottom, so that they may be "armed," as it is called. This arming consists of tallow or soap placed in the hollow, so that the nature of the bottom may be ascertained. If the latter is mud, sand, shingle, etc., portions will be found sticking to the tallow, while if it is rocky there will probably be indentations.

The process of heaving the deep-sea lead, as may be imagined, was a lengthy one, involving as it did the shortening of sail to stop the ship. Repeated sounding was out of the question, if not an actual impossibility, but it was not until Sir William Thomson—afterwards Lord Kelvin—whose genius has done such a lot for the present-day sailor, succeeded, in 1872, in obtaining a sounding of 2,700 fathoms in the Bay of Biscay that the old order of things commenced to change. To obtain this result he had used thin steel piano wire instead of the old-fashioned hempen line, and in 1874 he invented a deep-sea sounding machine, which was supplied to various vessels. Within two years, however, he outdid his own invention by producing a sounding machine on somewhat different but infinitely more successful lines. The apparatus, which could be employed with the ship in motion, is still in use, improvements, however, having been added from time to time. To give a brief description, it consists of a drum about a foot in diameter, upon which 300 fathoms of steel piano wire are tightly wound. To the end of the wire is attached a short length of plaited line, and to this is fastened the iron sinker. To the log line is made fast a thin brass tube with a removable cap, while the lower end of the tube is perforated. Before sounding, another glass tube, hermetically sealed at one end, and coated on the inside with chromate of silver of a light salmon colour, is placed inside it.

The drum is fitted with a brake cord, which controls its speed and eventually stops it when the lead reaches the bottom, and the wire is wound up again by means of a pair of winch handles, or, in the case of the very latest machines, by means of a small motor. As the lead descends, the water is forced up the glass tube by the pressure, which varies at different depths, and the action of the salt turns the salmon-coloured chromate of silver into chloride of silver of a milky-white hue. The tube, on being taken out of its brass sheath, is placed alongside a boxwood scale graduated in fathoms, and the depth is read off opposite the line of demarcation between the two colours. With these machines soundings can be obtained with very great rapidity, and with the ship travelling at any speed, so it will be understood how greatly the modern seaman has benefited by the invention of Lord Kelvin.

The Lead and Log

The Log

Before considering the question of how speed is measured at sea, we had better, I think, go into the subject of the "knot" and the "nautical mile." These two are often confounded, and how frequently does one hear or read the expression that such and such a ship travelled so many "knots an hour." It is quite wrong, for the *knot* is the world's unit of nautical speed, and "ten *knots*," or "twenty *knots*"—the "an hour" being omitted—means that the ship is travelling ten or twenty nautical miles an hour. Therefore, never use the term "knots an hour."

The statute or *land mile,* as we all know, is 5,280 feet, or 1,760 yards, but the *nautical mile,* on the other hand, varies slightly with the latitude, for it is 6,046 feet at the equator and 6,109 at the poles. As it is impossible to use two units, the distance of 6,080 feet—2,026.6 yards—is almost universally used, and it will be noticed that this is 800 feet longer than the statute or land mile. For roughly converting one into the other it is as well to remember that 15 land miles equal 13 nautical miles.

In olden days, when sailing ships proceeded at a very leisurely gait—anything from two to six knots—it is said that the speed was ascertained by the method known as the "Dutchman's log." A chip of wood, an empty bottle, or any other small object which would float, was thrown overboard from forward, and the time it took to pass between two marks on board the ship, the distance apart of which was known, was carefully noted. A simple proportion sum thus gave the speed the ship was actually travelling at the time the object was thrown overboard.

The hand log, as utilised at the present time, is only useful for comparatively low speeds. It consists of what is known as a "log ship," a piece of wood in the shape of a part of a circle, the curved edge of which is weighted with lead to keep it upright in the water. Three lines, one of which is fitted with a peg, attach the log ship to the log line, by which it is towed behind the ship.

The log line is 150 fathoms in length, and the first part of it nearest the wooden contrivance is known as the "stray line." This stray line takes the log ship clear of the disturbed water in the wake of the ship, and is 90 feet long, its inboard end being marked by a piece of bunting. The marking of the line commences from here, and it is equally divided into parts called knots and half-knots, being marked as follows: 47 feet 3 inches from the bunting is a piece of leather spliced into the line, and this denotes the first knot or mile; at every succeeding 47 feet 3 inches a number of knots are placed denoting the number of miles or knots; while between every knot is a half-knot, marked on the line with a single knot.

In connection with this form of log, second or sand glasses of the ordinary type are used to ascertain the time taken by the knots to run out. These glasses are usually of two kinds, the 14- and the 28-second, and when using the former the number of knots shown by the line must be doubled to find the speed of the ship. The division of knots on the line bears the same proportion to a nautical mile as the time in which the log glass runs out does to an hour. This can easily be worked out as follows:

$$\text{1 hour (3,600 seconds)} : \text{28 seconds (time of glass)} :: \text{1 nautical mile (6,080 feet)} : \text{Length of knot on the line}$$

$$\text{Therefore length of knot on the line} = \frac{28 \times 6080}{3600} = \text{47 feet 3 inches}$$

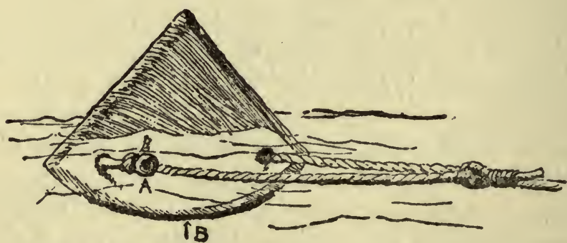
The log line is usually wound up on a reel, and to "heave the log," as it is called, the peg is first inserted in the hole in the log ship. The latter is then thrown overboard from the stern of the vessel, the question "Is the glass clear?" having been previously asked. The wooden segment, on dropping into the water, remains stationary and carries the line away with it, and when the piece of bunting marking the end of the stray line passes the person who is heaving the log the latter calls "Turn!" to the man with the sand-glass. The latter, when all the sand has run out of the glass, cries "Stop!" upon which the line is checked and the nearest mark looked for, which shows the rate at which the ship is travelling. When the strain comes on the line the peg is pulled out, and the wooden log ship floats flat upon the surface of the water, in which position it is more readily hauled in.

Patent Logs

The method of finding the speed by heaving the log soon became inconvenient when high-speed steamers were built, and what are known as "patent logs" were invented before very long.

There are many different kinds of these now upon the market, but the ones in most common use are those manufactured by Messrs. T. Walker and Son.

The "Neptune" log is made to register accurately at high rates of speed, 18 knots and upwards, while the smaller "Cherub," working on exactly the same principle, is used for lower speeds. The registering apparatus consists of a brass cylindrical box fixed to the stern of the ship, and inside this box are wheels to transmit the revolution of the rotator at the end of the line to the pointer on the dial face of the box. Ball bearings ensure freedom from all unnecessary friction, and a governor wheel is fitted a short distance down the line to prevent vibration and the jerkiness of action caused by the length of the line. The length of the latter varies, but is usually from 60 to 100 fathoms. The rotator is made fast to the end of this line, and, being in the water, the forward movement of the ship causes it to revolve by the water impinging upon the vanes or blades. This rotation is transmitted up the line to the machinery in the log, and the distance the ship has travelled is thus shown on the dial face, which, it will be noticed, is marked up to 100 miles. Two small dials, one showing tenths of a mile and the other hundreds of miles, are also fitted. In a ship at sea the patent log is usually reset or put to zero each day at noon, and in some cases at noon and at midnight. Some of the later Neptune logs are now fitted with an electrical device inside the case of the registering apparatus fixed on the stern, and wires leading up to the navigating bridge cause the reading of the log to be shown on a similar dial in the chart house. This device is of very real use, for the log is thus constantly under the eye of the officer of the watch.



LOG SHIP
A PEG
B LEAD.

CHAPTER XX

Bends, Hitches, Knots and Splices

Half Hitch.—Used generally, and often in conjunction with other hitches.

Timber Hitch.—For securing the end of a rope to a spar; also for making a rope fast round light cases and bales.

Clove Hitch.—For general use and for making a rope fast to a spar.

Rolling Hitch.—For making a small rope fast to a larger one.

Round Turn and Two Half-Hitches.—For securing a rope to the ring of a buoy.

Marline-spike Hitch.—Is used for making the turns of a rope tight with a marline-spike. It can also be used for hooking the hook of a tackle to a rope where a light pull is required.

Blackwall Hitch.—Is used for hooking a tackle to a rope; and also for bringing the end of one tackle to the double block of the other.

Double Blackwall Hitch.—Used for the same purpose as the Blackwall Hitch, but is not so liable to slip.

Half Hitch and Timber Hitch.—Is used for towing a spar, the large end of which should be towed first.

Marling Hitch.—Is used for lashing two spars together temporarily.

Midshipman's Hitch.—Is used instead of a Blackwall Hitch if the rope is at all greasy.

Fisherman's Bend.—Used for tying a rope to the ring of an anchor.

Carrick Bend.—Used for tying two ropes together when they are required to go round a capstan or bollard.

Single-sheet Bend and Double-sheet Bend.—Both used for securing a boat's painter (the rope in the bows) to any object with a hole in it.

Bowline.—Used for slinging a man over the side of a ship, and also for binding two hawsers together.

Running Bowline.—Forms a running noose for throwing over anything out of reach.

Bowline on the Bight.—Used for lowering an injured man from aloft or from a window.

Reef Knot.—Used for tying the reef points of sails and also for joining two ropes together.

An *Overhand Knot.*—Used for preventing the end of a rope unreeving through a block.

A *Figure of Eight Knot.*—Used for the same purpose as an overhand knot.

Inside Clench and Outside Clench.—Used for securing the standing end of a rope. An inside clench is more secure than the other, for it is less liable to jam.

A *Sheepshank.*—Used for temporarily shortening a rope which requires lengthening again. If any strain is to be put on the rope the two eyes should be seized to the rope.

Cat's-paw.—Used for hooking the hook of a tackle to the end of a rope.

Hawsers or other large ropes are made fast by two half-hitches and seizing the ends.

A *Hook is Moused* to prevent it becoming unhooked.

A *Stopper* is used for securing a rope on which there is a heavy strain while it is being made fast.

A *Parbuckle* is used for hauling up or lowering a cask where no crane is available.

Slinging a Cask.—There are various methods of doing this. It is slung on end if the head is damaged, and where slinging it in the ordinary way would spill the contents. Other methods of slinging a cask are by means of Bale Slings, Can Hooks, and Butt Slings.

To secure a rope round a cleat, take a round turn and then put a figure of eight knot round the cleat and repeat it at least twice. On no account put a half hitch over the pin or cleat afterwards, for the main object is to make certain that the rope will not jam.

Splicing

Splicing, or the joining together of two ropes, is an operation which is carried out very often on board ship, but there are many other occasions ashore when a knowledge of splicing ropes comes in very handy, so I will describe the more important splices in detail.

A *Short Splice* is used for joining ropes which are not required to travel through blocks, for the splice itself enlarges the diameter of the rope.

To make a short splice, first unlay or unwind one rope for about 18 inches and the other for 12 inches, in the case of small rope. Then marry the two ropes together, and after pulling them tightly together tie them in this position.

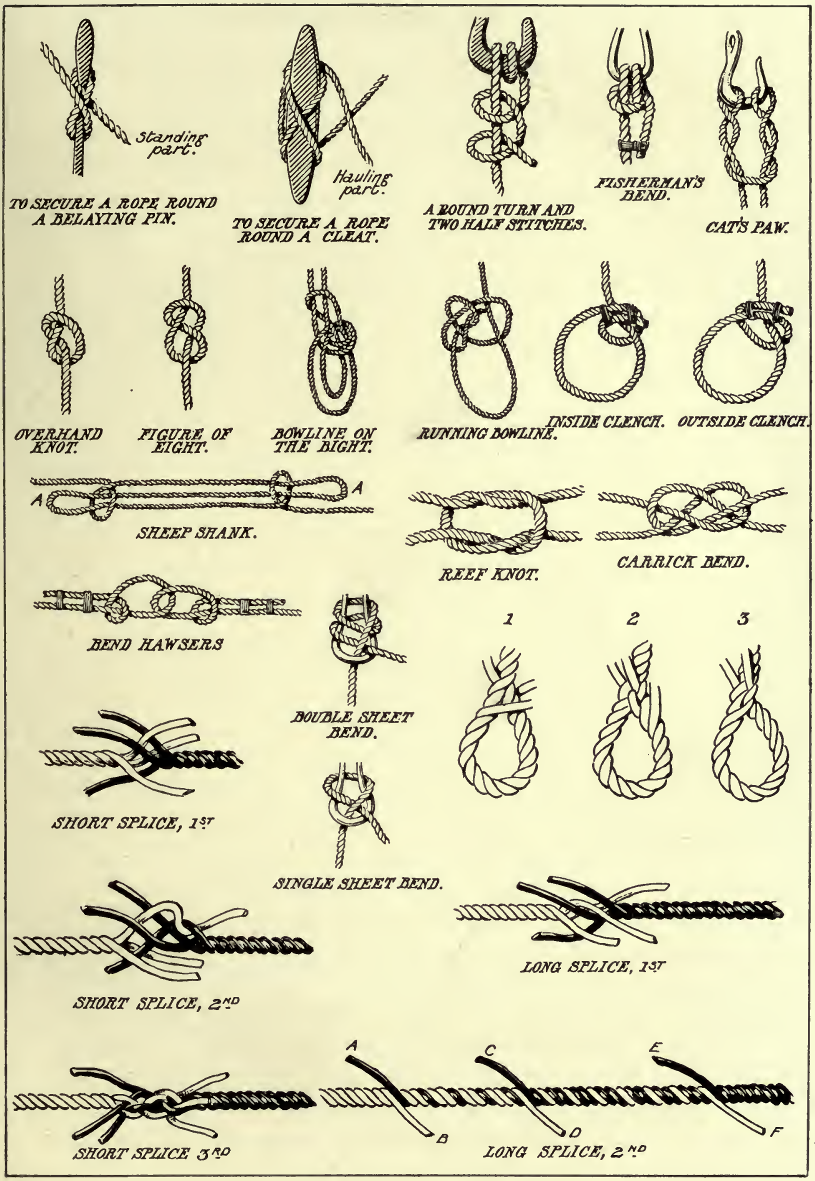
Now tuck the long ends in twice, and the short ends once, passing the left-hand strand *over* the first strand next to it, and then *underneath* the second strand. Haul it taut and then enter the right-hand strand, and lastly the middle strand, in a similar manner to the first or left-hand strand. Then haul taut again, put the long ends in as before and cut them off. Now put the short ends in again, stretch the splice, and cut them off. The splice is then complete.

A *Long Splice* is used for splicing a rope which has to pass through a block, as the circumference of the rope is not altered.

First unwind the ends of the two ropes to be joined to the length of five and a half times their circumference, and marry them together in a similar manner as when you were making a short splice. Then unlay one strand, and fill up the vacant space it leaves with the opposite strand next to it. Then turn the rope round and take the next two strands that will come opposite each other, unlay one and fill up the vacant space as before. Now take one-third out of each strand, and knot the opposite strands together; heave them well into place, and then tuck all six ends under one strand, and cut their ends off after having well stretched the splice. The join is then complete.

An *Eye Splice* is used when you wish to make an eye in the end of a rope. First bend the end of the rope down, having just opened out the strands, and leaving the middle strand on the top of the rope. Then dip the middle strand under the top strand from right to left. The left-hand strand is then forced from right to left over the middle strand and under the next to the left. The rope is now turned round to the left so as to bring the remaining strand on top, and then tuck it from right to left under the strand not already used. Dip all three strands a second time and finish the splice by splitting the strands, and taking half of each and seizing them together. Then cut the ends off. The splice should then be sewed, that is, whipped round with yarns, to prevent chafe.

Splicing is a rather difficult matter to explain on paper, and an hour's instruction from a coastguardsman or fisherman will teach you far more about it than any amount of reading will do. When next you are at the seaside, therefore, I should strongly advise you to make friends with some seafaring man who can give you practical help with it.



BENDS AND SPLICES.

Bends, Hitches, Knots and Splices

A Few Notes on Rope

Yarns are the threads in a rope, and each one is supposed to bear a weight of 100 lb.

Rogues' Yarn.—All hemp rope manufactured in the Government dockyards is marked by a distinguishing yarn of coloured jute laid up in the other yarns. Portsmouth-made rope has a red yarn in it, Plymouth a blue, and Chatham a yellow. The idea of this is so that all Government rope can be easily identified.

Strands consist of a number of yarns laid up together, the number depending upon the size of the rope the strands are to form.

Spun Yarn is a number of yarns twisted up together.

Rounding is old rope cut up and supplied for lashing, etc.

Oakum is old rope unlaid and unpicked.

Coir or Grass Rope is made from the fibre of the coco-nut tree. It is one-third lighter than hemp rope of the same size, but it is not so durable, as it rots if it is not thoroughly dried after use. This sort of rope floats, so it can be used for warping boats and ships.

Hemp hawsers are generally supplied in coils of 113 fathoms, 678 feet, and both hemp and grass rope is always measured by its circumference. The following is a rough method of finding the breaking, proof, and working strains of hemp rope up to 6 inches in circumference. Square the size of the rope and divide by 3, 4, and 6, the result being in tons.

For instance, with a 3-inch hemp rope:

Breaking strain $= \frac{3^2}{3} =$ 3 tons.
Proof Strain $= \frac{3^2}{4} =$ 2.2 tons
Working Strain $= \frac{3^2}{6} =$ 1.5 tons

Above 6 inches the factor is $3\frac{1}{3}$ for finding the breaking strain; thus, the breaking strain of a 21-inch hemp hawser (ropes of this size were used for cables in large ships before chain was adopted) is:—

$$\frac{21^2}{3\frac{1}{3}} = \frac{441}{\frac{10}{3}} = 132.3 \text{ tons.}$$

Coir or grass rope has the same strength as hemp rope of the same size.

Wire rope.—All rope of this description is six stranded, and is invariably made of steel. There are two different kinds, flexible and non-flexible, and the former is used for ordinary work, while the latter is utilised for standing rigging, etc. All wire rope is very carefully tested before issue, and remember that rope of this kind is measured by its circumference in the same way as that made of hemp.

The following is a rough method of ascertaining the strength of steel wire rope. For non-flexible wire, square the circumference and multiply by 2½, the result being in tons. Thus, for 4-inch non-flexible wire, breaking strain = $4 \times 2\frac{1}{2} = 40$ tons. For flexible wire, square the circumference and multiply by 2 if the hawser is of 4½ inches or under, and by 2¼ if it is over this size. Thus, for 4-inch flexible wire, breaking strain = $4^2 \times 2 = 32$ tons; and for 6-inch flexible wire, breaking strain = $6^2 \times 2\frac{1}{4} = 81$ tons.

The working strain of a flexible wire rope is usually about a fifth of the breaking strain.

Purchases

Purchases or tackles are used for hoisting heavy weights where a single rope would not suffice. Fig. 1 shows a "single whip," as it is called, and in this the rope passes through a single block. No power is gained, but the whip is useful for many purposes, such as for hoisting light articles out of a boat.

There is, however, a purchase called a "double whip" which is used for all common purposes where the single whip is not powerful enough. If you pull on the end of the rope marked X with, say, a weight of 20 lb., you will be able to lift a weight of 40 lb. attached to the hook Y. In this way your power is doubled, but it must be remembered that the hook Y will move upwards at half the speed the end X is being pulled by you. Fig. 3 shows a "luff tackle," which is, perhaps, the most commonly used of all tackles, and is most frequently seen in use on board ship. In this case the power with which you pull on the rope is multiplied by three or four, according as to whether the lower or the upper block is the moving one. What is known as a "threefold purchase" consists of a rope rove through two threefold blocks—that is, blocks with three sheaves or rollers, and in this case the power gained is six or seven times the original, according to which is the moving block. Similarly in a "fourfold purchase" the power gained is eight or nine times the original.

A general rule to find the power gained by any particular kind of purchase is to count the number of parts of rope at the moving block and to multiply this by the weight you are putting on the free end. Thus, in a threefold purchase there are six parts at the lower block, perhaps, so if you are putting a 25-lb. pull on, the rope will be able to lift $6 \times 25 = 150$ lb.

Parts of a Block

The *Shell* is the outside case.

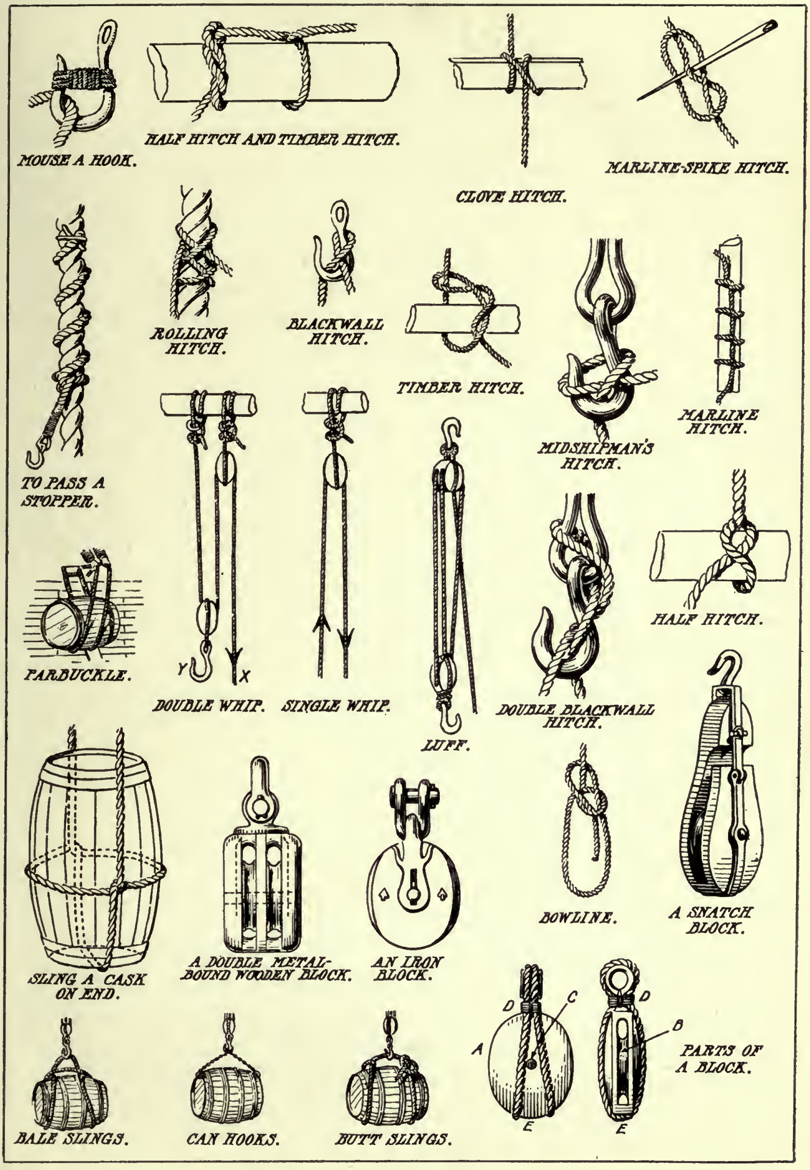
The *Sheave* is the wheel on which the rope travels, and is usually made of brass, lignum-vitæ (a very hard wood), or iron.

The *Pin* is made of iron, and passes through the shell of the block and through the centre of the sheave.

The *Crown* is the top of a block, while the bottom is known as the *Tail*.

Besides wooden blocks, there are many kinds of iron blocks used for different purposes, but they are all constructed on the same principle as the wooden ones.

A *Snatch Block* is usually an iron-bound wooden block with part of the shell cut away to allow of any part of a rope to be lifted in or out of the block without putting the end through first. A hinged clamp is fitted to prevent the rope jumping out.



BLOCKS, SLINGS, HITCHES, ETC.

CHAPTER XXI

Charts—and Something About Them

NAVIGATION may be defined as the art of taking a ship from place to place, and it also implies that at any given time you are able to discover exactly where your vessel is. In olden days navigation was more or less a hazardous undertaking, and ancient seamen rarely left the vicinity of the coast, but hugged the land by day, and either anchored or steered by the stars at night. In the course of time, however, when the compass came into general use, and navigation instruments were manufactured which could be relied upon to give a position with a tolerable degree of certainty, mariners undertook longer voyages out of sight of land, but at all times a chart or map of the ocean they were to traverse formed an important item in the equipment of voyagers. It can be readily understood, however, that a chart of an ocean or harbour cannot be made until the place has been visited, and therefore the earliest navigators had little to guide them in their voyages except a very primitive form of compass. Ships in those days, however, travelled very slowly—six knots, perhaps, under the most favourable conditions—and this speed would enable the depth of water to be taken at frequent intervals, so that the mariner would usually get a fair inkling when he was approaching land by the shoaling of the water.

A chart is simply another name for a map, but whereas the latter represents the land, the former shows the sea. Hills and valleys exist on the bed of the ocean in the same way as they do ashore, and in a modern chart of a much frequented expanse of water these are all shown. The first modern sea charts were brought to England in 1489 by Bartholomew Columbus to illustrate his brother's theory respecting the existence of a western continent, but in those days and for many years subsequently their accuracy left much to be desired. In a present-day chart the exact position of every lighthouse, lightship, sandbank, shoal, rock, buoy, prominent building, etc., is marked, and not only this, but at frequent intervals in the expanse representing the water will be found row after row of numbers showing the depth. In the large scale charts of harbours, where three inches of paper perhaps represents a mile of actual water, these soundings, as they are called, will be in feet; in coastal and ocean charts, however, drawn on a smaller scale, they will be in fathoms (1 fathom = 6 feet), the fact as to which unit is used being mentioned in the title of the chart itself.

Now, perhaps, if you have thought about the subject of depth, you will ask, How is it that the depth of water can be placed on the chart, for it is constantly changing, due to the varying height of the tide? The answer to the question is as follows: All the depths shown on a chart are reduced to the state of the tide known as "low water ordinary springs," so on ordinary occasions you will usually get a greater depth in any particular locality than that shown on the chart. It sometimes happens, though, when the tide is extraordinarily low, that the depth will be less than that shown, but this the mariner can always ascertain by referring to his tide tables.

In England there is a Hydrographical Department, under the control of the Admiralty, which is constantly employed in making and correcting charts. Surveying ships manned by officers and men of the Royal Navy are constantly at work at home and abroad, and the results of their observations are sent home and are made into charts, which can eventually be purchased by anyone. When it is recollected that every inch of coast has to be surveyed, every rock and shoal accurately marked, and every depth actually taken by hand with a lead line, it will be seen that the work performed by the surveying branch of the Royal Navy is by no means easy. They work in comparative obscurity, it is true, but on the result of their labours depends the safety of many ships, and they have the satisfaction of knowing that the British Admiralty charts are the best in the world, and that is saying a great deal.

As you all know, the earth is roughly spherical, so you might ask how a portion of this sphere can be accurately represented on a flat piece of paper. When a very small portion of the earth's surface is to be shown, it can be taken as being approximately flat, and can be laid off a paper easily enough; but when it comes to constructing an ocean chart—covering, perhaps, a third of the earth's surface—it is a very different matter, for the curvature of the earth brings in a large error. This difficulty is overcome, however, by the discovery of Mercator's Projection, so called from its inventor, who lived during the sixteenth century. In a chart of this kind the figuration of the land and water at the Equator is quite accurate, but as the Poles are approached the drawing is out of all proportion. The distortion, however, is made on a regular scale, and the true relative direction of one part of the world from another is obtained, so the track of a ship steering one course can be laid off in a straight line.

The soundings marked on charts are of very great importance, for in thick weather the master of a ship can only tell where he is by the depth of the water. In the English Channel, for instance, which is very minutely surveyed, soundings can be taken at frequent intervals, and these, taking into consideration the speed of the ship, can be applied to the chart, and will give an accurate position. It is no rare thing for a ship to feel her way up-Channel by soundings alone, and in a fog so dense that land has been invisible the whole time; and this result could not have been obtained if the charts were not strictly accurate.

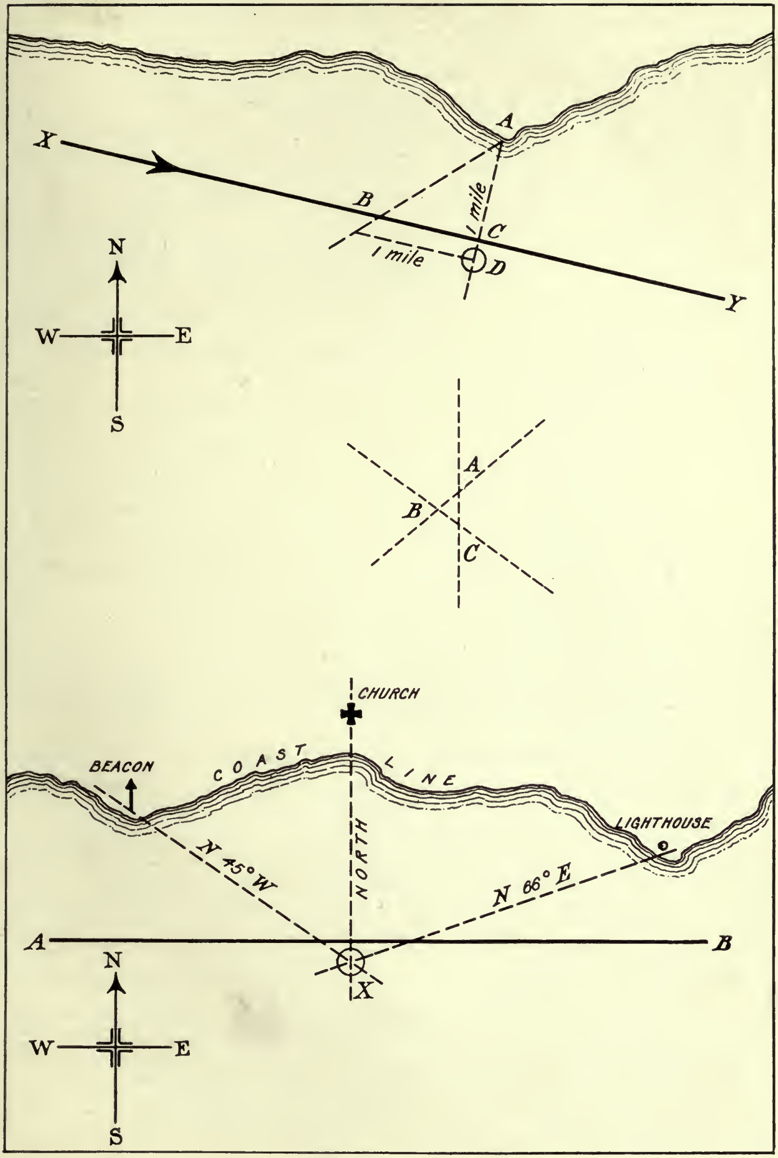
Alongside some of these depths marked on the chart are often seen small letters, such as blk. speck. sh. s., etc., and these are abbreviations denoting the nature of the bottom, the example we give meaning black speckled shells and sand. Other similar abbreviations show that the bottom is composed of rock, mud, clay, etc. By means of the "armed" lead, soundings can be taken by which the master of a vessel can ascertain the nature of the bottom over which his ship is sailing—knowledge which in a fog is sometimes extremely useful in determining his whereabouts.

There are various other abbreviations used in charts, and alongside buoys marking a channel you will sometimes see: R., B., B.W.H.S., R. W. cheq., R.W.V.S.; which mean red, black, black and white horizontal stripes, red and white chequered, red and white vertical stripes. This enables a buoy to be recognised at a glance.

Lights of all kinds are shown by a yellow splash with a red dot in the centre, while a description of the light is placed alongside it. Thus, Lt. occ. ev. 10 secs. means light occulting every ten seconds. As to the difference between the various species of lights, however, I must refer you to Chapter XXV.

On the shore there are various conventional signs which mean different things, and a few of the more important ones are illustrated here.

The subject of ocean navigation when out of sight of land is too vast to be treated of here, but I will give a brief description of coastal navigation, so that you


X
A
B
mile
C
1 mile
D
Y
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E
S
A
B
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CHURCH
BEACON
COAST LINE
LIGHTHOUSE
N 45° W
NORTH
N 66° E
A
B
X
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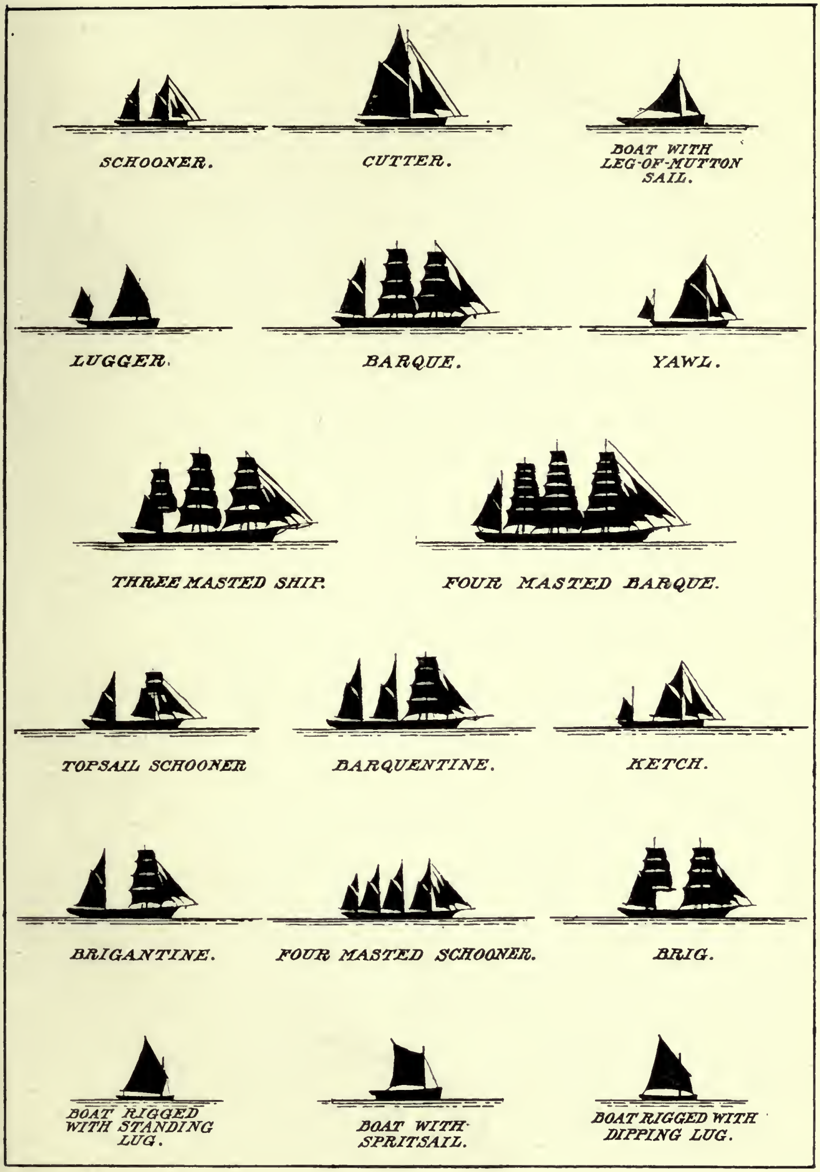
S

CHARTS.



RIGS OF SAILING VESSELS.

can see how a ship is taken from place to place in sight of the shore: Now, suppose a vessel is sailing along close to the coast on a line A B, and she wishes to find out her exact position. On the land there are three prominent, well-defined objects in sight, namely, a beacon, a church, and a lighthouse. An officer goes to the compass and takes bearings (that is, he ascertains the direction by compass) of all three, and these are laid off from the compass on the chart and lines are drawn through the various objects. The bearings have all been taken practically simultaneously, and suppose that of the beacon to be, approximately, N. 45° W., that of the church N., and that of the lighthouse N. 66° E. Now, the ship is on all these lines at the same time, and her position is therefore marked by the spot at which they all intersect, i.e. the circle marked X.

This is one of the simplest ways of fixing the position of a ship. If possible, three bearings are always taken, for the third, as a rule, checks the other two. Sometimes the lines do not exactly intersect, and we get what is called a "cocked hat," and this shows that there is a small inaccuracy somewhere, either in the compass itself or in the taking of the bearings. If the triangle is small, the position of the ship may be taken as being the centre of the triangle; but if it is large, the bearings should be retaken.

Another method of obtaining the position of a ship is what is known as the "four-point bearing," and this is useful when it is required to know how far off an object is when it is abeam, or exactly at right angles to the course on which the ship is proceeding.

Suppose A to be a conspicuous object ashore, and suppose the ship is travelling along the line X Y in the direction of the arrow head. It is required to know how far off A is when it is abeam. Let us assume the course to be south 80° east. Now, 45° to the northward of this is N. 55° E., and the time is taken when the ship is on this bearing—that is, the line A B. The ship goes on, and when the object A is exactly abeam—i.e. N. 10° E., exactly at right angles to the course—the time is again taken. In the triangle A B C the angle A B C is 45°, B C A is a right angle or 90°, which therefore makes B A C also 45°. B A C is thus an isosceles triangle, with B C equal to A C; and thus it will be seen that the distance you are off the object at the time you took the second bearing is the same as the distance you have travelled in the time between the first and second bearings. Let us suppose the ship is travelling 10 knots, and that the interval between the bearings is 6 minutes. Ten nautical miles in 60 minutes means one mile in six minutes; therefore, you are one mile off the object, or at the spot D. I must apologise for introducing that hated subject Euclid, but it only points out how useful a knowledge of it is in modern coastal navigation.

CHAPTER XXII

Rigs of Sailing Vessels

Any vessel which floats, except perhaps an open boat, is commonly called a "ship," but in referring to sailing craft a ship or ship-rigged vessel is one with three, four or five masts, with square sails on all of them. By square sails are meant those which are set on yards slung at right angles to the fore-and-aft line of the vessel.

Many of the larger ocean-going sailing vessels are rigged in this manner, and the majority have three masts. Four-masted ship-rigged vessels are by no means rare, but those with five are seldom seen in English waters, the majority of the latter hailing from the United States.

In five-masted vessels the masts are named as follows, commencing from forward:

(1) Foremast.
(2) Mainmast.
(3) Mizen-mast.
(4) Jigger-mast.
(5) After jigger-mast.

A *barque* is usually a three- or four-masted vessel carrying square sails on all her masts except the after one, on which she has fore-and-aft sails alone—i.e. those which are set in the fore-and-aft line of the vessel. Three-masted barques are the ones most frequently seen, but many of the larger four-masted vessels are barque rigged.

A barquentine is, again, a three-masted vessel, but carries square sails on her foremast only. On the main and mizen-masts she has the usual fore-and-aft sails.

A *brig* is a two-masted vessel carrying square sails on both masts. This rig is comparatively rare nowadays, although as lately as nine years ago vessels of this type were still used for training boys for the Royal Navy.

A *brigantine* has two masts and is fully square rigged on the fore, while on the main she carries fore-and-aft canvas only. This rig is rather an unusual one at the present time.

A *topsail schooner* is usually a two- or three-masted vessel carrying a square topsail and topgallant sail on the foremast and fore-and-aft sails on all the masts. Two-masted vessels of this type must not be confounded with a brigantine, which carries nothing but square sails on her foremast. Many of the smaller sailing craft plying between the ports of the United Kingdom are rigged as topsail schooners, as it is a most easily managed rig and requires few men to handle it.

Schooners are two-, three-, four- or five-masted craft carrying fore-and-aft sails on all their masts. Two-masted vessels of this type are those most ordinarily seen, and many yachts, foreign pilot vessels and other small craft are rigged in this manner. Four- and five-masted schooners are not often seen round about the United Kingdom, but in the United States they were comparatively common a short time ago. The largest schooner in existence is one with seven masts, launched in 1903 in Maine, U.S.A. Her registered tonnage is about 2,750, while she has a carrying capacity of some 5,000 tons.

A *yawl* is a two-masted vessel with fore-and-aft sails only. The after mast—called in this case the mizen—is much shorter than the other. The rig, being an easy one to handle, is seen in many yachts, barges and fishing smacks.

A *ketch* is the same as a yawl, except that the mizen-mast is stepped well before the rudder-head, whereas in a yawl it is placed right aft in the stern.

A *cutter* is a one-masted vessel carrying fore-and-aft sails only. Most of the British pilot boats, many of the large racing yachts, including Sir Thomas Lipton's well-known *Shamrock*, are cutter rigged. The old revenue cutters were good examples of this type of craft. The cutters in use in the Royal Navy in the time of Nelson—there was one, the *Entreprenante*, present at the battle of Trafalgar—carried one mast, which raked, or sloped, well aft. They carried the usual fore-and-aft canvas, but also one square topsail on a yard. Vessels of this description are still occasionally seen on the Dutch, German and Danish coasts.

Broadly speaking, a *lugger* is any vessel which carries a lugsail, and of these there are two different kinds, known as the "dipping lug" and the "standing lug." In the former a large portion of the sail is in front of the mast, and this means that every time the boat is put about from tack to tack the sail must be dipped according to whether the wind is brought on the port or starboard side. A standing lug is often seen in small boats which have only one sail. It is a handy rig and very easily managed, for it has not to be dipped when the boat goes about from tack to tack. The majority of luggers seen nowadays are fishing craft, and those hailing from Penzance and the East of Scotland are nearly all rigged in this way.

Other sails sometimes seen in boats and larger craft are "spritsails" and "leg of mutton" sails. The former is spread on a "sprit" or spar stretching from the foot of the mast diagonally across the sail; while the latter is a simple triangular sail, which is called by its peculiar name on account of its resemblance to the shape of a leg of mutton.

Standing and Running Rigging

The standing rigging in the larger sailing ships is now almost entirely made of steel-wire rope, which is very necessary on account of the heavy strain brought on the masts when all the sails are set or when the vessel is pitching or rolling in a heavy sea. The veritable network of ropes aloft in a sailing ship are puzzling to the unnautical eye, but every single rope has its own particular use and is known by its own name.

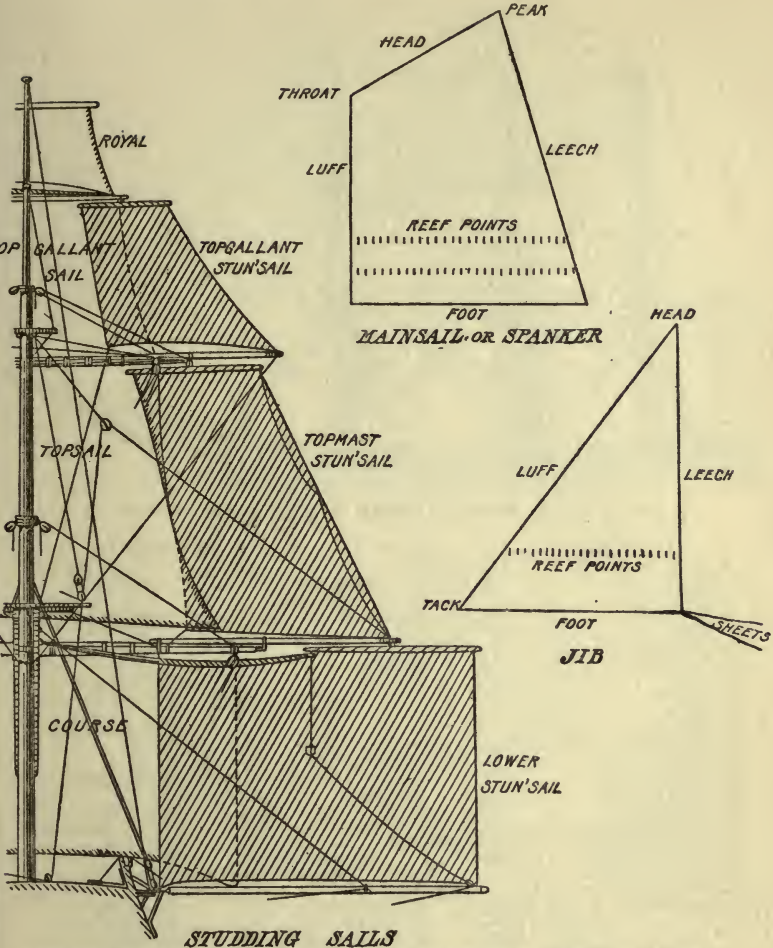
All the ropes shown in the diagram of the "hull and standing rigging of a ship" are immovable, or "standing," while those shown in the "running rigging of a ship" move and are required for working the sails.

The Sails of a Ship

The sails of a ship-rigged sailing vessel are all enumerated in the diagram. The vessel illustrated, it will be noted, carries what are known as "double topsails" and "double topgallant sails." This simply means that the original area of the sails has been divided into half and extra yards fitted. This reduces the manual labour of furling, for there are two smaller sails instead of the one large one.

"Studding sails" are the extra square sails set from the yards to attain a greater speed when a ship is running before the wind.

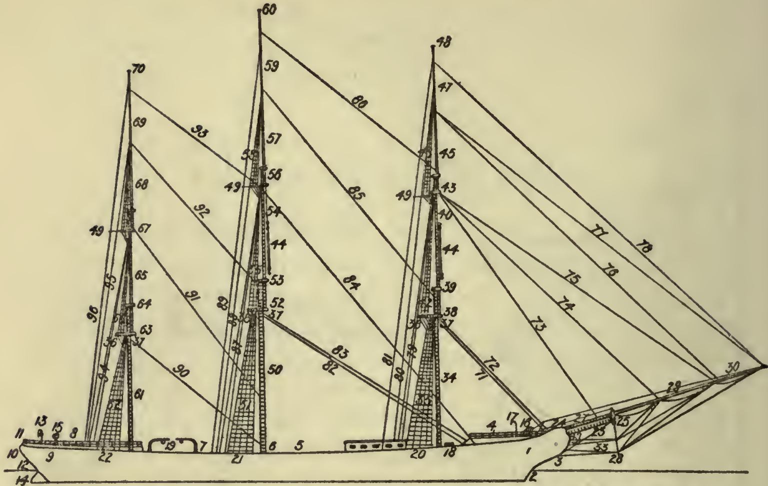
Rigs of Sailing Vessels



STUDDING SAILS, AND DIAGRAMS SHOWING PARTS OF A SAIL

Head.—The upper edge of a sail.
Luff.—The foremost edge of a sail.
Leech.—The after edge of a sail.
Foot.—The lower edge of a sail.
Throat.— The upper foremost corner.
Peak.—The upper after corner.
Tack.—The lower foremost corner.
Clew.—The lower after corner.
Halliards hoist the sail into position.
Sheets keep the sail set in position, and are hooked to clew.

Tack Tackle is used to bowse the tack down.
Cringles of various sizes are worked into the corners of the sails, and at each end of each reef.
Eyelet Holes are worked into the head of sails, for bending the sails to the yard or gaff.
Reef Points are pieces of line worked into and through the sail for stopping up reefs.



THE HULL AND STANDING RIGGING OF A SHIP

THE HULL.

1. Bow.
2. Stem.
3. Heads.
4. Forecastle.
5. Waist.
6. Gangway.
7. Quarterdeck.
8. Poop.
9. Quarter.
10. Stern.
11. Taffrail.
12. Counter.
13. Wheel.
14. Rudder.
15. Binnacle.
16. Cathead.
17. Anchor davit.
18. Sidelight box.
19. Boat davits.
20. Fore chain.
21. Main chain.
22. Mizen chain.

THE BOWSPRIT.

23. Bowsprit.
24. Gammoning.
25. Bowsprit cap.
27. ,, horses.
28. Dolphin striker.
29. Jib-boom.
30. Flying jib-boom.
32. Bobstays.
33. Martingale.

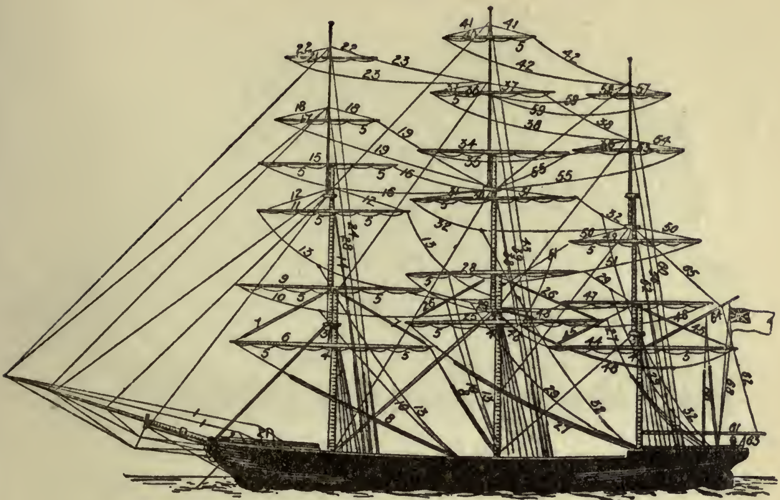
MASTS, &c.

34. Foremast.
35. ,, rigging or shrouds.
36. Futtock shrouds.
37. Lubber's holes.
38. Fore-top.
39. ,, mast cap.
40. ,, topmast.
42. ,, ,, rigging.
43. ,, ,, cross-trees.
44. Burtons and pendants.
45. Fore-topgallant mast.
46. ,, ,, rigging.
47. ,, royal-mast.
48. ,, truck.
49. Backstay outriggers.
50. Mainmast.
51. ,, rigging or shrouds.
52. Main-top.
53. ,, mast cap.
54. ,, mast.
55. ,, ,, rigging.
56. ,, ,, cross-trees.
57. ,, gallant mast.
58. ,, ,, rigging.
59. Main royal mast.
60. ,, truck.
61. Mizen-mast.
62. ,, rigging or
63. Mizen-top. [shrouds.
64. ,, mast cap.
65. Mizen topmast.
66. ,, ,, rigging.
67. ,, ,, cross-trees.
68. ,, topgallant mast.
69. ,, royal mast.
70. ,, truck.

STAYS.

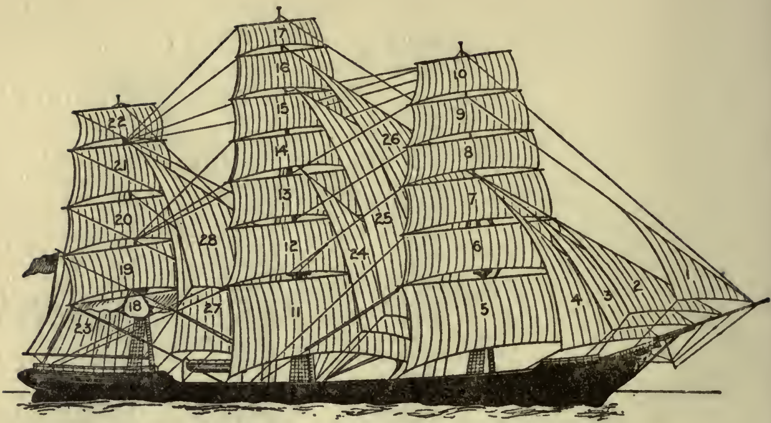
71. Fore preventer stay.
72. Fore stay.
73. ,, topmast stay.
74. Inner jib stay.
75. Outer jib stay.
76. Fore topgallant stay.
77. Flying jib stay.
78. Fore royal stay.
79. ,, topmast backstays.
80. ,, topgallant ,,
81. ,, royal ,,
82. Main preventer stay.
83. Main stay.
84. ,, topmast stay.
85. ,, topgallant stay.
86. ,, royal stay.
87. ,, topmast backstay.
88. ,, topgallant ,,
89. ,, royal ,,
90. Mizen stay.
91. ,, topmast stay.
92. ,, topgallant stay.
93. ,, royal stay.
94. ,, topmast backst'ys.
95. ,, topgallant ,,
96. ,, royal ,,

Rigs of Sailing Vessels



THE RUNNING RIGGING OF A SHIP

1. Jib-boom guys.
2. Whiskers.
3. Slings of fore, main and mizen yards.
4. Goosenecks do. do. do.
5. Stirrups and footropes.
6. Fore yard.
7. ,, lifts.
8. ,, braces.
9. Lower fore-topsail yard.
10. ,, ,, braces.
11. Upper ,, yard.
12. ,, ,, lifts.
13. ,, ,, braces.
14. ,, ,, halliards.
15. Lower fore-topgallant yard.
16. ,, ,, braces.
17. Upper ,, yard.
18. ,, ,, lifts.
19. ,, ,, braces.
20. ,, ,, halliards.
21. Royal yards.
22. ,, lifts.
23. ,, braces.
24. ,, halliards.
25. Main yard.
26. ,, lifts.
27. ,, braces.
28. Lower main-topsail yard.
29. ,, ,, braces.
30. Upper ,, yard.
31. ,, ,, lift.
32. ,, ,, braces.
33. ,, ,, halliards.
34. Lower main-topgallant yard.
35. Lower main-topgallant braces.
36. Upper ,, yard.
37. ,, ,, lifts.
38. ,, ,, braces.
39. ,, ,, halliards.
40. Main royal yard.
41. ,, lifts.
42. ,, braces.
43. ,, halliards
44. Cross-jack yards.
45. ,, lifts.
46. ,, braces.
47. Lower mizen topsail yard.
48. ,, ,, braces.
49. Upper ,, yard.
50. ,, ,, lifts.
51. ,, ,, braces.
52. ,, ,, halliards.
53. Mizen topgallant yard.
54. ,, ,, lifts.
55. ,, ,, braces.
56. ,, ,, halliards.
57. ,, royal yard.
58. ,, ,, lifts.
59. ,, ,, braces.
60. ,, ,, halliards.
61. Spanker boom.
62. ,, ,, topping lift.
63. ,, sheet.
64. ,, gaff.
65. ,, ,, lift.
66. ,, vangs.
67. Bumpkin.
68. Signal halliards.



SAILS OF A SHIP-RIGGED VESSEL

1. Flying jib.
2. Outer jib.
3. Inner jib.
4. Jib.
5. Foresail or fore course.
6. Lower fore topsail.
7. Upper ,, ,,
8. Lower fore topgallant sail.
9. Upper ,, ,,
10. Fore royal.
11. Mainsail or main course.
12. Lower main topsail.
13 Upper ,, ,,
14. Lower main topgallant sail.
15. Upper main topgallant sail.
16. Main royal.
17. ,, skysail.
18. Crossjack (brailed up).
19. Lower mizen topsail.
20. Upper ,, ,,
21. Mizen topgallant sail.
22. ,, royal.
23. Spanker or driver.
24. Main topmast staysail.
25. ,, topgallant staysail.
26. Mizen royal staysail.
27. ,, topmast staysail.
28. ,, topgallant staysail.

CHAPTER XXIII

A Few Hints on Boat Sailing

Preliminary Definitions

THE *keel* is the lowest part of a boat. It forms the backbone into which the rest of the boat is built.

The *kelson board* is a plank running along on the top of the keel, to which the steps for holding the foot of the masts are secured.

Bottom boards are the pieces of wood fastened together and laid over the bottom of the boat. They form a flooring or platform for things to rest upon.

The *stempost* is the foremost continuation of the keel, to which the planking at the fore end of the boat is fastened.

The *bow* is the foremost end of the boat.

The *stern* is the after end of the boat.

The *sternpost* is the after continuation of the keel, on which is hung the rudder.

The *transom* is a piece of wood fitted to the fore side of the sternpost, to which the after ends of the side planking are fastened.

The *gunwale* is the term used to express the top sides of a boat.

Thwarts are the seats for the rowers to sit upon.

Knees are the curved pieces of wood used for securing the thwarts to the sides of the boat.

Stretchers are the pieces of wood against which the rowers place their feet.

The *counter* is the overhanging part of the stern.

Crutches are the metal, fork-shaped fittings in which the oars rest.

Thole-pins take the place of crutches, and consist of wooden pins fitting into holes in the side of the boat.

Rowlocks are the openings in the gunwales of some boats through which the oars pass.

The *rudder* is the appliance hung on the sternpost, and by means of which the boat is steered.

The *tiller* is the long piece of wood or metal fitting into the rudder-head, and by means of which you transfer the necessary motion to the rudder for steering the boat.

Cleats are pieces of wood or metal of various sizes secured to the side of a boat. They are used for belaying the halliards.

The *halliards* are the ropes used for hoisting the sail.

The *sheets* are the ropes used for handling the sails when they are once hoisted.

A *painter* is a piece of strong rope in the bows of a boat used for towing or making fast to anything.

The following definitions are used in boat sailing

Luff means let the boat come to the wind—i.e. put the helm down.

Keep her away means the opposite—i.e. put the helm up.

Heave to means keeping the boat as near the wind and as nearly stationary as possible.

Check means to ease away.

Settle means to lower.

Full and by is an order to keep the boat as near the wind as possible while still keeping the sails full.

Running free. A ship or boat is said to be running free when she has the wind abaft her beam.

Weather helm. A boat is said to carry weather helm when the helm has to be put up to keep her on her course.

Lee helm is the opposite to weather helm.

N.B.—A boat should always carry a little weather helm, so that if it should be necessary to bring her to the wind in a squall she will the more readily answer her helm. Weather helm may be given a boat by moving crew or ballast forward, while lee helm may be produced by moving them aft.

I know well, from my own experience, that a long list of definitions form very dry reading. Those I have given above, however, are constantly occurring when referring to boat work and boat sailing generally, so, much against my will, I have been forced to include them.

Boat sailing is, perhaps, the most enjoyable form of sport imaginable, and the sensation of rushing through the water and feeling that your little vessel is obeying every movement of your hand upon the tiller is one which cannot fail to be appreciated. In boat sailing, like everything else, it is a question of "practice makes perfect," and reading any amount of books upon the subject will not make a good boat sailer. Constant experience is what is required to teach people how to handle a boat, but there are one or two points which it is as well to remember.

Do not, if you can help it, venture in a boat of any kind unless you can swim with your clothes on. Accidents do happen, and a sudden squall, the jamming of a sheet, or a hundred and one other things, may capsize your boat and throw you into the water. If you can swim you are comparatively safe, but if you cannot you are in a bad fix; and for this reason it is far better not to get into any boat, particularly a sailing one, until you can swim well.

If you do have the misfortune to capsize, stick by your boat if she floats. She is always something for you to hold on to. If she sinks, strike out for a piece of wreckage or an oar, and hold on to that until help arrives. There is a good reason for this, for remember that a capsized boat is a comparatively conspicuous object compared with the head of a swimmer struggling in the water. The shore, also, which from the water invariably looks closer than it really is, may be difficult to reach on account of the tide or surf, so, I repeat, always stick by your boat if she still floats.

I have seen bank-holiday trippers in rowing and sailing boats standing up on the thwarts, and going through the most dangerous evolutions with the utmost unconcern. Do not emulate them, for they only show their ignorance of the first principles of seamanship. Nothing is so dangerous as standing up on the thwarts of a small sailing or rowing boat, and in doing so you are taking a most unnecessary and unseamanlike risk. If you are compelled to change your seat, do not stand up to do so, but crouch, and so keep the weight of your body as low as possible.

Do not allow anybody to climb the mast, for the weight of a person at a height above the hull tends to capsize your boat. It is far quicker and safer in the long run, if anything jams aloft, to get the mast itself down, and clear it in that way. Never overload a boat; and remember that heavy weights should be kept out of the ends so far as possible. The sight of two heavy people in the stern of a boat with her bows well out of water may be amusing, but it is unsafe.

In a sailing boat keep your sheets in hand, and never secure them; if a sudden puff of wind comes, it may upset your boat before you have time to cast them off, and many a boat has been capsized in this way.

See your craft is well ballasted before going out for a sail. You can always get rid of superfluous ballast by throwing it overboard, but when you are once under way it is a difficult matter to take it in. The sails should always be trimmed to the wind, for no boat will sail close to the wind with flowing sheets, nor will she run before the wind with the sheets flat aft. This advice may appear unnecessary, but it is wonderful in how many cases it is neglected.

Always see your sails properly set. Nothing looks worse, or is more unseamanlike, than badly set canvas.

If you are caught in a squall when sailing close hauled, ease the sheets and put the boat's head into the wind.

Never jam the tiller over suddenly, but use it gently, as you would the handles of a bicycle. A boat will never carry as much sail close hauled as she will when running before the wind. Bear this in mind, and before bringing her close to the wind after running, consider whether or not you ought to reef your sails.

In going alongside a pier or ship always, if possible, go the lee side—i.e. the side from which the wind will blow you off when you want to leave. I once saw a struggling party of amateur yachtsmen stuck for an hour through neglect of this precaution. They did not enjoy the situation, but they afforded great amusement to the crowd of people on the pier.

Make up your mind in plenty of time as to whether or not you can weather—i.e. pass to windward of—a rock, shoal or any other obstruction. It never pays to wait until the last minute, and procrastination has always been the thief of time.

If you have the misfortune to be in an open boat and a gale springs up, lash the masts, bottom boards and oars together; hang the anchor, or any other weight to them; make a hawser fast to the whole and then throw it overboard. This will not only keep your head on to the sea, and form a breakwater, but will prevent your drifting so fast to leeward. If you have sails in the boat, lay them down over the forepart and lash them as securely as possible to keep the heavy water from coming in. Keep your boat well baled out.

If you are in an open boat with no water, dip your clothes overboard twice a day and put them on wet. It is said that this greatly alleviates thirst.

If you run ashore in a boat, get the sail down at once, for a boat ashore with the sail up is in a most dangerous position. In small sailing boats you can very often get the boat off by moving the people forward or aft, according as to whether the stern or bows are fixed.

The great art of boat sailing is one which cannot be learnt without bitter experience. Do not ever be discouraged because you cannot do things right the first time you try. Perseverance is everything, and if you stick to a thing, you are bound to be successful in the end.

CHAPTER XXIV

Anchors—Cables—Capstans

ANCHORS are of unknown antiquity, and at first consisted of large stones, logs of wood loaded with lead, or bags filled with small stones. Iron anchors are said to have been forged in England in A.D. 578.

What is known as the Admiralty pattern anchor has been in general use for many centuries, and it consists of an iron shank, at the lower end of which are two curved arms. These arms are broadened out at their ends into what are known as "flukes." At the other end is the "stock," nearly at right angles to the direction of the arms, and in the old-fashioned anchor this was always of iron covered with wood bound round with iron bands. In the newer types, however, the stock was of iron, and on a pin being taken out it could be moved through the hole in the shank of the anchor until it lay flat against the shank.

When an anchor of this type was let go it was pulled along the bottom with the stock flat, the consequence being that the lower fluke entered the ground and so held the ship.

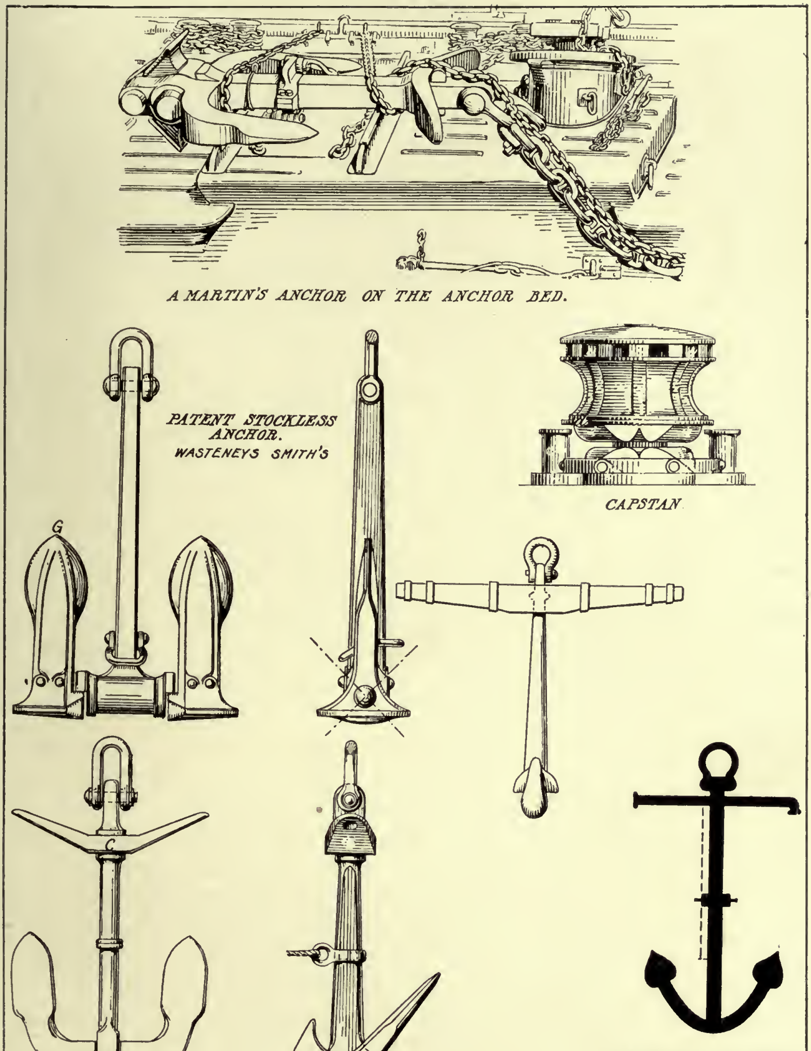
One great disadvantage of the Admiralty pattern anchor was that the upper arm stood above the shank, and as the ship swung the cable would very possibly be wrapped round and round it. This would mean a tangle which would be very difficult to clear when the anchor was weighed. In men-o'-war, also, the upstanding stock of the Admiralty anchor was very much in the way of the guns firing across the deck, so another type known as the "close stowing anchor" was introduced.

In this type the stock and the arms are in one plane, and as there are no parts projecting the anchor can lie flat. The arms, also, are movable, and turn round on a pin or ball socket in the crown. When it is let go and is drawn along the bottom the arms are forced into the ground by means of the "canting pieces" or "tripping palms."

There are various makes of these close stowing anchors in existence, but they all work on much the same principle. When not in use they are stowed on an "anchor bed," a recess cut in the forecastle of a ship and sloped at an angle of about 20 degrees to the horizontal. Steel runners are fitted to enable the anchor to slide off the bed into the water, and it is secured in this position by chains which are let go when the anchor is to be dropped. In both the Admiralty pattern and close stowing anchors, the anchor has to be "catted," as it is called. In other words, it is first hove up until it is out of the water, and a wire rope is then hooked on to the balancing band and the anchor hoisted into its stowing position.

This operation of "catting" entailed a great deal of labour, and in all modern vessels what are called "stockless anchors" are fitted. These, as will be seen from the plate, are very similar to the close stowing anchors, except that they have no stock, the flukes, however, biting into the ground in exactly the same way. With stockless anchors no catting is necessary, for the cable is hove in until the shank of the anchor is right inside the "hawse pipe," or the hole in the bows through which the cable passes.

The majority of large vessels in the Royal Navy carry five or six anchors, which all have their own


A MARTIN'S ANCHOR ON THE ANCHOR BED.
PATENT STOCKLESS ANCHOR.
WASTENEYS SMITH'S
CAPSTAN
G
C
CLOSE STOWING ANCHOR.
IMPROVED MARTIN'S PATENT
ADMIRALTY PATTERN ANCHOR WITH IRON STOCK.

ANCHORS.

names and are used for different purposes. They are as follow:

(1) *The Bower Anchor.*—Fitted one on either side of the forecastle, and used for anchoring under ordinary circumstances. They vary in size, of course, according to the tonnage of the ship, but in the larger battleships weigh as much as 6½ tons each, while in the enormous liners they are considerably heavier, one in the *Olympic* weighing 15½ tons.

(2) *The Sheet Anchor* is another anchor of the same, or much the same, weight as the bower anchor. It is fitted for use in emergency, or if the bower cable parts or the ship drags her anchors.

(3) *The Stream Anchor* was originally used for anchoring in places where there was not much tide or wind, but nowadays it is very rarely used.

(4) *The Stern Anchor.*—This was and is still used when it is required to moor a vessel head and stern in a narrow river. It is, as a rule, far lighter than the bower or sheet anchors.

(5) *The Kedge Anchor* is usually a light anchor used for kedging purposes. It is taken in a boat and dropped some distance ahead of the ship, which then hauls up to it.

When talking about ships at anchor always remember that a vessel is "at anchor" when she has only one anchor down. If she has two down, or if made fast to a buoy or wharf, a ship is "moored."

Cables

Cables for use with anchors originally consisted of long, very thick hemp ropes, and for the larger ships, line-of-battle ships, etc., had a circumference of as much as 21 inches and a breaking strain of 132 tons. In Chapter I I have mentioned the Veneti, who used iron chains for mooring their boats in the time of Cæsar, but iron cables were not introduced into the British Navy until about 1812.

The cables now in use are made of iron and vary in size from 3⅜ inches to $\frac{7}{16}$ths of an inch, this size being the diameter of the metal of which the link is made. The new battleship *King George V.* has cables made of 3-inch iron links, the breaking strain of which is 243 tons. Iron has been adopted for cables, in preference to steel, as it is not so brittle. Studded chain—that is, with bars or studs across the links—is always used for cables, as it is stronger than ordinary chain of the same size, while the studs also prevent kinking.

A length or shackle of cable is 12½ fathoms long, and all large men-o'-war are supplied with three cables, one of fifteen shackles for each bower anchor, and one of eight shackles for the sheet anchor.

Capstans

A capstan in its simplest form is merely a barrel of wood or iron mounted on a vertical spindle. It is turned horizontally round and round by means of capstan bars, steam, or electricity, and is used for weighing the anchor, lifting heavy weights, etc. In most modern vessels in the Royal Navy and mercantile marine steam or electric engines are fitted for revolving the capstan, but in many sailing ships not fitted with steam the capstan is revolved by means of bars placed in holes on the drum.

In many small sailing vessels a winch is fitted instead of a capstan. This is a drum whose axis lies parallel to the deck, and it is operated by means of winch handles which turn it round and round. Steamers sometimes are fitted with steam winches for the same purpose.

CHAPTER XXV

Lighthouses and Lightships

THE first lighthouse on record is said to have been that built near Alexandria in Egypt some three centuries before the birth of our Lord. It is stated to have been 500 feet high, while the light itself, consisting in all probability of a coal or wood fire on its summit, is supposed to have been visible forty-two miles.

The first lighthouses, or lighted beacons, in Great Britain were probably instituted by the Romans in about the second century, and although there is no direct evidence on this point, it is known that they built daymarks which were illuminated at night at various places on the French coast. There is no reason to suppose, therefore, that the same procedure was not carried out on the Roman occupation of this country.

As early as the middle of the thirteenth century lights were beginning to come into general use in the British Isles. They consisted, for the greater part, of coal or wood fires displayed on church or monastery towers, or lights shown in windows facing seaward. They were looked after and kept burning by members of various religious brotherhoods, who regarded the maintenance of an efficient light as a sacred duty, and, feeble as they must have been, they offered, nevertheless, some sort of guidance to vessels approaching the coast during the hours of darkness. The lights, apparently, were in no way regulated by the State, but were solely under the control of the members of the various religious orders whose settlements happened to be situated in the immediate vicinity of the coast. The well-known lighthouse on St. Catherine's Point in the Isle of Wight is a good example. The present building was only erected at the end of the eighteenth century, but a light had been shown from a chapel on Chale Down for nearly six hundred years. It had been tended by the monks and had been established in 1314 A.D.

The dissolution of the monasteries during the reign of King Henry VIII. did away at one blow with all attempts to solve the difficult question of effective coast lighting, for the measure removed the monks who had looked upon the tending of the lights as their duty. The result was that for many years our coasts remained unlit, many ships and lives being lost in consequence. The need became more and more apparent, however, and eventually private people stepped in and erected lighthouses or showed lights at their own expense. The permission to do this was granted by licence from the King, and the lighthouse owners were allowed the privilege of collecting toll from all passing vessels to recompense them for their original outlay. The maintenance of these lights was necessarily a costly business, for they consisted of coal or wood fires in open hearths which, fanned by the wind, consumed enormous quantities of fuel. We read of the cost of upkeep being as much as ten shillings a night, and that amount, in those days, was no inconsiderable sum.

Owing to the difficulty in collecting the tolls the builders were, in the great majority of cases, greatly out of pocket over their transactions; but in spite of this numbers of lighthouses were erected at various places round the coast. There was, however, great opposition offered to the efforts of these private builders from another direction.

The Trinity House, founded in 1512 as an association for piloting ships, had, by the middle of the seventeenth century, become a wealthy and powerful organisation holding many important royal charters. They were responsible for the buoyage of channels and rivers, and for the licensing of pilots, etc., the result being that they regarded the erection of lighthouses by private owners as a usurpation of their rights. They therefore vehemently opposed all measures for lighting the coasts, and characterised the existing lights as useless and dangerous to navigation. In spite of this opposition, however, the number of lights grew steadily; but at times there was great friction between the fraternity of Trinity House and the private owners. By the middle of the eighteenth century the attitude of the Trinity House officials had changed, for from that time onward they helped the sailor to maintain his rights, in that for the payment of his dues he was entitled to a clear and a steady light. The corporation undoubtedly did a vast amount of good in this direction, and also in endeavouring to perfect the means of illumination then employed. Recognition, as may be expected, was not long in coming; and sailors, persons interested in shipping, and merchants soon began to regard the Trinity House as everybody regards it to-day—that is, as a public-spirited institution, labouring its hardest in the interests of safe navigation.

It was not until 1836, however, that privately owned lights were finally done away with, and at that time the corporation of Trinity House took over and became responsible for the control of all the lighthouses in England.

We must now pass to the methods of illumination employed. In early days, as has been said before, there were two distinct methods of lighting. If the light was placed on the summit of a tower or steeple, it consisted of a wood or coal fire burnt in a grate; but if, on the other hand, it was shown from a window facing seaward, groups of candles or oil lamps were probably utilised. Towards the end of the seventeenth century it occurred to people of an economical turn of mind that, if the coal or wood fires were enclosed in lanterns with funnels or chimneys fitted at the top, the rate of consumption of the fuel would be greatly reduced. The idea was carried into effect, and caused a great saving in the expenditure of fuel; but the fire, no longer fanned by the wind, did not burn so readily, and needed the constant application of the bellows to keep it alight. The glass of the lantern also became smoked, so that the rays of light could not filter through, and complaints were received from sailors on all sides as to the inefficiency of the lights. So great was the outcry that after a while the lanterns were once more removed, the light being supplied by a fire in an open hearth. For almost a century and a half lights of this kind were employed round the coast, and the last open coal fire was used in a lighthouse in England so lately as 1822.

The Eddystone Lighthouse—about which we shall speak presently—was the first instance where a lighthouse was erected upon an isolated rock out at sea, and in 1698, the date at which a light was first instituted in this locality, candles had to be used as the illuminant, as there was no space for the stacking of coal or wood. The candles, however, had great disadvantages, for the excessive heat generated in the lantern caused them to melt, and thus impaired their efficiency, while the snuffers had to be constantly used to keep the light bright.

Oil came into use as a lighthouse illuminant about the middle of the eighteenth century, and is even now found in many places. In 1763 the first endeavours were made to increase the intensity of the light by means of reflectors; and about 1780 M. Argand, a native of Geneva, improved on the existing system by his invention of the cylindrical wick lamps burnt in front of a silvered mirror. Argand's idea was soon afterwards in turn improved on by Fresnel, who adopted a system of lenses in addition to reflectors.

Gas in lighthouses was introduced as early as the beginning of the nineteenth century, but for many years was only used for lighting piers and other places in close proximity to gas works. It was not until 1865 that it was utilised as an illuminant in more isolated positions. Electricity and limelight were first employed in 1853.

During the first few years of the eighteenth century great difficulty was experienced in identifying one lighthouse from another, but it was not until 1730 that a plan for distinguishing the various lights was put forward. The scheme, strange as it may seem, originated with a barber named Robert Hamblin, and consisted in placing the lights in various forms, elevations, and numbers, so that not one of them should resemble another. He undertook, if his plan was adopted, to publish a chart of the British Isles, giving particulars of all the lighthouses on the coast, and the idea—which was, however, modified to a certain extent—was successfully carried out. The method employed at the present time to distinguish the various lights is somewhat different, and consists in hiding the light shown for varying intervals, or in changng the colour. The following are the different kinds of lights shown from our lighthouses and lightships.

Fixed.—A continuous steady light.

Flashing.—Shows a single flash, the period of darkness being always greater than that of light.

Group Flashing.—Shows groups of two or more flashes in succession separated by short eclipses. These flashes need not necessarily be of the same colour.

Fixed and Flashing.—A fixed light varied by a single white or coloured flash, which may be preceded and followed by a short eclipse.

Fixed and Group Flashing.—Similar to the above, except that a series of two or more white or coloured flashes take the place of the single flash.

Revolving.—The light gradually increases to its full brilliancy, then decreases until it is no longer seen. At short distances a faint, continuous light may usually be observed.

Occulting.—A steady light with, at regular intervals, a sudden and total eclipse. The duration of light is always equal to or greater than the period of darkness.

Group Occulting.—A steady light, with groups of two or more sudden eclipses at regular intervals.

Alternating.—Lights which change colour from red to white, white to green, etc. etc. All the above, from fixed to group occulting, can be alternating lights as well, so it will thus be seen that there are an infinite number of varieties which can be used.

For instance, one light may be group flashing, and show two quick flashes every 30 seconds; another may be occulting, and show for 45 seconds, and then be eclipsed for 15 seconds; while yet another may be alternating group flashing, and show a red and a white flash every 35 seconds. The sailor, by referring to his chart, on which all particulars of the lights are given, is therefore able to identify at a glance any one he sees, and is able to fix his position at night as easily as he can in the daytime.

The case of the Eddystone, as I have said before, is the first instance in the United Kingdom where a lighthouse was built on an isolated rock out at sea, Winstanley, its architect, commencing work in 1696. About three years were taken in its completion, for the work was greatly impeded by rough weather and other causes. On one occasion a French privateer appeared on the scene, and carried off the architect and his workmen employed on the rock. Winstanley was actually taken to France as a captive, but was soon afterwards released by Louis XIV., who said that, although he was at war with England, he regarded the erection of a lighthouse on the Eddystone rock as a benefit to humanity at large, as indeed it was.

By November, 1698, the structure was completed, and the light, consisting of candles, was shown for the first time. The tower itself was a strange building, and looked more like a Chinese pagoda than a lighthouse, for the upper part was ornamented with all manner of strange vanes and devices, while various heavy and useless cranes added greatly to its already top-heavy tendencies. The rooms in the tower included a kitchen, state room, and apartments for the accommodation of the keepers. Early in 1699 Winstanley returned to the scene of his labours to see how the tower had fared during the winter gales, and discovered that, although it was unshaken, it was not nearly high enough, for the sea during gales would at times completely obscure the light in clouds of flying spray. He, therefore, set to work to heighten the building, and it was this extra height that probably brought about its overthrow. Its destruction occurred in 1703 during a terrific storm, and Winstanley perished with his work, nothing remaining to mark the site of the edifice except a few twisted iron bars. The building of the next Eddystone lighthouse was supervised by a silk mercer, named John Rudyerd, and although a man of his profession seems a strange person to erect a building of this kind, its construction was successfully accomplished by August, 1708. The tower was of wood, built up for some distance round a granite core, and that it was more secure than its predecessor may be judged from the fact that it stood till 1755, when it was totally destroyed by fire. The keepers had narrow escapes, yet only one old man of 90 perished. He was standing on the rock, gazing open-mouthed at the flames above, and swallowed some of the molten lead falling from the tower. After lingering in agony for several days he died, and at the post-mortem examination a lump of lead weighing seven ounces was found in his body.

The well-known Smeaton tower, completed in 1759, was constructed of stone throughout. Each block was carefully dovetailed to the next, and on October 17th of that year the first light was shown. The illuminant consisted of a number of candles set in two circular frames, and Smeaton, by making vent holes at the bottom of the lantern, managed to keep down the heat, and so prevented them from melting. Early in the nineteenth century oil was substituted for the candles, but very soon afterwards it was discovered that the rock on which the building stood was becoming gradually undermined by the action of the water. Extensive repairs were carried on at intervals, but by 1877 the undermining had become so great that it was resolved to build another tower on a neighbouring rock which offered a more secure foundation.

Sir James Douglas undertook the work, and the tower, constructed of granite throughout, was finished in 1881. The old Smeaton tower, as sound as when it was erected, was taken down block by block, and rebuilt on the Hoe at Plymouth, where it still stands, and forms a useful landmark for ships approaching from seaward.

The life of a lighthouse keeper is a very arduous one, and the solitary existence has been known to drive men out of their minds. The most terrible occurrence which ever took place in a lighthouse, however, was an event which happened in 1801 at the Smalls Light off St. David's Head in Wales. There had been a period of exceptionally bad weather, during which communication with the shore, although attempts had been made time after time, was completely interrupted. The sea was so bad that no boat could live near the rocks on which the lighthouse stood, and all that could be learnt was that, crouched in the gallery running round the lantern, was a human figure. Time after time whenever a boat got a sight of the building, the figure was still there, in spite of the bitter cold and clouds of driving spray. At length the weather moderated, and a boat managed to reach the lighthouse and brought off the two men—one of whom was alive and the other dead. The latter had become ill at the very commencement of the bad weather, and in spite of all the efforts of his companion had succumbed. The survivor dared not commit the body to the sea, for fear of being accused of murder, and there was nothing for it but to live with the corpse until help should arrive. Lashing the ghastly object to the trellis work of the gallery rail, the survivor carried on his appointed task for nearly four months until he was rescued. A more awful existence it is impossible to imagine.

On account of this episode a rule was subsequently put in force that three men were always to be on duty in isolated lighthouses, so a similar incident is now happily impossible.

Light vessels are moored in dangerous places off the coast where it would either be impossible or too costly to erect a lighthouse. In England, Scotland and Wales they are painted red, and have their names on their sides in large white letters, while in Ireland they are black and are marked in the same way.

Light vessels always carry at the masthead what is known as a "day mark." It usually consists of a ball placed above the light on the principal mast, but in places where many lightships are moored within short distances of each other, such as the entrance to the River Thames, the shape of the day mark is varied by a small ball over the usual one, a ball surmounted by a diamond, or something else of this kind, so that it can be readily recognised.

All lightships having only one principal mast are fitted with a small mizen-mast in the stern, on which a trysail is set during bad weather to keep the vessel head on to the sea. A riding light, in addition to the main light, is also exhibited during the hours of darkness, so that it may be seen in which direction the vessel's head lies.

If through any accident the vessel is unable to burn her main light, she shows her riding light only, thereby indicating to passing vessels that she is in her position but cannot show her light. If, on the other hand, she breaks adrift from her moorings and is no longer a guide to shipping—by day, she lowers the day mark, and at night she extinguishes her main light and shows a fixed red light at the bow and stern, and burns a red flare every quarter of an hour.

If from any lighthouse or lightship in the United Kingdom a ship is seen to be standing into danger, the two signal flags J. D. of the International code, meaning "You are standing into danger," are hoisted and kept flying until answered. In addition to this signal a gun or a rocket may be fired to attract attention.

There is also a special code of signals, consisting of one or more guns, red star rockets, or ordinary rockets, in use among all lighthouses and lightships round the coasts of Great Britain. These signals are employed for summoning assistance to the lightship, or for calling the lifeboat to help a ship in distress.

In the event of a fog coming on all lighthouses and lightships have their own fog signals, and the following are the different ones in use all over the world.

Fog Sirens.—These are the principal and the best of all fog signals. They are distinguished one from the other by high and low notes.

Fog Trumpets or Horns.—These are usually found in lightships, and are worked by compressed air.

Fog Bells.—These are rarely used, as the rapid ringing of a bell is the fog signal for a ship at anchor.

Explosive Reports.—These are used on outlying rock lighthouses, such as the Eddystone, and consist of slabs of guncotton or dynamite exploded electrically at stated intervals.

On some mainland lighthouses explosive reports are used, and Anvil Point, near Swanage, is a good example. The explosive is used in this particular instance because the lighthouse is situated between the Shambles lightship and St. Catherine's Point, in the Isle of Wight, both of which have a fog siren.

Fog Gongs.—These are small brass gongs beaten with hammers, and are but rarely used.

Fog Guns are usually small brass howitzers, and are often used on the end of piers during a fog and when a mail steamer is expected.

Fog Rockets are generally used from headlands. On attaining a height of about 600 feet the rocket explodes with a loud report.

Submarine Bells may be placed in the following positions : (1) On light vessels; (2) on buoys, where they are worked by the movement of the sea; (3) on the sea bottom, where they are controlled electrically from the shore.

Their effective range is far greater than that of ordinary sound signals, and has been known to exceed fifteen miles. If a vessel is equipped with receivers—a sort of telephone apparatus, the receiver of which is below water—the bearing of the bell can be determined with sufficient accuracy for safe navigation in a fog. Even should a ship not carry receivers, the submarine bell can be heard from below the water-line for distances well outside the range of ordinary fog signals, though its bearing cannot then be so well ascertained.

CHAPTER XXVI

Buoys and Buoyage

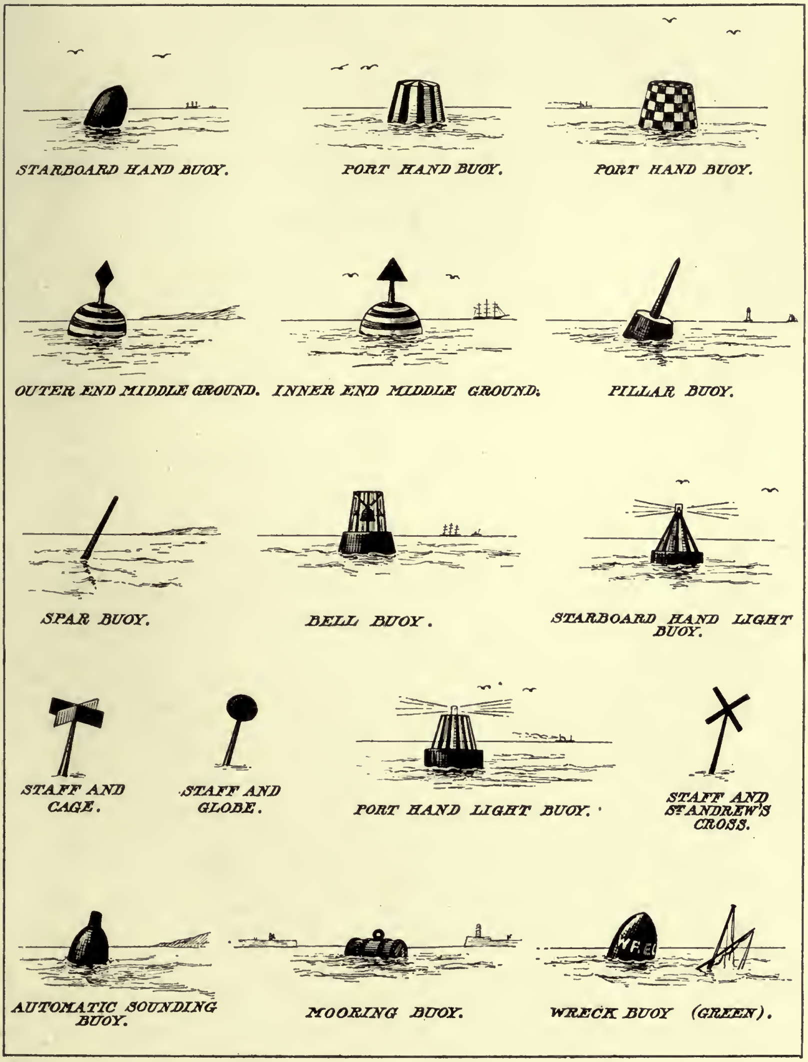
THE work of accurately buoying our harbours, rivers and sandbanks is necessarily of very great importance, for the different sorts of buoys all tell their own tale, and to pass the wrong side of one might mean that a ship would run ashore. In speaking about buoyage, the term "starboard hand" means that side which is upon your right hand when you are travelling with the main stream of flood (or incoming) tide, or when you are entering a harbour or river estuary from seaward. The term "port hand," similarly, denotes that side which is upon your left hand under similar conditions.

Starboard Hand Buoys are always conical in shape, and painted one single colour.

Port-hand Buoys, on the other hand, are can-shaped—that is, flat topped—and are painted either an opposite single colour to the starboard-hand buoys, or are vertically striped or chequered. In England port-hand buoys are nearly always chequered or striped, while in Scotland and Ireland starboard-hand buoys are always red, and port-hand buoys black.

A middle ground is a shoal or sandbank, which lies in the centre of a navigable channel or harbour mouth. Its outer end, or that nearest seaward, is marked by a spherical buoy painted in horizontal bands of white and some other colour. This buoy is surmounted by a staff with a black diamond shape on the top of it.

The inner end is marked by a similar spherical buoy, surmounted by a staff bearing a black triangular shape.


STARBOARD HAND BUOY.
PORT HAND BUOY.
PORT HAND BUOY.
OUTER END MIDDLE GROUND.
INNER END MIDDLE GROUND.
PILLAR BUOY.
SPAR BUOY.
BELL BUOY.
STARBOARD HAND LIGHT BUOY.
STAFF AND CAGE.
STAFF AND GLOBE.
PORT HAND LIGHT BUOY.
STAFF AND ST ANDREW'S CROSS.
AUTOMATIC SOUNDING BUOY.
MOORING BUOY.
WRECK BUOY (GREEN).

BUOYS.

The staff and globe is only used on starboard-hand or conical buoys, while the staff and cage is only used on port-hand or flat-topped buoys. If it should be found necessary to specially mark a starboard- or a port-hand buoy which lies next to one which is already marked with its own special beacon, the staff and St. Andrew's cross is employed.

A *Pillar Buoy* is one having a tall central structure on a broad base, and marks a special position.

A *Spar Buoy,* which consists of a spar anchored to the bottom, is sometimes used for marking a position when no other buoy is available.

Bell Buoys mark special spots where the ringing of a bell may be useful to a passing vessel in the event of a fog. The bell is rung by suspended clappers, which move with the motion of the water.

Any buoys may be fitted with a light, and these are generally used to mark the more important turns in a channel. They are constructed in skeleton shape, so that the wind will not heel them over and extinguish the light. They are alight day and night, and when filled contain sufficient oil or gas to last for six weeks. They are, however, refilled every fortnight. As a general rule, they are fitted with occulting or flashing lights (*vide* Chapter XXV.), so that they may not be mistaken for a boat at anchor, which shows a fixed light.

Automatic Sounding or *Whistle Buoys* are fitted with a whistle worked by the motion of the sea. They are placed in special positions, and it is useful to remember that if it is calm there is a possibility that the whistle is not working.

Mooring Buoys may be of any shape or colour, according to the directions of the local harbour authorities. They may be generally recognised by the ring on the top, to which a vessel makes her cables fast.

Wreck and *Telegraph Buoys,* the former used for marking a wreck and the latter for showing the position of the end of a submarine telegraph cable, are painted green, and have on them the word "WRECK" or "TELEGRAPH" in white letters. Buoys used for marking submarine minefields are always coloured in green and white horizontal stripes.

What are known as *Watch Buoys* are placed near light vessels which are too far away from the shore to take bearings. The buoys indicate to them if they are dragging their moorings, and are usually small, flat-topped, and painted red, with the name of the lightship followed by the word "WATCH" in white letters.

Foreign countries all have their own systems of buoyage, and in many cases these are not the same as that in use in the United Kingdom.

If a wreck takes place in waters through which there is a large amount of traffic, what is known as a "wreck-marking vessel" is usually placed in the vicinity to show that there is an obstruction in the channel. In the United Kingdom these wreck-marking vessels are, if possible, painted green, with the word "WRECK" on their sides in large white letters. (In the event of a proper vessel not being obtainable, a wreck may be marked by a barge or open boat flying a ball or flag at her masthead.) A proper wreck-marking vessel carries a mast and yard, and from the latter she exhibits, by day three balls—two hoisted vertically at one end, and one at the other. The single ball is at the side nearest the wreck. At night three lights are shown in the same manner. In foggy weather, when possible, a bell and a gong will be sounded in quick succession at intervals of not more than one minute; but if the gong is not available, a bell only will be struck. If a vessel is seen to be standing dangerously close to a wreck-marking vessel or wreck, a warning gun is fired if possible.

From the above it will be seen that the system of buoyage in the United Kingdom is a very complete one, and the fact of all the navigable channels, shoals, sandbanks, or other obstructions being marked, almost, if not quite, does away with the possibility of a ship running ashore in or near the entrance to a river or harbour. The Corporation of Trinity House are responsible for the buoyage of the waters adjacent to England and Wales, while the Scottish and Irish lighthouse authorities supervise those in their respective countries.

CHAPTER XXVII

Rule of the Road

VERY stringent regulations are laid down as to the rule of the road at sea, and in crowded waters like the English Channel a strict observance of these rules is imperative if all risk of collision is to be avoided. In the "Regulations for Preventing Collisions at Sea," every steam vessel under sail and not under steam is to be considered as a sailing vessel, and every vessel under steam, whether under sail or not, is to be considered a steam vessel. A "steam vessel," also, includes any vessel propelled by machinery, while a vessel is "under way," when she is not at anchor, made fast to the shore, or aground.

With regard to lights, the word "visible" means visible on a dark night with a clear atmosphere. A steam vessel when under way carries on the foremast, or in the forepart of the vessel, at a height of not less than twenty feet above the hull, a bright white light, so constructed as to show an unbroken light from right ahead to two points abaft the beam on either side. This light must be visible at least five miles. On the starboard side she carries a green light, so fixed as to show from right ahead to two points abaft the beam, while on the port side she carries a red light which shows from right ahead to two points abaft the beam. Both these lights are to be visible at least two miles. These "sidelights," as they are usually called, are ordered to be fitted with screens, so as to prevent their being seen on the wrong side.

A steamer under way may carry on the mainmast an additional white light similar in construction to that already mentioned—i.e. it must show from right ahead to two points abaft the beam on either side. The two lights are to be placed in line with the keel, so that one shall be at least fifteen feet higher than the other, while the lower light shall be in front of the upper one. The extra white light is very useful, for it enables the direction in which the ship is heading to be noted by other vessels. Fig. 1 in the sketches shows a steamer carrying the red and green lights and the one white light only. Figs. 5 and 6 show steamers carrying the additional light moving to the right and left respectively, while Fig. 2 shows a steamer carrying a single light moving to the right.

A sailing vessel under way carries the red and green lights only, and under no circumstances must she ever carry the white light. Fig. 3 shows a sailing ship as she appears when heading directly for you, while Figs. 4 and 7 show sailing ships moving to the right and left respectively.

A steamer when towing another vessel carries two white lights of the sort already mentioned, in addition to her red and green bow lights. She may also carry a white light aft for the vessel towed to steer by, but this light must not be visible before the beam. Fig. 13 shows a steam vessel towing a sailing ship. If she is towing more than one vessel, and if the length of the tow, measuring from the stern of the towing vessel to the stern of the last vessel towed, exceeds 600 feet, the tug shows an additional white light forward six feet above or below the other two. Fig. 8 shows this, and will explain what I mean.

In all cases the vessel towed, no matter whether she is a sailing vessel or a steamer, shows her red and green lights only. A vessel which from any accident is not under control carries instead of the white steaming light two red lights, visible all round the horizon and not less than 6 feet apart in a vertical line. They have to be visible at least two miles. Broken-down vessels when moving through the water carry their side lights, but not otherwise. Fig. 9 shows a vessel not under control and stationary, while Fig. 10 shows one moving through the water. By day a broken-down vessel shows, where they can best be seen, two black balls or shapes, each two feet in diameter. Fig. 28 shows this.

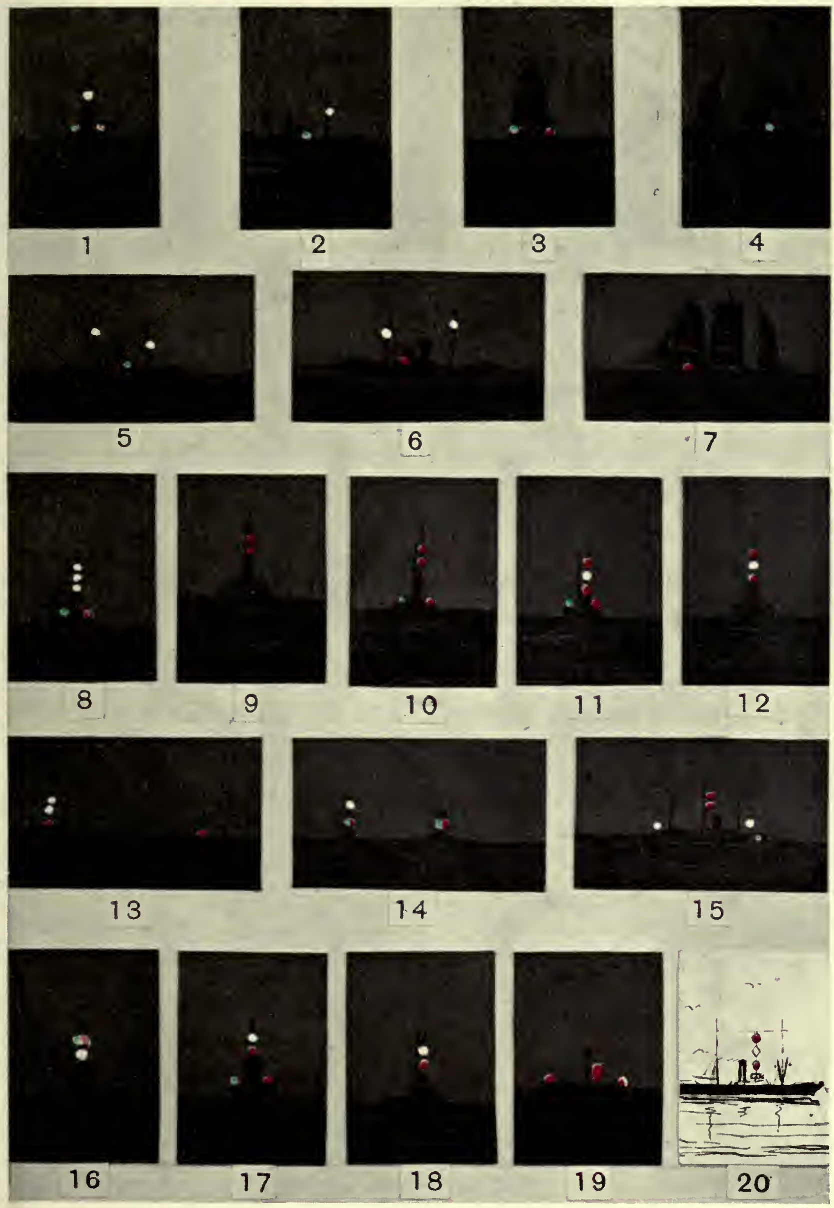
A vessel employed in laying or picking up a telegraph cable carries three lights in a vertical line, and not less than 6 feet apart. They are visible all round the horizon, and the upper and lower lights are red, and the centre one white. They obey the same regulations as the ship not under control as to the use of the green and red sidelights. Figs. 11 and 12 show telegraph vessels at work, when under way and when stopped respectively.

Small steam vessels of less than forty tons, and ships under oars or sails of less than twenty tons, are not compelled to carry the white steaming light and red and green sidelights. They are, however, allowed to; but if they do not, they must carry—

In the case of a steam vessel of less than forty tons:

(1) A bright white light which shall show from right ahead to two points abaft the beam on either side. It must be visible at least two miles, and must be placed above the gunwale at a height of not less than 9 feet.

(2) A combined lantern, with both green and red glasses, having the same limits as the ordinary sidelights. This lantern must not be carried less than 3 feet below the white light. This is shown in the left-hand sketch of Fig. 14.



THE RULE OF THE ROAD.

In the case of vessels under oars or sails, of less than twenty tons:

They shall have ready at hand a lantern with a green glass on one side and a red glass on the other. This lantern is to be shown in sufficient time to prevent a collision, and the green light must not be shown on the port side, nor the red light on the starboard side. This is shown in the right-hand sketch of Fig. 14.

Rowing boats, whether under oars or sail, must always have ready after dark a white light, which must be shown in sufficient time to avert collisions. In bad weather, when the red and green lights cannot be fixed in small vessels, they are always to be kept ready lighted, and are to be shown on their proper sides on the approach of another vessel. Pilot vessels when on pilotage duty carry a white all-round light at the mast-head, and burn a white flare at intervals not exceeding 15 minutes. They must also have sidelights ready to show if required. Fig. 25 shows a pilot vessel on pilotage duty.

An open boat with fishing nets or lines extending not more than 150 feet shows an all-round white light. When the nets or lines extend more than 150 feet, another white light, 3 feet below and 5 feet horizontally from the first, is shown in the direction in which the nets and lines lie. This is shown in Fig. 21.

A vessel or boat fishing with a drift net shows much the same lights, and this is shown in Fig. 22. The lights in this case must be visible three miles.

Steam trawlers of over twenty tons when engaged in trawling show a combined lantern with green, white, and red glasses. The green shows from two points abaft the beam to two points on the starboard bow; the white from there to two points on the port bow, and the red glass from there to two points abaft the port beam. In addition, a steam trawler carries below the combined lantern a white all-round light. These lights are shown in Fig. 16.

Fig. 23 shows a vessel being overtaken by another, and she is showing at her stern a white light.

A ship of less than 150 feet in length at anchor shows forward where it can best be seen, and at a height of not more than 20 feet above the hull, a white all-round light, visible at least a mile. A vessel over 150 feet in length at anchor carries forward, at a height of not less than 20 feet or more than 40 feet above the hull, a white all-round light, while near the stern she carries another light of the same description. Fig. 26 shows vessels of less and more than 150 feet in length at anchor.

A vessel aground in or near a fairway carries the white lights of a ship at anchor, and also the same red lights as a vessel not under control. This is shown in Fig. 15.

A steam pilot vessel under way carries the usual lights for a steam vessel, but in addition carries a red light under the white steaming light. If she is at anchor, she extinguishes her sidelights. This red light is to be visible all round the horizon, and Figs. 17 and 18 show its use.

All open boats at anchor must carry a white all-round light, and this is shown in Fig. 24.

A vessel marking a wreck—which is fully described in Chapter XIV.—carries the three white all-round lights shown in Fig. 27. The passage is on the side of the two lights.

A light-vessel which has broken adrift from her moorings shows a red light at each end of the vessel and a red flare every quarter of an hour. This is shown in Fig. 19. When a light-vessel cannot, for any reason, show her light, she shows the ordinary white riding light only.

By day, as said above, a vessel not under control carries two black balls, as shown in Fig. 28. Fig. 20 shows a telegraph ship at work, and carrying three shapes, the upper and lower ones being red and circular, and the centre one white and diamond-shaped. A fishing vessel with nets, trawl or lines down by day is supposed to show a fish basket, while a steam vessel under sail alone shows a black ball at her fore masthead. Both these latter are shown in Figs. 29 and 30.

The Rule of the Road

The following verses by Thomas Gray should be learnt by heart:

(1) *Two steamers meeting.*

"Meeting steamers, do not dread
When you see three lights ahead,
Port your helm and show your Red."

(2) *Two steamers passing.*

"Green to Green—or Red to Red—
Perfect safety—go ahead."

(3) *Two steamers crossing.*

[N.B.—This is the position of greatest danger, and there is nothing for it but a good look-out, caution and judgment.]

"If to Starboard Red appear
'Tis your duty to keep clear;
Act as judgment says is proper—
Port or Starboard, Back, or Stop her.
But when upon your Port is seen
A steamer's Starboard light of Green,
There's not so much for you to do,
For Green to Port keeps clear of you."

(4) *All ships must keep a look out, and steamers must stop and go astern if necessary.*

"Both in safety and in doubt
Always keep a good look-out;
In danger with no room to turn,
Ease her, stop her, go astern."

(5) *Every vessel overtaking any other shall keep out of the way of the overtaken vessel.*

There is no verse by Thomas Gray which sums up the last situation, so the following original doggerel may help you to remember it :

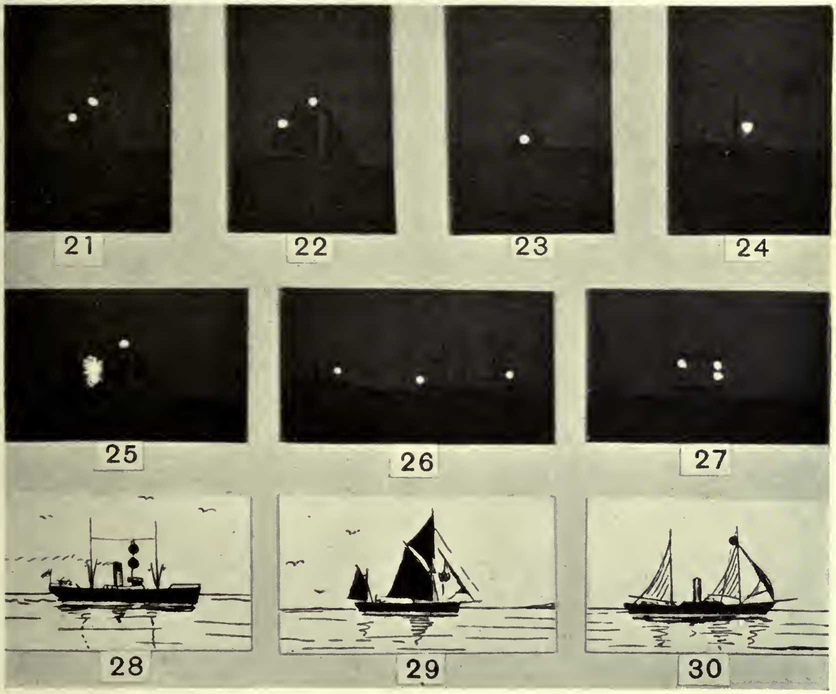
> If a ship you're overtaking,
> Don't waste time by hesitating.
> No matter if you're steam or sail,
> Tramp or Cruiser, Royal Mail,
> It is you who must keep clear,
> So always watch the course you steer.

An overtaking steamer, by the way, is one which is approaching another from more than 2½ points, or 22½ degrees, abaft the latter's beam, or the imaginary line drawn at right angles to the ship's course. If she is before or in front of this bearing she becomes a crossing ship, and has to obey the rules laid down for two steamers crossing.

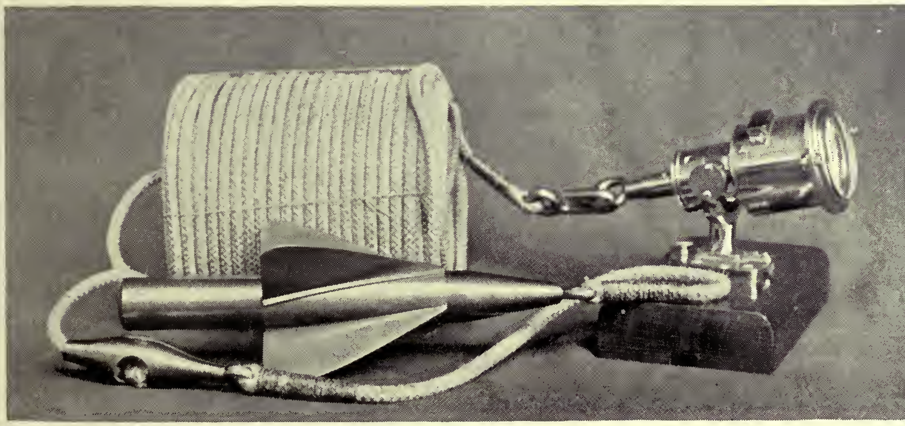
Ships when towing obey the ordinary Rule of the Road for steamers, except when in a fog. Then, as they make the same sound signal as a vessel not under command, all other craft should keep clear of them.

Small steam- or motor-boats should always give way to boats under sail or under oars, except where the latter are overtaking, when they give way. Boats under oars should also give way to boats under sail, except when one is overtaking the other, when the overtaking boat keeps clear.

I cannot sufficiently impress upon you the importance of the Rule of the Road, and the necessity of exact adherence to the regulations therein laid down. Collisions at sea are still painfully frequent, and though in cases of fog it is sometimes extremely difficult to avoid a calamity, it is always found, in disasters happening in clear weather, that either one or other of the vessels has disobeyed the Rule of the Road.



RULE OF THE ROAD—WHITE LIGHTS, ETC.



PATENT LOG.

Rule of the Road

Sound Signals for Vessels in Sight of One Another

One short blast.—"I am directing my course to starboard."

Two short blasts.—"I am directing my course to port."

Three short blasts.—"My engines are going full speed astern."

Sound Signals for Fog, etc.

Steam Whistle or Siren.

ONE

PROLONGED BLAST

at intervals of not more than 2 minutes.

Steam vessel having way upon her.

TWO

PROLONGED BLASTS

at intervals of not more than 2 minutes with an interval of about 1 second duration between them.

Steam vessel under way, but stopped and having no way on.

THREE

ONE PROLONGED FOLLOWED BY TWO SHORT BLASTS

at intervals of not more than 2 minutes.

Vessel when towing.

Vessels employed laying down or picking up telegraph cable.

Vessel not under command.

Vessel towed (optional).

Reed Foghorn.

ONE

BLAST

at intervals of not more than 1 minute.

Sailing vessel under way on starboard tack.

TWO

BLASTS

in succession at intervals of not more than 1 minute.

Sailing vessel under way on port tack.

THREE

BLASTS

in succession at intervals of not more than 1 minute.

Sailing vessel under way with wind abaft the beam.

A BELL

rung rapidly for about 5 seconds at intervals of not more than 1 minute.

Vessel at anchor.

Steering and Sailing Rules

Two Sailing Ships Meeting.

(*a*) A vessel which is running free shall keep out of the way of a vessel which is close-hauled.

(*b*) A vessel which is close-hauled on the port tack shall keep out of the way of a vessel which is close-hauled on the starboard tack.

(*c*) When both are running free, with the wind on different sides, the vessel which has the wind on the port side shall keep out of the way of the other.

(*d*) When both are running free, with the wind on the same side, the vessel which is to windward shall keep out of the way of the vessel which is to leeward.

(*e*) A vessel which has the wind aft shall keep out of the way of the other vessel.

Two Steamers Meeting.

The verses which have already been given apply during the daytime just as much as they do at night, so it is therefore unnecessary to mention again what is done on steamers meeting.

A steamer invariably keeps out of the way of a sailing ship unless the latter is overhauling her, in which case the rule as to overtaking vessels applies.

A sailing ship is always—no matter whether she has the rule of the road in her favour or not—to keep out of the way of vessels fishing.

In narrow channels every steamer keeps to that side of the fairway or channel which lies on her own starboard side.

Distress Signals

When a vessel is in distress and requires assistance from other vessels or from the shore, the following shall be the signals to be used or displayed by her, either together or separately, viz.:

In the daytime—

1. A gun or other explosive signal fired at intervals of about a minute.
2. The International Code signal of distress indicated by N.C.
3. The distant signal, consisting of a square flag, having either above or below it a ball or anything resembling a ball.
4. A continuous sounding with any fog-signal apparatus.

At night—

1. A gun or other explosive signal fired at intervals of about a minute.
2. Flames on the vessel (as from a burning tar-barrel, oil barrel, etc.).
3. Rockets or shells, throwing stars of any colour or description, fired one at a time, at short intervals.
4. A continuous sounding with any fog-signal apparatus.

CHAPTER XXVIII

How to Judge the Weather

THE correct forecasting of the weather must be a subject of great interest to all people, landsmen and sailors alike, but to the latter it is a subject of more than ordinary importance. When you, perhaps, are sitting comfortably by your fire listening to the wind howling in the chimney, you congratulate yourself that you are not out in the storm; but think of what this same gale may mean to a sailor far out at sea in his ship. If he is in a well-found, seaworthy steamer he has comparatively little to fear, but in a small sailing craft, perhaps, in the chops of the Channel, it is a very different matter. If he has been able to foretell the gale, he may have had time to furl his sails and make all snug for the approaching storm; but if he has not, he is what one might call caught with his boots off, and suffers for it.

The verses below, which do not, by the way, pretend to be poetry, give in a concise way the principal signs of the prevailing weather conditions, so I give you them for what they are worth:

I

Now list to these signs of the weather;
  These signs that have lasted for long.
Follow them, and you will hardly ever
  Be able to go very wrong.
Let the weather be clear or be cloudy,
  Rosy sky at sunset's a good sign,
So you can with the utmost safety
  Leave out your washed clothes on the line.

How to Judge the Weather

II

If the sunset is green or looks sickly
You then may be certain of rain;
In that case it's advisable quickly
To take down washed clothes once again.
If the clouds at the sunset are tawny,
Coppery-coloured, dark red,
To-morrow will likely be stormy,
Or rain perhaps will come instead.

III

A pink sky at dawn means bad weather;
A grey one means it will be fine.
A high dawn means wind nearly always;
A low dawn says you'll get sunshine.
A high dawn is when the first daylight
Is seen o'er a bank of thick cloud.
A low dawn is when the first sunlight
Is not obscured thus by a shroud.

IV

Soft, delicate clouds mean fine weather,
With moderate, soft, gentle breeze;
A dark blue sky means nearly always
A wind that will ruffle the seas.
Light blue sky and the weather is steady;
A sunset bright yellow means wind;
A pale yellow one makes you ready
For rain; so your washed clothes please mind.

V

Bright orange or bright copper colour
At evening is not a good sign;
It foretells quite as well as the other
That there will be wind, also rain.
Thus by gauging the red, the orange, the green,
The yellow, the brown, and the grey,
It can usually very nearly be seen
What the weather will do the next day

VI

Light, delicate clouds always promise
  That the weather next day will be fair;
But should they be gaudy you then may surmise
  That rain and that wind will appear.
Hard, definite clouds mean rain and strong blow;
  Small, inky clouds foretell rain,
And if scud drives 'cross cloud masses below
  It foretells the same thing once again.

VII

If high upper clouds are seen crossing the sky
  In directions opposite to the drift
Of the lower ones, then keep your weather eye
  Lifting, for the wind's bound to shift.
A damp misty cloud hanging on a hill
  Shows that rain and that wind will appear;
But if it should rise 'tis no foreboding of ill,
  For it means that the weather will clear.

VIII

A great fall of dew, so some people say,
  Is often a very good sign;
But if you can see a very long way
  It means you'll get rain, not sunshine.
Haloes round the moon, twinkling of a star
  Means heavy wind, fall of rain;
Likewise remember that if objects afar
  Appear close, the result's much the same.

IX

Now these few signs are usually true,
  And allow us to tell what the weather
Will be doing in the course of a day—perhaps two—
  But please understand me, however;
There are often exceptions which prove every rule,
  So with too much faith don't rely on
A blatant weather prophet—he's often a fool—
  While a good one's a real acquisition.

How to Judge the Weather

A mercurial barometer in its simplest form is merely a glass tube closed at one end and filled with mercury. It is then boiled to extract any particles of air which may be sticking to the sides of the glass. After that the tube is inverted, and the open end is placed in a small cistern containing mercury. The mercury descends in the tube until the weight of the column is counteracted by the pressure of the outside atmosphere on the surface of the mercury in the cistern. The height of the column thus measures the pressure, and by means of a scale of inches, minutely subdivided, the exact height can be read off at a glance.

A mercurial barometer thus shows at once as soon as the air pressure is changing. If the pressure at one place is less than that at another, the air has a tendency to move towards it from the place where there is a greater pressure, and thus what we call "wind" is caused. The weather changes almost always with a shift of wind, and on the extent of this change depends whether the new wind is warmer or colder, wetter or drier, than that which has been blowing before.

If the level of the mercury in the barometer remains constant, fine weather may be expected; but when it is unsteady, a change must be looked for. A sudden rise is almost as bad as a sudden fall, for it shows that the weather is uncertain.

The most usual type of barometer used on shore is what is called an "aneroid." This instrument depends for its indications on the movement of the top of a metal drum, which is made very thin and corrugated. This drum is partially exhausted of air, and thus is very susceptible to the least change in the outside air pressure. The appearance of the instrument is that of a small circular box, having a graduated dial face marked off in inches and tenths of inches. The top of the drum is connected to a pointer by means of a very delicate mechanism, which has the effect of greatly magnifying its movement, and on the top of the drum, moving in and out, the pointer travels along the graduated scale. The pointer itself can be set by means of a screw at the back of the instrument, and, as the mechanism is very delicate and liable to disarrangement, the readings of an aneroid should be frequently compared with that of a mercurial barometer. If any change is found, the instrument should be adjusted.

The great advantage of the aneroid is its convenient size, while its sensitiveness makes it extremely rapid in showing any change of pressure in the air.

A barograph is really a self-registering aneroid. A series of thin, circular, corrugated boxes are connected by delicate mechanism to a pointer, on the end of which is a pen filled with ink. The end of this pen is in contact with a drum, on which is wound a graduated paper marked off horizontally in inches and tenths of inches, and vertically in hours and half-hours. To set the instrument the drum, which contains clockwork, is wound up, and the pen-point is placed opposite the time it is at the moment you set it. The pen is then allowed to rest on the paper, and as the drum revolves it traces out a line, which is read off by means of the horizontal graduations. The clockwork goes on for seven days, and the great advantage of this instrument is that it requires little attention, while the height of the barometer can be read off for any previous hour.

Space will not permit of my entering into a longer dissertation on the very interesting subject of meteorology. The chapter on winds will give you a little more information on the matter, but this chapter, I hope, will have given you some idea of the commoner weather signs, and also of that great aid to correct weather forecasting—the barometer.

CHAPTER XXIX

Winds, Currents and Tides

WIND, that great and irresistible force which has driven our sailing ships all over the world ever since we had vessels worthy of the name of ships, is often assumed to have become a factor of little or no importance since the advent of steamships. In olden days, when all our seaborne commerce was carried on in sailing craft, a fair wind meant a speedy voyage and a large profit on the cargo at the end of it, while a foul wind meant that perhaps double the distance had to be traversed, with a corresponding loss of time and profit. The captains vied with each other in their knowledge of the great ocean winds, and he who knew where to steer to get their full benefit, and what localities to avoid because of calms or contrary winds, proved himself the better seaman and made the quickest passage.

People are too apt to imagine sometimes that the modern steamer can, with her powerful engines, drive her way through anything short of an actual hurricane. No idea is more erroneous, for, let it be remembered, wind is the primary cause of heavy seas, and the largest steamer that was ever built cannot afford to ignore them. The principal cause of wind is difference in temperature, and consequent barometric pressure. You probably all know that air when heated expands and becomes lighter; it therefore rises, and the colder air flows in to fill up the gap, if one may so call it, and this current of air is what we call wind.

At the Equator, where this earth of ours revolves more rapidly than it does farther north or south, a permanent wind blowing from the east is caused by this rotation. At the same time there are winds approaching the Equator from the north and south to replace the ascending heated air, and, as winds cannot blow from two directions at the same time, it follows that the two forces will unite and blow in one direction. This may sound complicated, so perhaps it had better be explained with the aid of a figure.

A horizontal line represents the Equator, and two arrows B parallel to it represent the permanent winds caused by the earth's rotation. Two arrows A and D represent the air currents flowing in from the north and south to replace the ascending heated air. It is quite obvious that A and B and B and D cannot blow at the same time, and the consequence is they unite and take up a north-easterly and a south-easterly direction respectively. It will thus be seen that there is a north-easterly wind above the Equator and a south-easterly one below it, and these are what are known as the north-east and south-east trades. They are called permanent winds, for they blow all the year round in the Atlantic and Pacific oceans between the parallels of 27° N. and 6° N., and between the Equator and about 27° S., these limits varying, however, according to the time of year.

In the Indian Ocean and China Sea the effect is not the same. Land has a considerable effect in influencing the direction of the wind, and throughout the summer the mainland of Asia gets very hot, and a low pressure is formed over that continent. The low pressure means that the heated air is rising, and, as before, the cooler air rushes in to take its place, the consequence being that a south-westerly wind is created, which goes by the name of the south-west monsoon. In winter the conditions are reversed, and the north-east trade resumes its sway, but is known in this particular locality

—the Indian Ocean and China Sea—as the north-east monsoon. From November to March the north-east monsoon, on crossing the Equator in the easterly part of the Indian Ocean, changes its direction and forms a north-west monsoon, which generally blows between the Equator and 10° S. and from longitude 60° E., past the north of Australia, and as far east as the New Hebrides in the Pacific.

The land and sea breezes which are felt in fine weather on nearly all seacoasts, but more particularly in the tropics, are due to the same cause as the monsoons. The land becomes heated during the day, and causes a wind to blow in from seaward, while at night the conditions are reversed, and the breeze blows from off the land.

I must now hark back nearer home. In the English Channel the prevailing wind is westerly, and gales from that direction are more frequent than from any other. They most usually occur between the months of October and March, while in May, June and July they are rare. Gales often last four days, and are most dangerous in the eastern part of the Channel, for those from the south-west sometimes fly suddenly round to the north-west or north, and cause a heavy sea. Winds from north to north-east are sometimes strong, but seldom last for long. Easterly winds are most common in the spring, and those from the south-east, accompanied by rain and a falling barometer, almost always develop into gales. Moderate winds from north-west to north-east, as a rule, mean fine weather. Calms are of rare occurrence, even in summer, and do not last for long. They generally foretell bad weather, which is also heralded by swell out at sea and surf on the coast during a calm.

At all the more important seaports in the United Kingdom a system of storm signals is shown. When the warning has been received from the Meteorological

Office in London, a black cone is hoisted. A north cone is a cone hoisted with its point up, and it indicates to the sailor that gales or strong winds are probable from south-east, through north, to north-west. A south cone is a cone hoisted point down, and the sailor who sees it knows that strong winds are probable from south-east, round by south, to north-west. At night three lights, all of the same colour, are hoisted in triangular form to represent the cone.

Revolving storms are those in which the wind revolves round an area of low pressure. They are a source of great danger to sailing vessels, and even to well-found steamships which happen to pass through their centre. They occur in the West Indies and Pacific Ocean, Indian Ocean, and China Sea, and in these localities they are known as "hurricanes," "cyclones," and "typhoons" respectively. All these names, however, mean the same thing, but it is not correct to talk about a "hurricane" in the China Sea or a "typhoon" in the Indian Ocean.

Currents

All currents are named according to the direction towards which they flow, and they are of two kinds. A drift current is the effect of the wind on the surface of the water, and is comparatively slow and shallow, and can only flow to leeward. A stream current is nothing more or less than an ocean river caused by the accumulation of the drift current into a mass by land or some other obstruction. It then branches off in a direction caused by the obstruction, and varies in strength according to circumstances.

Currents must not be confounded with tides, which latter, as we all know, are caused by the attraction of the sun and moon. The most important of all currents, perhaps, to us here in England is the famous Gulf Stream, which owes its existence to the revolution of the earth on its axis. It issues with great strength—sometimes as much as five miles an hour—from the Gulf of Florida, and, coming from a sea of a very high temperature, it deposits a large amount of warm water in the North Atlantic Ocean. After entering the Atlantic, the Gulf Stream increases in width from 50 to 250 miles. It first flows to the northward, and then to the north-east, and, travelling eastward across the Atlantic, strikes the coasts of Great Britain and Norway. Without the warmth brought by the Gulf Stream, which keeps our climate comparatively mild even in winter, England would be in a very bad way. Our ports would all be icebound throughout the winter season, and our trade would suffer, so it will be seen that we owe a very real debt of gratitude to the beneficial effect of the Gulf Stream.

Tides

Tides, as said above, are caused by the attraction of the sun and moon upon the water on the surface of the earth, and the moon, being far closer to us than the sun, has the corresponding greater effect.

To make this clear, let us suppose that the earth is entirely covered by water. The earth, being fixed, can only be attracted as a whole; but the water, being movable, can have every particle of it separately attracted. As the attractive power varies with the distance, it follows that there is more attraction at the surface of the water nearest the moon than there is at the centre of the earth, and the water therefore rises towards the moon, with the consequence that it is high water at two opposite places on the earth. As the amount of water does not change, it follows that there is less water where there is less attraction, and hence we have low water. The sun, by its power of attraction, is also trying to cause two high waters, but its effect is much less owing to its distance, and is only roughly half that of the moon.

The moon revolves round the earth every 30 days, approximately, while the earth takes 365 days—one year—to travel round the sun, every 30 days the moon

DIAGRAM EXPLAINING SPRING TIDES

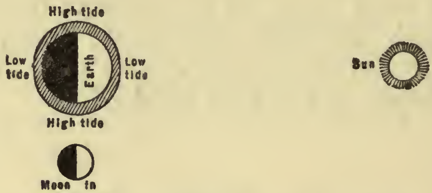


DIAGRAM EXPLAINING NEAP TIDES

passes between the sun and the earth. Fifteen days later the earth will be between the sun and the moon. In the first case it will be seen that the sun and moon are both pulling the water on the earth in the same way, and in the second that the moon is pulling one way and the sun the other. The effect on both occasions is to cause what are known as "spring tides," which are those that occur twice every lunar month and rise highest and fall lowest from the mean level. For the same reason, it is clear, twice during each lunar month the moon will exert her power at right angles to that of the sun. In this case it will be seen that the moon is trying to create a high water under her and a low water under the sun, while the sun is trying to create a high water under it and a low water under the moon. As said before, the moon's effect is the greater, so the result is she gets her way, and a high water is formed under her and a low water under the sun. It is evident, however, that the tide under the moon will not be so high as it was in the other cases, as here she and the sun are not both exerting their influence in the same direction, so we get what are known as "neap tides"—i.e. those which, twice a lunar month, rise least and fall least from the mean level of the water.

The "Tide Tables," a book which few seamen omit from their library, gives the times of high water for many ports both at home and abroad. If, however, the ship happens to be going to a place for which the time of high water is not given, the captain can make a simple calculation and find out not only the time of high water, but also to what height the water will rise at any particular time.

CHAPTER XXX

Nautical Terms

Aback.—A ship is said to be "aback" when the surfaces of the sails press against the mast.

Abaft.—The afterpart, the stern, or on the afterside of a ship.

Abandon.—To leave a ship and take to the boats.

About.—On the other tack.

A-box.—The yards are said to be "a-box" when they are braced in opposite directions.

Adrift.—A ship is said to be "adrift" when she has broken from her moorings.

Afloat.—Borne on the water. Floating on the surface.

Ahead.—In advance. Any object in front of the ship.

Athwartships.—At right angles to the keel.

Athwart-hawse.—Lying across the bow.

Avast.—To hold fast—i.e. "Avast heaving" means stop pulling.

Awash.—Level with the surface of the water.

Bare poles.—Having no sail set.

Batten down.—Securing the hatches by means of gratings and tarpaulins to prevent any water finding its way below.

Bear up.—To keep farther away from the wind.

Beating to windward.—Tacking towards the direction of the wind.

Bight.—Any part of a rope which is folded, except the ends, is called the bight.

Bilge.—That part of the bottom of a ship near her keel.

Bilged.—A ship or boat is said to be bilged when her bottom is stove in.

Bolt rope.—The rope round a sail to which the canvas is sewn.

Bow fast.—A hawser for holding a vessel by the bow.

Bowse.—To pull.

Brace of shakes.—Another way of saying "A couple of seconds."

Break bulk.—To commence unloading a full hold.

Bring to.—A sailing vessel is said to bring to when she checks her way by means of her sails.

Broach to.—A vessel is said to broach to when she comes suddenly up into the wind.

Brought to his bearings.—The pride taken out of anyone who imagines he knows a great deal.

Caboose.—A small house on deck.

Careen.—To heel or list a vessel over on one side so as to get at her bottom for repairs, etc.

Carry away.—To break anything.

Cat's-paw.—A light breeze seen at a distance in a calm by the water being ruffled.

Check.—To ease gradually.

Close hauled.—Sailing close to the wind.

Con.—To con a ship is to direct her steering.

Crank.—A boat or ship is said to be crank when she heels over a lot in a slight breeze.

Derelict.—A vessel abandoned at sea.

Draw.—A sail is said to draw when it is steady and well-filled with wind.

End on.—A ship is said to be end on when only her bows can be seen.

Eyes of a ship.—The extreme bows.

Flake.—To arrange a rope or hawser so that it will run clear.

Flat aback.—When the wind fills the sails on the wrong side.

Flat aft.—When the sheets of the fore-and-aft sails are hauled as taut as possible.

Flotsam.—The cargo of a wrecked ship which may be floating about freed from the wreck.

Flush deck.—When the deck of a vessel is the same height out of the water throughout her whole length.

Forge ahead.—To forge ahead is to shoot ahead of another vessel.

Foul anchor.—A vessel is said to have a foul anchor when the cable has a turn round the anchor.

Gang board.—A plank fitted with steps for passengers to disembark from a boat on a beach.

Go about, To.—To tack.

Ground swell.—A swell which is not occasioned by the wind blowing at the time.

Handsomely.—To pull handsomely on a rope is to pull slowly and with care.

Handy billy.—A small tackle.

Harness cask.—A large tub containing salt meat for present use.

Housed.—A mast is said to be housed when it is partly lowered down.

Hove to.—Remaining stationary.

Hug the land.—To do this is to keep as close to the shore as possible.

Hull down.—A ship is said to be hull down when nothing but her masts are visible above the horizon.

Irons.—A ship is said to be in irons when she is head on to the wind and will not pay off on either tack.

Jetson.—Cargo thrown overboard to lighten a ship.

Jury mast.—A temporary mast fitted in place of one carried away.

Kit.—A seaman's clothing.

Larboard.—The old term for "port."

Leeboard.—A large board fitted to flat-bottomed sailing vessels to make them more weatherly. Most of the barges seen round the coast are fitted with them.

Ligan.—Articles thrown overboard and buoyed for subsequent recovery.

List.—A vessel is said to have a list if she leans over to one side.

Muffle.—To muffle the oars is to put some soft substance round the looms to prevent the noise of rowing.

Offing.—To seaward.

Overhaul.—To overtake another vessel. To ease up. To examine.

Rake.—The inclination of a mast from the perpendicular.

Rogues' yarn.—A coloured yarn found in all Government rope : blue for Portsmouth, red for Devonport, and yellow for Chatham.

Shipshape.—In a seamanlike manner.

Show a leg.—To hurry up.

Soldiers' wind.—A wind that will allow a boat or vessel to reach a place without tacking.

Splice the main brace.—To issue an extra allowance of grog.

Stand by.—A caution to be ready.

Steerage way.—A ship is said to have steerage way when she is moving with sufficient speed for the rudder to act.

Taut.—A rope is said to be taut when it is stretched as tightly as possible.

Unship.—To remove.

Veer.—To ease out more cable. The wind is said to "veer" when it shifts with the hands of a watch, and to "back" when it shifts against the hands of a watch. (The conditions are reversed in the Southern Hemisphere.)

Wake.—The track left in the water by a moving vessel.

Warping.—Hauling a vessel from one position to another by means of a hawser.

Waterlogged.—A vessel full of water, but still floating.

Weigh.—To weigh an anchor is to lift it off the ground.

Wind rode.—An anchored vessel is said to be "wind rode" when she rides by the force of the wind instead of the tide.

Yaw.—A ship is said to yaw when she is not steering a straight course.

CHAPTER XXXI

The Romance of the Sea

How many of us are there, I wonder, who at one time or another in our lives have not been smitten with the idea of becoming sailors? The annual summer visit to the seaside and the reading of innumerable books of adventure dealing with the sea have both had their effect, and there are few British boys who, at a certain period in their lives, have not decided to go to sea to find out whether all these wonderful things they have heard and read about are really true. There is in the innermost heart of nearly every one of us an intense feeling of regard for the sea and everything that pertains to it, and although on the part of some this regard may occasionally change into actual hatred in the course of a rough crossing from Calais to Dover, we never tire, in our less agonising moments, of reading about the ocean and the ships which sail upon it.

Ever since that memorable year A.D. 897, when King Alfred built a fleet of galleys and succeeded in defeating three hundred sail of Danish pirates off the Dorset and Hampshire coasts, the sea has been our heritage, and so long as we keep our noble traditions before us, and breed men worthy of upholding them, the national flag of Great Britain will continue to fly in the uttermost parts of the earth.

Go where you please—from the Straits of Magellan to Spitzbergen, from Kerguelen Island, in the Southern Ocean, to Behring Straits—you will still see the British flag flying. Through typhoon, cyclone and blizzard, through the raging sea off Cape Horn, through the winter gales in the North Atlantic, there British ships still pursue their way. What our maritime greatness has cost us is dreadful to think upon, for many are the rock-bound coasts on which the timbers of our gallant vessels have been ground to destruction, while many a nameless grave in some far-away land is the final resting-place of a British seaman. By fire and tempest, by shot and shell, by pestilence and famine, these noble men have met their fate. They are not mourned as public heroes, and their names are not handed down to posterity, but it is to such men as these that our country owes its maritime greatness. Dying, as they lived, in comparative obscurity, they are none the less heroes—heroes on which the limelight of publicity has never chanced to fall. No wonder, then, that we regard the sea as our heritage, for every ocean is traversed by our ships, while every mile they travel has cost a man his life.

There is, however, romance of another kind in connection with the sea. The very sight of the wavelets lapping the beach on a calm summer's day has its fascination, while the spectacle of the mighty billows dashing themselves into clouds of flying spray against the fringe of rock round some ironbound coast is enough to stir the imagination of anyone. How far has this water we are now looking at travelled? It is said that every particle of water visits in turn nearly every portion of the earth, and there is no knowing but that the drops you are now looking at have not been borne across the broad Atlantic on the bosom of the Gulf Stream or carried down from the frozen north on some mighty polar current.

Yes, even in the water itself there is far more to think about than in the most wonderful ship one ever meets at sea, for is not the water the creation of the Almighty, Whose works are far more mysterious and wonderful than the greatest of those achieved by men? Ships have their interest, it is true, but they change according to the trend of modern requirements and ideas. The great ocean, however, never changes, and now in this, the twentieth century, we have the same gales and the same spells of fine weather as did our forefathers of centuries ago.

The sight of a vessel sailing for an unknown port has an irresistible attraction, and we naturally long to see for ourselves how men can navigate this craft, and how they dare pit their insignificant fabric of wood or steel against the whole force of the limitless ocean. Without a doubt there is a deep-rooted love of the sea inherent in the heart of every Briton; and well it may be, for are we not the inhabitants of an Island Empire, dependent upon ships to carry from distant lands the greater part of the food we consume but cannot ourselves produce at home? Do we not, also, owe our very existence as a maritime power to the upkeep of an efficient navy? Where should we have been in 1588, when the Spanish galleons laden with men came to conquer our country, if men like Drake, Raleigh, Howard and Hawkins had not risen to the occasion? What would our present position be if, during the Napoleonic era, Nelson and others like him had not been instrumental in stopping the projected invasions of England by defeating the enemy's fleets and so assuring themselves of the command of the sea?

We owe everything to our ships and men, and not only to those of the fighting service, but also to those of the mercantile marine, who have so ably followed up our naval victories by showing the flag of Great Britain in every corner of the earth. No wonder, then, that the sea fascinates us when we begin to realise how much we owe to it. In this, the twentieth century, people are sometimes apt to imagine that the romance of the great ocean has gone, that since the gradual fading away of our great fleets of sailing vessels, their towering pyramids of canvas showing up over the cleat blue of the horizon like gigantic icebergs, the romantic side of life at sea has become non-existent. Never was an idea more erroneous, for though the homely tramp, with her rust-covered sides and dingy funnel emitting volumes of black smoke, may not be a thing of beauty in the generally accepted sense of the word, there is still something romantic about her. Look at her steaming down Channel in the teeth of a south-westerly gale, her bluff bows plunging into the advancing surges and the spray flying over her funnel-top in clouds of spume, and then try to realise what her function is and how she and others like her came to be evolved. She carries, perhaps, a cargo of British-made goods to some far-away portion of the earth; her owners depend upon her to do the work to which she has been allotted, so it will be seen that her existence is a very necessary one if our oversea trade is not to suffer. Down below in her grimy stokehold are men who earn their living by driving the quivering fabric above them, and although there may be little romance in the lives of these modern firemen, they are, through force of circumstances, perhaps, doing an enormous amount towards upholding the prestige of their country, however little they themselves may realise it.

See a modern liner cleaving her way through the water at a speed which would have turned one of the old clipper ship captains green with envy; see her massive hull standing out of the water like a gigantic building, while the rush of the seas hardly cause her to curtsy. Look at her well, for vessels of this kind flying the British flag carry thousands of passengers, mails, bullion and specie to the uttermost parts of the earth with the speed and regularity of express trains. It is impossible to say that the great ship is not a thing of beauty, and as we look at her we can hardly realise how men alone can have constructed such an enormous mass of steel, and how they can have contrived to fit it with engines to drive it in the teeth of a gale.

Although the number of sailing vessels owned by British and Colonial firms has greatly diminished within the past thirty-five years or so, it does not appear possible that the large sailing ships will ever totally disappear from the face of the ocean. Certain species of cargo, whose speed in reaching their destination is not a matter of vital importance, will probably always be carried by sailing craft for reasons of economy.

There is undoubtedly nothing so beautiful as the sight of a full-rigged ship sailing close-hauled in a stiff breeze. The slender hull, almost eclipsed by the bellying clouds of canvas, every square inch of which is doing its work in helping to drive the ship along, rushes through the water, while every now and then the spray will be flung high up to the lower topsails as the ship dips her bow to the short, curling sea. It seems wonderful how the slender steel masts can withstand the enormous pressure of the sails; but the steel wire shrouds and backstays, strained taut until they thrum in the wind like harpstrings, are doing their work. The spectacle is one which cannot fail to stir the imagination of even the most prosaic of mortals from its very beauty, for the ship is a thing of life, although she is but made of inanimate wood and steel. I have seen many beautiful and well-executed pictures of sailing craft, but they have invariably failed to do full justice to the noble fabric they were intended to represent. What one misses in a picture is the sense of speed and movement, the ever-changing colour of the water, and the play of the light and shade on the wind-curved surfaces of the sails. For these reasons the most beautiful representation of a ship on canvas can never compare with the original.

The homely topsail schooner hugging the coast on her passage from port to port, her dingy, patched canvas showing years of wear, has also a certain romance of her own. She may be fifty, sixty, or even eighty years old, and her stout old timbers are as sound to-day as when the ship was first launched. She partly belongs, perhaps, to her captain, and the command of her has been passed down from father to son, through several generations, until the present time. She jogs along on her way in exactly the same manner as she did when first built, and her vocation has not changed in the course of time, in spite of the advent of 25-knot turbine-driven mail steamers.

Take the fishing fleets of Hull, Lowestoft, Yarmouth, Grimsby, Ramsgate, Penzance, Brixham, and many other places in the United Kingdom too numerous to mention. Practically all the year round they are to be found all over the North Sea, English Channel, Bristol Channel, Irish Sea and in the Atlantic off the Hebrides. Many of the vessels are propelled by steam, and their number is increasing every year, but many of them are the sturdy, broad-beamed, brown-sailed craft whose type has not altered for quite a century. With drift net, trawl and line, they catch the fish which appear on our tables, and whenever the price of that commodity goes up, you may be reasonably certain that bad weather has prevented the boats from landing their catches. Working singly and in fleets, the latter covering anything from 40 to 160 square miles of sea, they are to be seen in all waters in the vicinity of the British Isles. Ordinary bad weather does not stop the work, for the fisherman is a hardy individual who has been accustomed to roughing it from his childhood. Comfort there is none, for the accommodation on board a fishing smack would be scoffed at by a pauper in a workhouse, and the only time of respite the men have is when their vessels are undergoing their periodical refit. The lives of fishermen are not perhaps romantic in the strict sense of the word, but year in and year out they are at sea in their little craft; and through snow and storm, through fogs, in which a touch from the bluff bow of a steamer would mean instant destruction, these men are carrying out their work as their forefathers did before them. They know the sea as no other seaman knows it; every little breath of wind has its own particular meaning to them, while knowing the habits of the fish, where they are to be found, and where the haul is likely to be barren, is an exact science which has to be carried at the finger-tips if the fishing is to be successful. In their tiny craft, undergoing hardships and privations that their brethren ashore are never called upon to face, they do work of a kind which would make the stoutest landsman quail; so, all these things being considered, it will be seen that the fisherman is of just as much importance to his country, and is doing just as useful work, as are the men of the Royal Navy or Mercantile Marine.

Think of another class of men who unobtrusively do an immense amount of hard work: the pilots. See them in their cutters lying-to in the teeth of a gale waiting for some homeward-bound ship. It takes very bad weather to make a pilot cutter run for shelter, for upon them depend the masters of our homeward-bound ships, mail steamers, tramps and sailing vessels alike, and for the little vessel to desert her post, except under the most exceptional circumstances, is unheard of.

Take again the "hoveller," hailing from Deal and its vicinity, and think of the work he does. Mr. Frank Bullen, in his "Idylls of the Sea," gives a description of him which can never be surpassed. The hoveller is undoubtedly the finest boatman the world has ever produced, and, in his lug-sailed, open boat, will be found out in the English Channel in weather which has driven fishing craft and powerful tugs back to the friendly shelter of some harbour. The crew of the boat, drenched to the skin in spite of their oilskins, without hot food or drink, and with sleep an absolute impossibility, sit for hours at a stretch in their cramped positions, their streaming eyes endeavouring to pierce the spray and eddying fog wreaths for the welcome sight of a homeward-bound sailing ship groping her way up Channel. A hoveller is a sort of maritime odd-job man—a handy man in the truest sense of the word, for he is ready to turn his hand to anything. Above everything, however, he is a skilled pilot, and his idea in putting to sea in bad weather is to drive a hard bargain with the master of some homeward-bound ship who, if the weather is thick enough to shut out the coast lights, is none too certain, perhaps, about his position. The hoveller knows the eastern part of the English Channel as a Londoner knows the metropolis, and, come what may, he will be found at sea in the worst weather ready to offer his services as a pilot. Let there be a wreck on the Goodwins, and the hoveller will be there with his boat, as anxious to save life as he is to reap a rich harvest from the wreckage of the stranded vessel. Can we blame him, for has he not a wife and children at home to be cared for? His life is a hazardous one, and richly he deserves every little benefit that may be thrown across his path. He would, perhaps, be the last to acknowledge that his life was a romantic one, but, from the outside point of view, I think it is. At any rate, it certainly proves that it is an ill wind which blows nobody good.

I must now give you all a little bit of advice. If my humble opinion is worth having, and I must apologise to Mr. Bullen for being bold enough to give it, I cannot resist stating that of all the books of the sea I have ever read, his are the most attractive. I cannot do more than strongly recommend any of my readers who are not already familiar with his works to procure and read them at the earliest opportunity. I have read my copies of "Idylls of the Sea" and "A Sack of Shakings" until the bindings have parted company from the printed portions, and all I can say is: "Go thou and do likewise," for nothing finer about the sea has ever been written.

Turn again to the case of our men-o'-war. Are we to believe that in the ships which fought the battle of Trafalgar there existed a romance which is absent from their present-day successors? Is there nothing to hold the thoughts of a spectator in the sight of a 19,000-ton battleship, her lean guns pointing out of the turrets, and her squat funnels belching forth volumes of smoke as she drives her way up from leeward? Think of the power she represents; think of the money she has cost. The pull of an insignificant-looking brass trigger, and one of those enormous guns will send a shell weighing a third of a ton to a distance of fifteen miles; the pressing of an innocent knob will release a torpedo costing the best part of £1,000, and containing enough gun-cotton to knock a hole in the side of a ship through which it would be possible to drive a cart and horse. The deadly missile will travel unseen through the water on its deadly errand at a speed of 35 knots, or roughly 58 feet a second. High up on the bridge is the captain who wields all this power. He looks an ordinary enough person, it is true, and his responsibility appears to sit lightly upon him, but on looking closer into his face we see the puckered brows and wrinkled skin at the corners of the eyes which tell of years of sleepless nights and exposure to weather. From an age when most boys were just entering a public school he has been brought up in the Navy; for years he has been tried and not found wanting, and now he has come to command this gigantic mass of steel which obeys his every command with the docility of a child. An order through a telephone, and the turbines below the armoured deck will increase their speed and drive the great hull onwards with renewed energy; a motion to a man standing before a little wheel, and the monster ship will heel over as she swings round on to another course. He knows his ship as a mother knows her child; and well it is, for is he not trusted with nearly 900 lives and two millions of his country's money?

Far away below the armoured deck are the engine- and boiler-rooms. Go into the stokehold of a battleship running under forced draught, and see the grimy men tending the furnaces whose heat generates the steam in the boilers to drive the ponderous mass containing them. Grimy and dirty they are, but they tend their boilers with the care which comes of experience, for a single wrong movement might fill the stokehold with a cloud of scalding steam and water. Go into the engine-room, and hear the humming of the turbines as the steam drives them round at a speed which, fifteen years ago, was considered impossible for a big ship. The reciprocating engines of our earlier vessels have gone, and we miss the moving, highly polished cranks and pistons; but in their place we see these gigantic cylindrical structures in which are the turbine motors driving the ship with the energy of 25,000 horses.

In groups at their respective stations stand the men whose duty it is to control this great power. Silent, but ever watchful, they go about their appointed tasks. They look pale, and well they may, for they spend their days below the water-line, where the blessed sun of heaven cannot reach them, and where the air for them to breathe has to be pumped in by fans. Think of their situation in action. They can hear the roar of the guns far above their heads, but the excitement of battle is not theirs, and they feel none of the exultation of their bluejacket brothers serving the guns in the turrets on deck. They cannot see, cannot feel, what is happening above them, and they have to take their chance of what may happen. The everyday heroism of the men of the engine-room branch of the Royal Navy cannot be overestimated, for, without a grumble, they do work of a kind which would appal many of those who lead comfortable lives ashore.

Think of the Admiral in command of a fleet who controls, perhaps, a dozen such battleships as the one I have attempted to describe. Watch the strings of many coloured flags breaking out at the masthead of his flagship, and look at the massive hulls, in obedience to the master mind, performing evolutions which seem to the uninitiated to be more suited to squadrons of cavalry than to 19,000-ton floating monsters. Think of the Admiral's awful responsibility in action, when a wrong order or movement may jeopardise his country's chance of ever emerging victorious from the struggle, or may plunge many hundreds of his fellow-beings into oblivion. Years of training and application, however, have fitted him for the position he now holds, and he directs the operations with a calmness which seems almost unnatural.

Other branches of the Royal Navy which have a terrible fascination of their own are the destroyer and submarine services. The sight of the former murderous-looking craft at sea in search of the enemy's battleships, the lean black hulls crashing through the seas which break in clouds of spray until the funnels are caked white with salt, is a grand one. Our destroyers have had no war in which to prove their mettle, but for all that they are always at sea under active service conditions, fighting the most merciless and relentless of enemies, the weather. With nothing between them and destruction save a hull of three-sixteenths of an inch steel at the outside estimate, when a wrong movement of the helm—for torpedo craft manœuvre at intervals which to the layman appear perilously close—may mean the loss of a ship, our torpedo craft are at sea preparing themselves for the day when our proud position of Mistress of the Seas will be disputed.

So it is with the submarines, where officers and men lead a life which cannot be called anything but dangerous. In the same way as the personnel of the destroyers, they do not appear to realise the risks they run—or, if they do, they cast them aside. Think, however, of the great possibilities which are open to them in war time, when with one torpedo worth £600 they may sink an enemy's battleship costing over three thousand times that sum and carrying nine hundred men. There is the other possibility, of course, that they themselves may be sunk before they have fired their torpedo, but this is not to be thought about until it actually takes place.

My pleasant work is done, though I must confess I have discovered many more nautical subjects upon which I might have dwelt. We have touched upon certain things appertaining to the sea and its shipping, and if I have enlisted your sympathy, and have succeeded in further awakening your interest in your great heritage, the ocean, I am content, and with that I must say good-bye.

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Names of ships are in italics. Those marked with a dagger are men of war

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