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The sources of illustrations are given on page 48.

THE CHANGING SHAPE OF THINGS SERIES

TRANSPORT BY SEA

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FOREWORD

The design of ships has always been influenced by the materials and tools used in their construction, by the purpose for which they were built, and by the inventive genius of the shipbuilder. This is as true of the dug-out canoes of the Stone Age as it is of the oil-tanker and the transatlantic liner. In the following pages the changing shape of the ship is taken as a "line of development". This was the plan adopted in *Transport by Land* (in the present series), which dealt with the changing shape of vehicles since earliest times, traced the principal stages through which land transport had evolved and described the effects of various transport inventions on man's social life.

Transport by Sea, like its predecessor, is a graphic essay. It is an outline, in pictures and text, of the story of the ship and of ocean trade, told in relation to the maritime history of Britain and her changing place in the world.

The Evolution of the Ship. There have been three main stages of development in shipbuilding—one in the ancient world, another in medieval times, and the third since the Industrial Revolution. The first was the invention of the oar and sail, the latter remaining the chief means of propulsion for ships for over six thousand years. The second stage (medieval) was the introduction of the rudder and the evolution of the fully-rigged ship. Finally came the substitution of iron, and then steel, for wood, and the gradual decline of the sailing ship on the advent of mechanical power.

On the Tigris, the Nile, and the Euphrates, where civilization began, and on the enclosed seas of the ancient world, the sailing ship was never fully developed; and the great oceans were never crossed. Until the end of the Middle Ages all trade between East and West was carried overland. Some northern

routes stretched for seven thousand miles across Russia and Asia, and the southern, or Mediterranean routes, were subject to exorbitant tolls.

Britain astride the Ocean Routes. Then in the 15th and 16th centuries came that sequence of the most decisive events in Western civilization, the opening of the ocean routes, the beginning of the Age of Discovery, and the rise of the Atlantic powers. This country ceased to be a small island off the coast of Europe. It stood between the two great land masses of the western hemisphere. It commanded the world's most important ocean routes. And ultimately it became the greatest of all the maritime powers.

Of all countries Britain has been most influenced by the sea. Although it was the highway for the first invaders of these islands, the sea has secured us from the successive invasions which have ravaged continental Europe. Maritime supremacy made possible the founding of a Colonial Empire and the growth of the Commonwealth. We are an ocean people, and our future, like our past, depends on ocean trading.

The Great Adventure. These themes are briefly introduced by illustrations and maps drawn from contemporary references, and further explained by the text. The result is necessarily a very brief account of one of man's greatest adventures, his conquest of the sea. The full tale is told in the works mentioned on the last page; it is hoped that one of the effects of this book will be to increase the already lively interest in the literature devoted to the ship, and to the history of discovery by sea.

There are no more new continents to discover or great oceans to venture across for the first time. In reading the records of the great enterprises by sea, however, we may recapture something of that spirit of adventure which inspired them.

THE FIRST BOATS



Adaptation of natural objects. (Upper left) The floating log which gave to early man the idea of the boat. (Upper right) Inflated animal skins (also used to buoy rafts). (Lower) The dug-out canoe. A product of early man's tool-using ability.

The First Tools. In prehistoric times men were hunters and food gatherers and wandered about in small family groups because, in the days before agriculture began, there was never enough food for large communities.

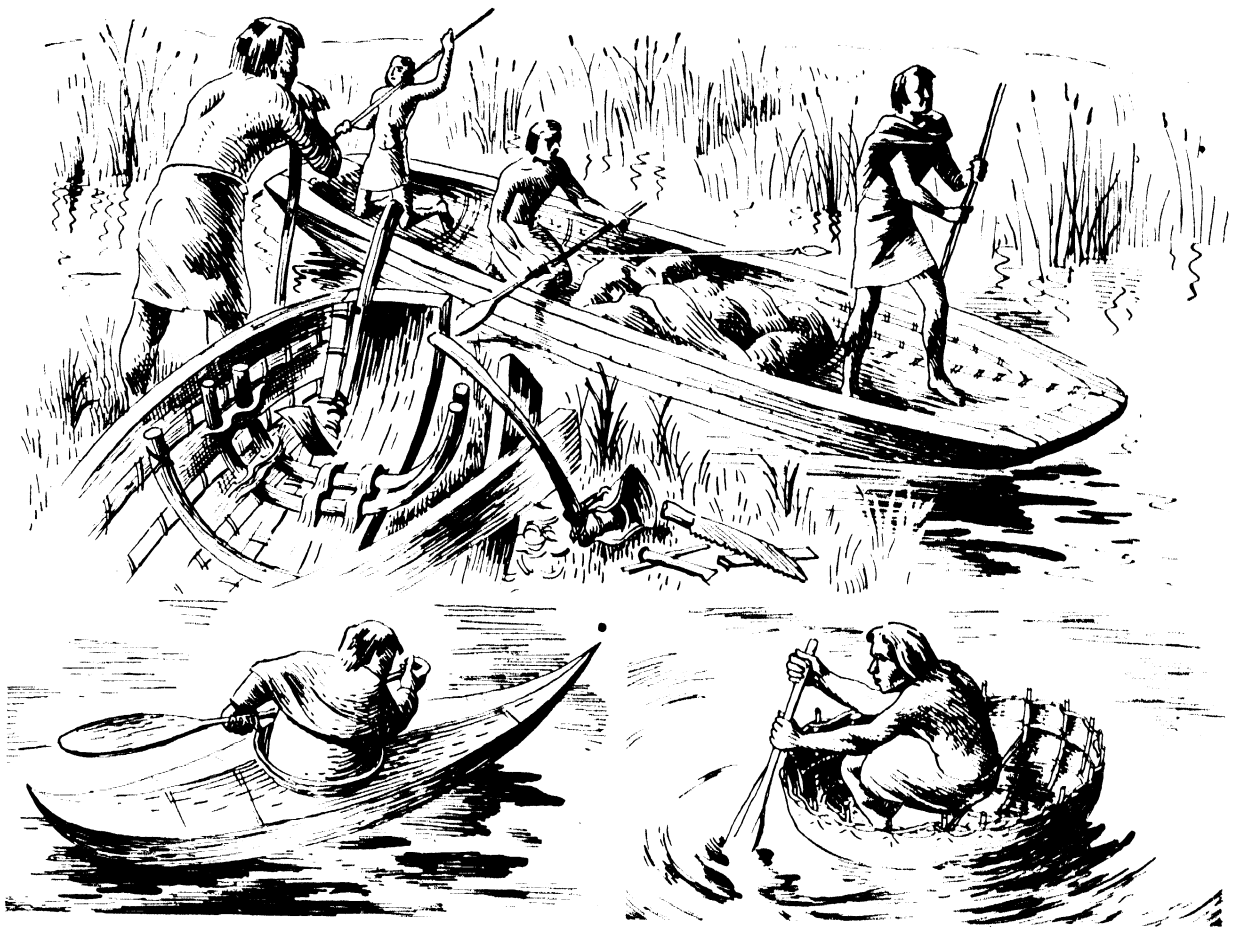
Perils and hardship were survived largely because men learned very early how to make weapons and tools. Probably the first hammers and axes were used as weapons, and when it was discovered that these could be used as tools better weapons followed. The only materials available were stone, horn and bone, and from these primitive man fashioned knives and daggers, arrows and lances, and even saws. It was the ability to use tools which made boat-building possible.

Why the First Boats were Built. We may imagine wandering tribes, urged by hunger to fresh hunting grounds, coming to river barriers. Men, unburdened, could have swum across the rivers and streams. But women and children, tools, weapons, and pottery, would have to be ferried.

There are no dates to act as signposts for us in the dawn of history, but it is reasonably certain that men of the New Stone Age had both the ingenuity and the tools to make boats.

Logs and "Dug-outs". Prehistoric man had seen the storm-felled trees floating with the river current. With his stone axes he could fell them himself. Sitting astride the trunk, he floated downstream, using his arms or a spear as a paddle. With axes, hammers and wedges, he found that wood could be split and cut into convenient shapes and sizes. Trees would float, and their round trunks could be pushed and paddled easily through the water. Moreover, wood could be hollowed out, first by fire and then by gouge and axe. Finally, dug-outs, as these hollowed-out craft are called, unlike logs, do not easily capsize. They are still sailed by primitive peoples, in many parts of the world.

Rafts, made by lashing several logs together, were another early stage in boat-building. They enabled



Examples of early boat construction. (Upper) Plank boat of 3,000 years ago suggesting great skill with varied tools. (Lower left) Kayak (skins over framework) used in treeless areas. (Lower right) Basket-boat (form of coracle).

far heavier and bulkier loads to be ferried, but rafts were unwieldy and difficult to steer. One of the most primitive types is still in use to-day on the Ganges. It is a buoyed raft made with inflated skins, and is in everyday use at ferries in Kashmir.

Boats from Baskets. Boat construction, rather than the adaptation of tree-trunks, probably began in areas where there were no trees. In treeless countries there are frequently cattle, or, further north, seals. With the skins of these animals stretched over a wicker framework men built coracles, canoes and kayaks, so that they could extend the range of their hunting and fishing. Basket-making probably inspired some of these craft, which were being used in Egypt long before recorded history began. Coracles are still used in Britain, especially in Wales and Ireland.

The Plank Boat. Slowly, in the course of thousands of years, tools and skill improved and men learned to build plank boats. These withstood harder

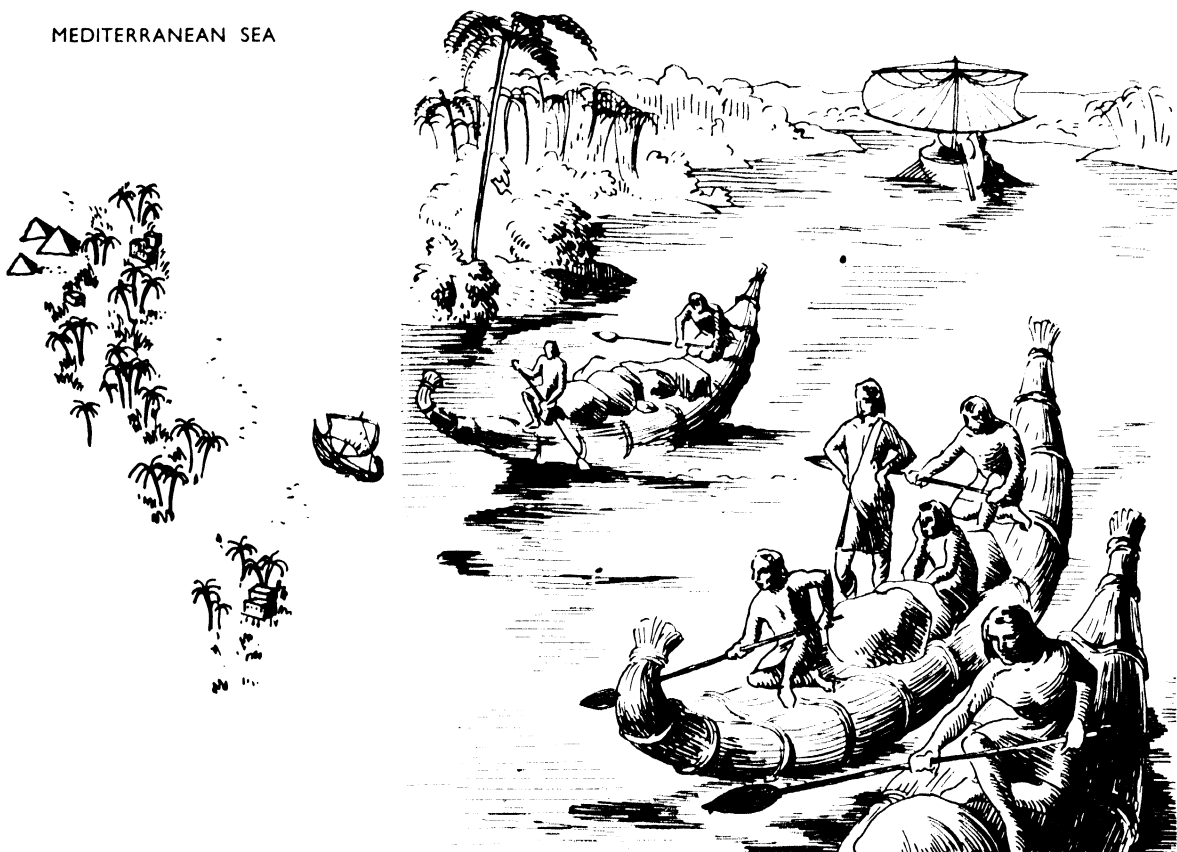
use, carried heavier loads, and were more stable than dug-outs or coracles. The skill which went into the making of these plank boats is shown in the picture. This was drawn from sketches of a boat dug from the mud in the Humber river. The boat is about 2,500 to 3,000 years old and was forty-five feet long and four feet wide. No metal was used in its building. The strakes are of oak, four inches thick, fastened with ropes of twisted yew, and the joints were caulked with moss.

Some Results of Boat-building. The immediate gains from boat-building were two-fold. Firstly, water, which had been a barrier, became a highway. Secondly, water transport gave freedom of movement, and this led to an increase in the food supply and in the opportunities for barter and trade.

While boat-builders of the New Stone Age in Britain were working with tools of stone, there was already, in the Nile valley, an advanced civilization making use of metal tools and building ships. ...

SHIPS WERE INVENTED WHERE CIVILIZATION BEGAN

MEDITERRANEAN SEA



(Left) The Nile, uniting a long fertile valley, was Egypt's natural highway. Egyptian ships were therefore river-craft or suited to the comparatively calm waters of the Mediterranean or Red Sea. They depended on oars rather than sails. (Right) The earliest Nile boats were made by lashing together bundles of papyrus (paper reeds).

Civilization began in River Valleys. If we can imagine all human history as having lasted one hour, the first permanent agricultural settlements, from which civilization grew, began along certain river systems about one minute ago. Of these early civilizations that of the Nile valley is the best example to take, for there is a wonderfully complete record of it.

In this fertile valley there was an abundance of game, fish and fruit. With an all-the-year-round supply of food, nomadic tribes wandered no further. They sowed crops, and the annual flooding of the Nile irrigated their lands.

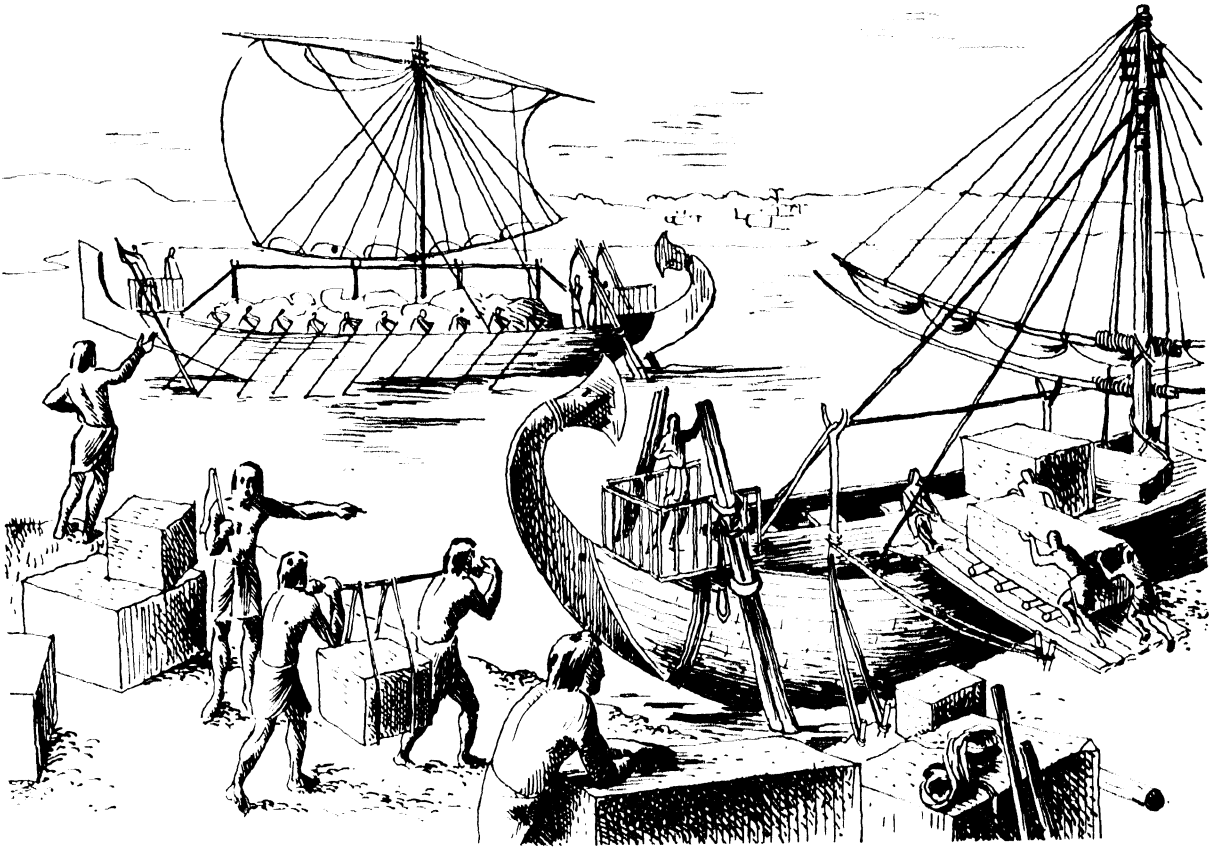
Materials Decided the Shape of Nile Boats. Egypt is almost treeless and for that reason the first boats on the Nile were papyrus bundles lashed together. There were probably rafts, too, made from bundles of reeds. When stronger and heavier vessels were built the Egyptian shipwrights used timber, both

acacia and cedar, but these trees provided the ship-builders with only short and irregular pieces of wood so they were not able to lay down long keels.

The sharp upward curve of bow and stern seen in the picture was, in part, a result of the method of building with short pieces of wood, and was partly due to the fact that wooden boats were copied from canoes built of reed bundles. At the same time, this characteristic, shallow Egyptian shape enabled vessels to be run ashore and loaded with a minimum of handling. The semicircular section of these boats had the effect of keeping the planks at the bottom of the ships compressed, on the principle of an inverted arch. To prevent "hogging" or sagging at bow and stern a "hogging truss" was used, and this is the rope or hawser which is seen running the length of the vessel.

Boats were Built to Carry Bulky Loads. Since the Egyptians, for all their wisdom, did not know how to

—ALONG THE VALLEY OF THE NILE



In ancient Egypt there were no roads and all bulky loads had to be transported on the Nile. As Egypt had no suitable timbers, Nile ships were made with short lengths of imported wood and had no keel. Note the hogging truss which prevented sagging at bow and stern.

harness draft horses, and, until 1600 B.C., were without wheeled vehicles, land transport was slow and costly.

The Nile, however, was a natural highway which united the long valley. Boats provided the Egyptians with their only means of long-distance transport for the great masses of granite and basalt needed to build their pyramids and temples. Along the Nile, too, came supplies of corn for the cities.

But although they relied so much on water transport, the Egyptians, throughout a civilization which lasted thousands of years, went on building barge-like boats dependent on rowers, and suitable only for sailing on the Nile or in calm coastal waters.

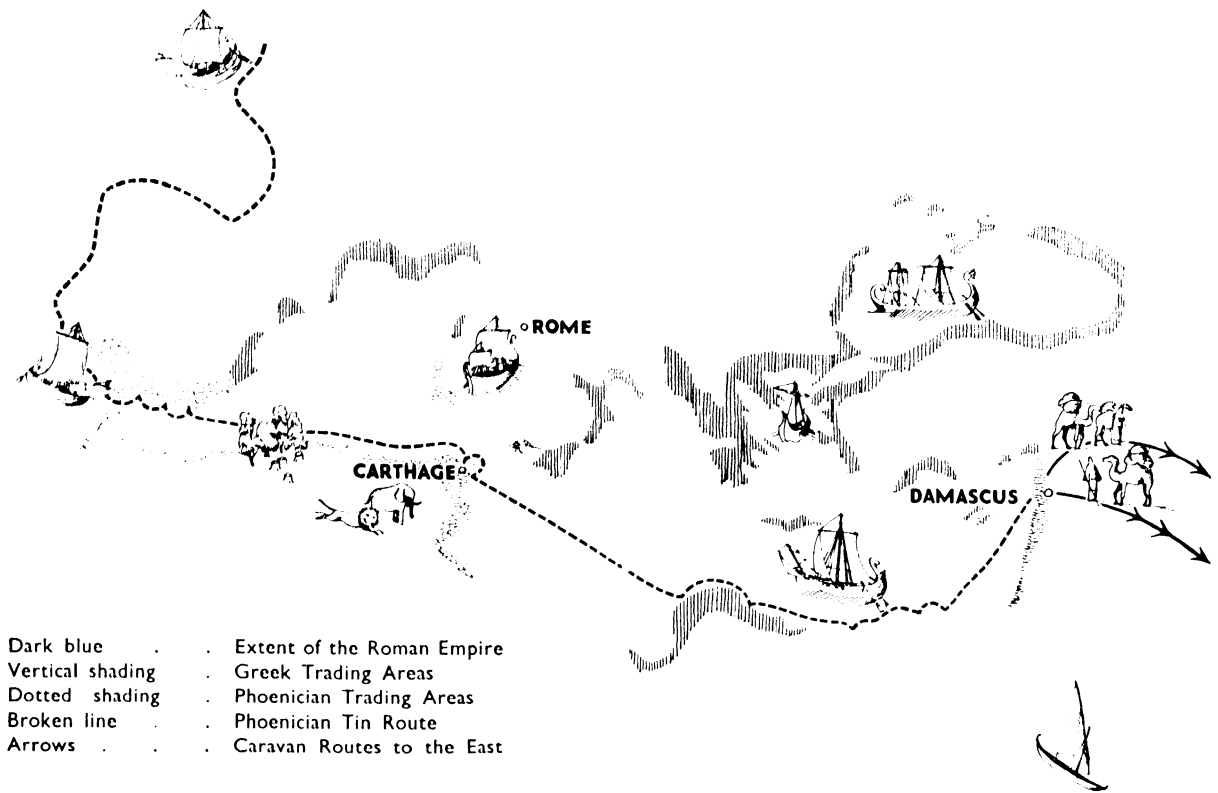
Why Egyptians Made Little Progress in Shipbuilding.

The map shows that Egypt was a long narrow country, a mere river-valley. The fertile, habitable area was about eight hundred miles long and little more than

thirty miles across. The rest was desert. It was bounded by the Mediterranean and the Red Sea. On these narrow seas a sailing ship might lie becalmed for days. So for many centuries slaves and oars provided the power for shipping on the Nile and in coastal waters, and the art of sailing was not fully developed. It was only on the shores of an open sea that shipbuilding could be learned.

The voyages of the Egyptians were confined to the eastern Mediterranean and the Red Sea. They sailed beyond the Nile delta, when trading to Phoenicia, to avoid the overland route through Palestine. From Phoenicia they imported timber, dyed fabrics and gold and silver vessels. They reached Punt (probably Somaliland) by way of the Red Sea. From there the Egyptians imported ivory, ebony and gold, and in return exported grain, papyrus and pottery.

TRADE ROUTES OF THE ANCIENT WORLD



Trade routes of the ancient world were centred on the Mediterranean. Its ports were the terminals of the caravan routes which stretched to Central Africa and across Asia. Shipping was confined to inland seas and coastal waters.

The Earliest Trade Routes. As populations in countries of the ancient world increased, and the food supply became insufficient, some communities were forced to disperse. They founded colonies, and in this way agriculture gradually spread along the eastern Mediterranean, and new cities grew up which depended for some of their food and luxuries on countries beyond their borders. Thus shipbuilding developed.

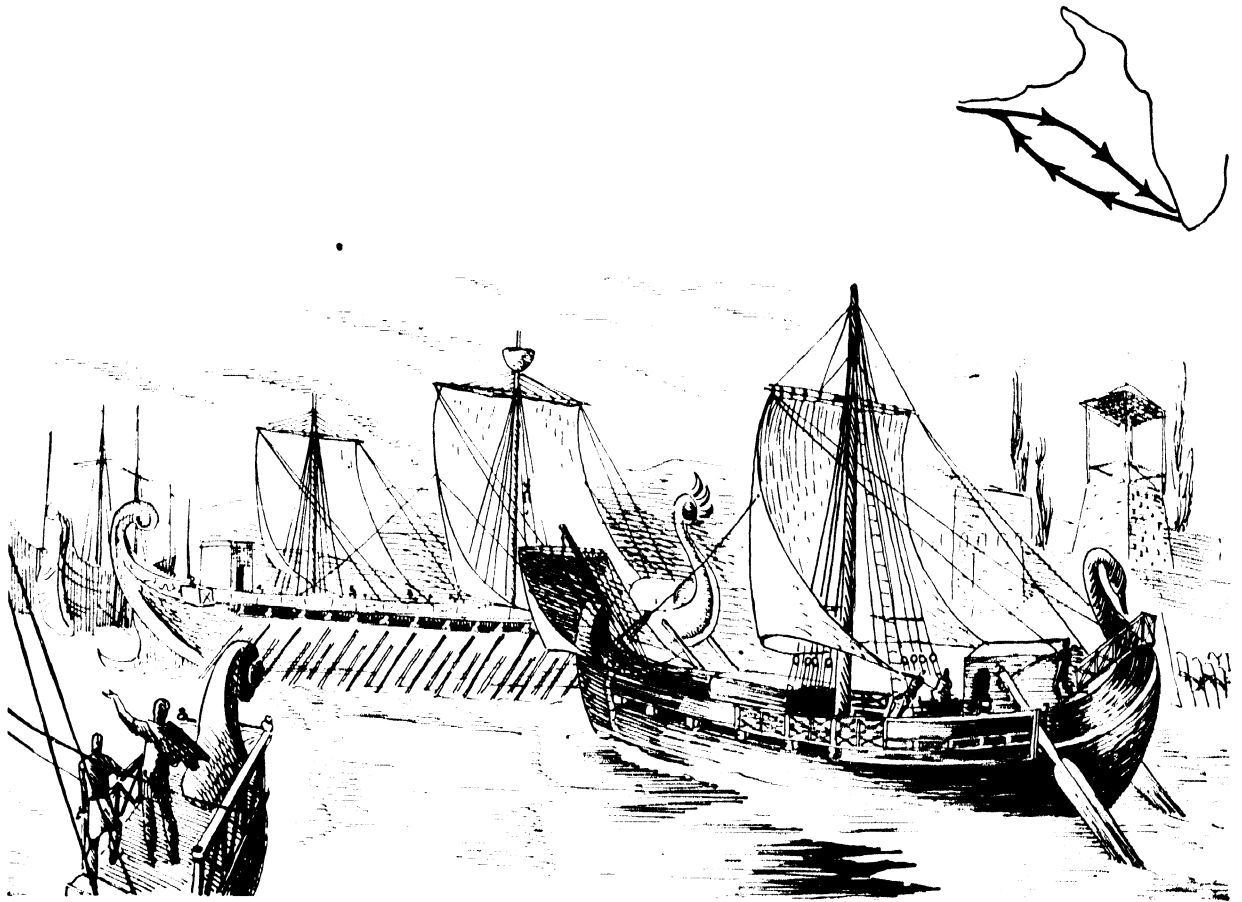
By caravan routes, overland, and then by sea, came ivory, jewels, perfumes and spices from central Africa, Arabia and India. From Siberia, Russia and the Baltic were brought amber, gold and furs. Metals were shipped from Spain and Britain. See from the map how closely the Phoenician tin route from Britain keeps to the coastline. The sailors who followed it were sailing at the edge of the known world, and the Atlantic was an unknown ocean. Homer's map shows how the earliest mariners thought

of the world as a flat disc with the Mediterranean at the centre.

Cargoes and Ships. The map above gives an indication of the varied cargoes carried on the seaways of the ancient world. Sidon and Tyre were the sea terminals of the caravan routes from eastern countries. From these came silks, spices, bronze, ivory, ebony, and dyed fabrics.

The sea-borne commerce of the old Mediterranean civilizations included trade with Egypt (corn, papyrus, linen); Syria (wine, silk, glass); Asia Minor (olives, ebony, wild animals); France (iron, pottery); Britain (lead, tin, hides, oysters).

The Greek bireme (ship with two banks of oars) and the Roman merchantmen illustrated were typical Mediterranean ship-types which endured for centuries. Warships were galleys which relied mainly on oars and used sails only with a fair wind. The merchant ships were slow and round-bellied. As



(Upper left) The earliest sailors thought that the world was flat. (Centre) Greek mathematicians proved that it was round and Ptolemy (A.D. 150) plotted latitudes and longitudes of known areas. (Right) How monsoon route shortened voyage to India. Thin line shows early coastal route. (Lower) Typical Mediterranean ships of the ancient world.

their space was needed for cargo they depended on sails rather than oars.

The Sailors of the Ancient World. The Phoenicians were the first sea-traders. Their country (now Syria) was a narrow coastal plain which grew fruit and vines but little corn, and to feed themselves they had to trade. The Phoenician coast was well provided with harbours and the sea was a natural highway to the rich markets of the Nile valley and the Persian Gulf.

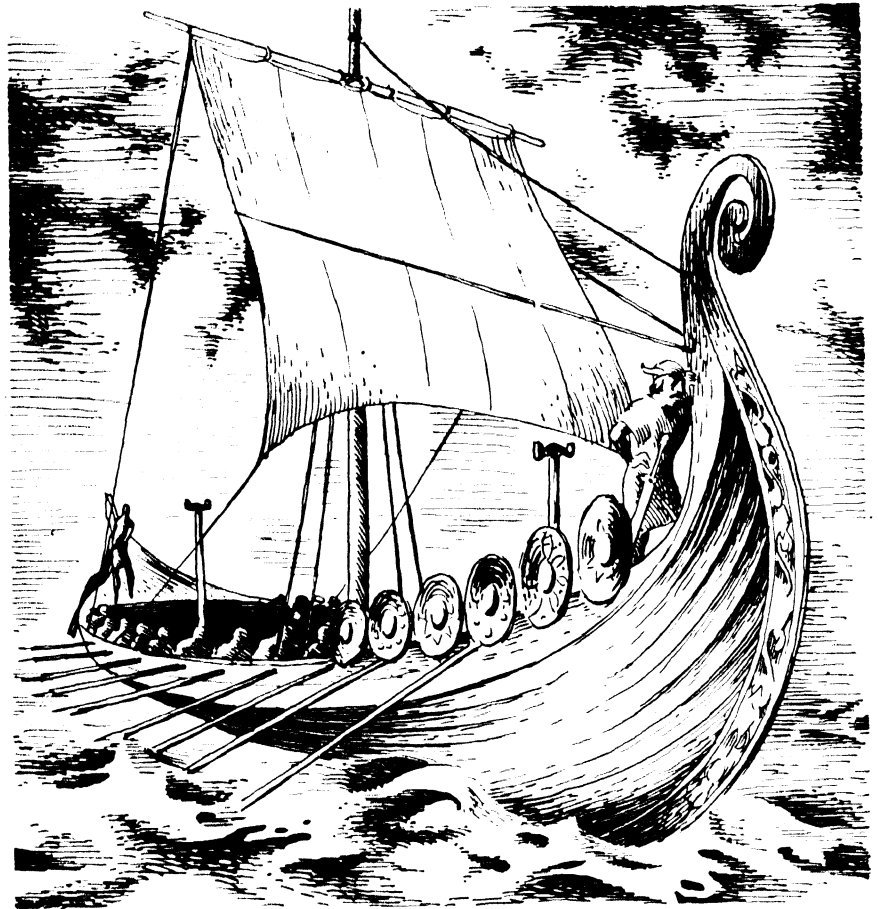
For centuries the Phoenicians dominated Mediterranean trade routes. Their trading stations and settlements, of which Carthage was the most famous, may be traced on the map.

By 450 B.C. they were challenged by the Greeks, who were to change all ideas about navigation by proving the earth was not flat. (See Ptolemy's map.) Much of Greece is mountainous, and the narrow valleys could only support a limited population, so the Greeks turned to the sea for a living as fisher-

men, pirates, traders and fighters. Their trading stations were stretched out along the Mediterranean and the coast of Asia Minor. The growth of population on the mainland of Greece led to the founding of colonies. The need to import corn from Egypt and southern Russia was also a reason for the rise of Greek sea-power.

Rome first developed her sea-power in order to destroy her rival, Carthage (146 B.C.), and during the long Roman peace the sea lanes became safer for shipping than ever before. Roman trade was mainly with the countries of the Empire. The chief "exports" were Roman soldiers and Roman law. In return the colonies of Rome had to pay taxes and send their produce to Rome. There was, however, some trade with India and, as may be judged from the map, voyages to that distant country were greatly speeded up after navigators found how to benefit from the monsoons (c. A.D. 50).

THE VIKINGS—FIRST SHIPBUILDERS AND



The Vikings came from poor farming country but with tall trees of Scandinavian forests they built fine ships. The Vikings had no slaves, so they had to learn the art of sailing. They were the first mariners of northern Europe to range the open ocean.

The Ships of the Vikings. The Vikings, daring, hardy, and enterprising seamen and shipbuilders, swept into history in the latter half of the 8th century, when Europe had lapsed into chaos after the death of Charlemagne. They came from the Danish peninsula and the Norwegian fiords. Their farms were poor and small and the climate harsh, but in the Scandinavian forests grew fine shipbuilding timbers. For the Vikings the sea was a highroad to plunder, a way to the riches which their own country could never yield.

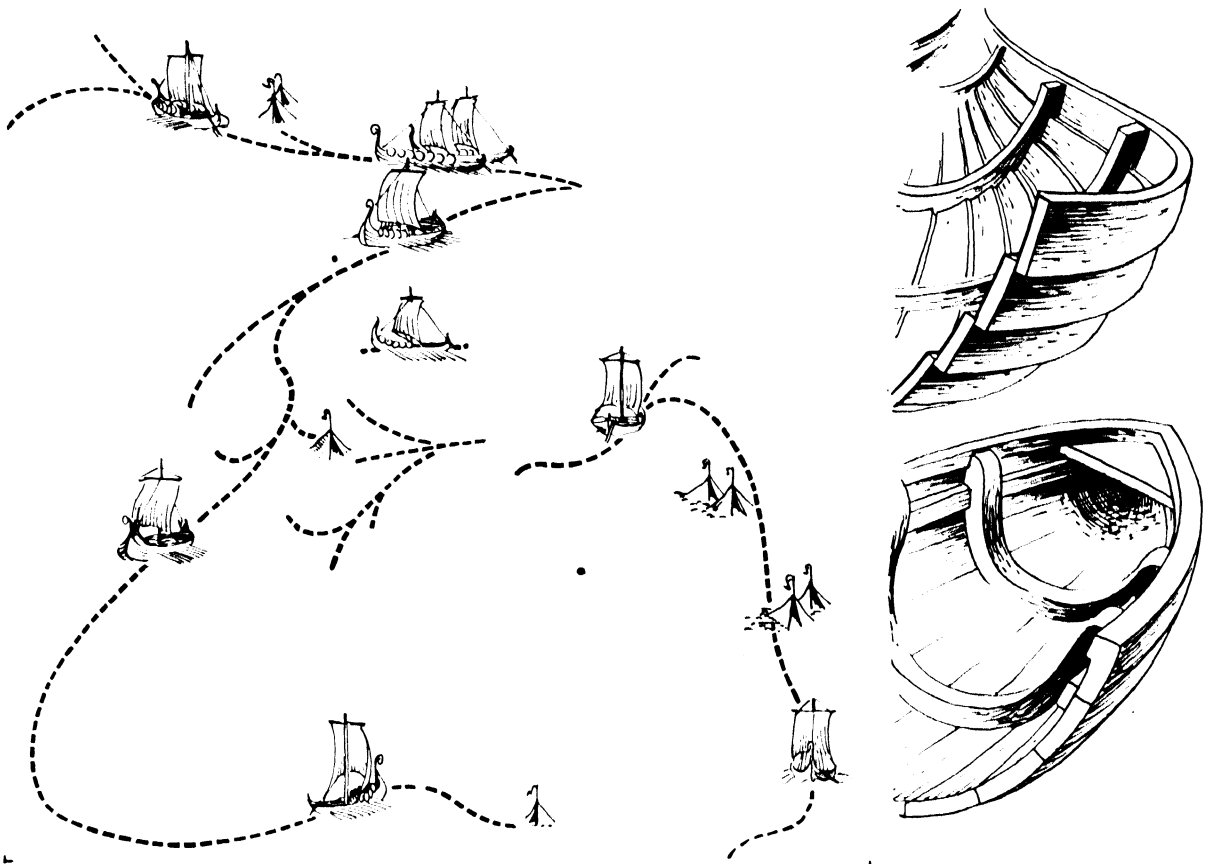
Their vessels were the first seaworthy ships to be launched in northern seas. The Viking ship was double-ended; it could be beached and launched quickly for surprise attacks and swift withdrawals. It rode high out of the water, stem and stern post sweeping sheer above the line of the keel: this bold upward sweep enabled the Viking vessels to ride the

most turbulent seas. Notice, too, that their ships were clinker-built (overlapping planks), not carvel (smooth sides): the overlapping planks made the boats stronger and more seaworthy.

So long as ships depended primarily on oars they were confined to narrow seas and inland and coastal waters. The Vikings did not depend on oars, for there were no slaves in northern Europe. They had to learn the art of sailing and how to tack, or sail zig-zag against the wind, and so the Norsemen became better seamen than their Mediterranean counterparts. Their sails were probably made of flax, bound at the edge with strips of hide. Emblazoned with a dragon's head, these sails became a symbol of Viking freedom.

The first northern ships had a single steering-oar (instead of two, as on some of the early Mediterranean ships) on the starboard (or steering) side.

MARINERS IN NORTHERN EUROPE



Voyages of the Vikings and their land route from the Baltic to the Black Sea. They founded the city of Kiev, pillaged the coasts of Europe, threatened Constantinople, and sailed to Iceland and America. (Upper) "Clinker" built. (Lower) "Carvel".

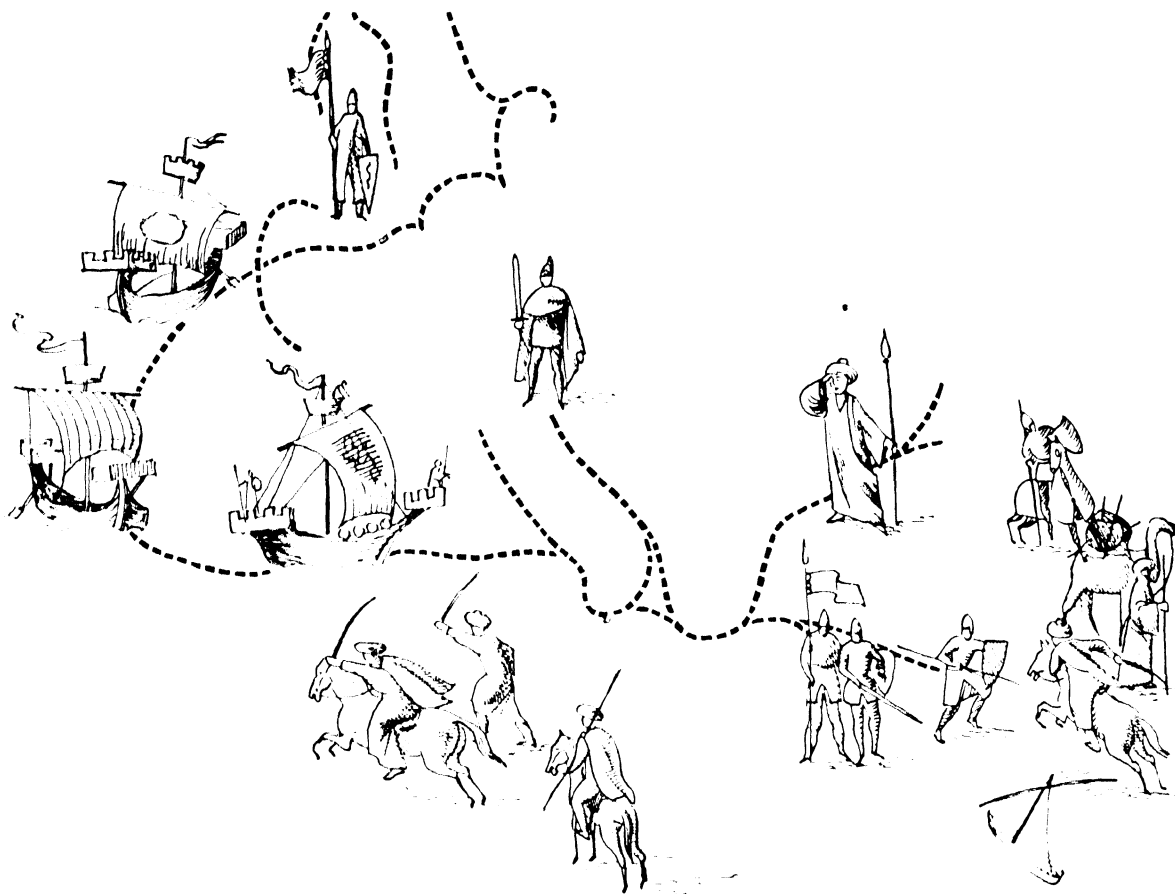
Viking ships were open-decked, but at night an awning was stretched across the uprights seen in the picture. When under sail wooden shutters over the oar-holes sealed the boat from the sea. The Vikings hung their shields in rows on either side of the ship for protection from the arrows and spears of their enemies.

The Achievements of the Vikings. The map shows the extent of the voyages which these Norsemen made in their open boats to the most distant parts of the northern hemisphere. More than any race which preceded them the Vikings showed what could be accomplished by seamanship. They descended on the monasteries of Ireland, England and France, and robbed them of their gold, silver, jewels and brocade. All the coasts of Europe were open to the swift attacks of these pirates, who burnt and pillaged and swiftly made their escape.

Piracy, however, was not the sum of their achievements. Look on the map at the bold sweeps across northern seas. The Norsemen attacked the Orkneys, Shetlands, and Hebrides, and made settlements there. They claimed the Faroes in the 9th and 10th centuries, went to Iceland, and from there to Greenland, from which they reached Vinland (probably Labrador). Not only were they the first European seamen to cross the Atlantic, but their dreaded ships were even sighted from the walls of Constantinople.

Never before had movement been so swift on the sea, navigation so accurate, or ships so seaworthy. This, then, was the Viking contribution to the art of seamanship—they were the first people to show that ships could be sailed on accurate courses over open oceans, and that they could be staunchly built to ride out fierce storms.

TRADE BY SEA IN THE MIDDLE AGES



Principal trade routes by sea at the time of first Crusades. Notice that shipping still keeps to narrow seas and coast-lines. Northern routes were controlled by the Hanseatic League, those of the south by Venetians and Genoese.

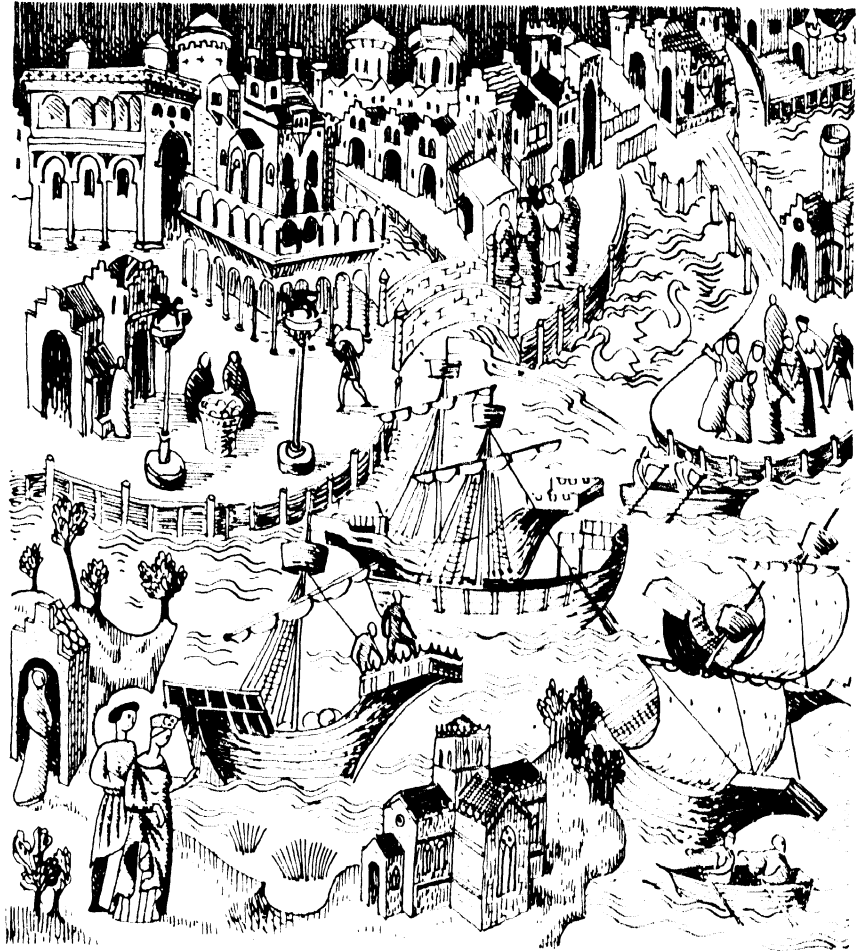
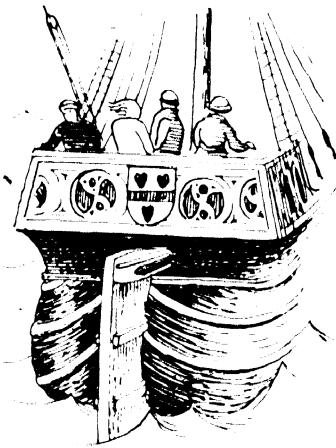
Crusades and Trade Routes. As our map shows, the ships of the Middle Ages (say the 12th-15th centuries) still kept to the narrow seas and coastal waters. The geographical knowledge of ancient times was lost during the Dark Ages, and most seamen believed that the world was flat. There were two main trade routes, a northern and a southern. The first followed the river system of Russia to the Baltic. The southern route passed up the Red Sea and the Persian Gulf, which were connected by caravans to Mediterranean ports.

In those centuries England was practically self-supporting, foreign trade serving mostly to increase the magnificence of feudal lords. But, as a result of the Crusades, which began at the end of the 11th century, not only the lord of the manor but his peasant retainers became familiar with Eastern luxuries. In particular, Crusaders returned with an appetite for spices, which were used to disguise the taste and

smell of badly-preserved meat. There were then no root crops to feed cattle during the winter and these had to be killed in the autumn, the meat being salted down.

The Power and Wealth of Venice. The drawing (right) depicts mediæval Venice at the height of her prosperity as a great naval power. The Italian cities were the first in Europe to emerge from the misery of the Dark Ages. The Crusades brought them some prosperity: the ports, especially Venice, Genoa and Pisa, from which the later Crusaders sailed, were well-situated for trade with the East. Italy, moreover, had already more roads, towns and ports than other European countries.

The ships in the picture probably came from Egypt or Syria, for the Venetians distributed to northern Europe spices and silks brought by sea from the caravan terminals of the East. Practically



(Upper) Anglo-Saxon ship of A.D. 900. (Lower) The stern rudder, invented in the 12th century. (Right) Venice, A.D. 1338. In medieval times this city distributed the trade of the East to northern Europe.

all foreign trade during the Middle Ages was in luxuries, for costly goods of small bulk were all that could profitably be carried over great distances.

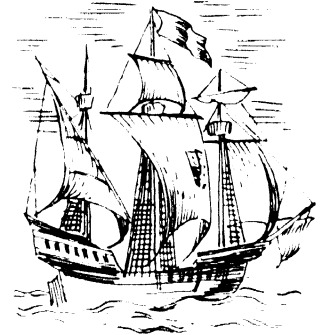
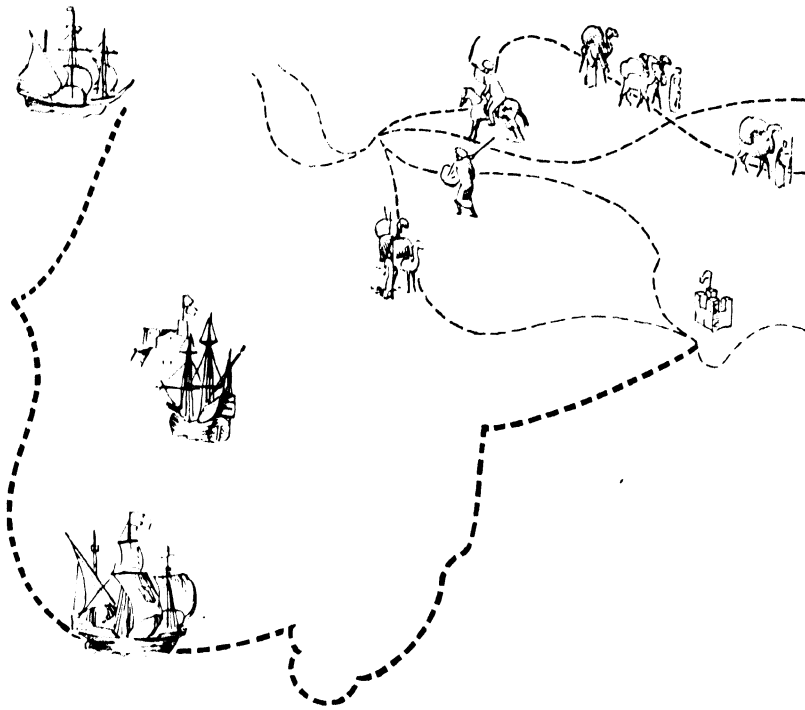
The Hansa. On fast days in medieval times meat could not be eaten, so fish was an important item of trade. The fisheries of northern Europe were controlled by the Hansa (merchants' guilds), which was centred on northern Germany. Merchants of the Hanseatic League were also the chief distributors in northern Europe of Eastern goods. Their trade routes, one over 7,000 miles long, stretched across Russia and beyond, via Kiev. So with the Italians controlling the Mediterranean routes and the Hanseatic League those of northern Europe, the English, on the edge of the known world, played only a small part in international trade.

The Development of the Ship. Medieval vessels were either long ships (for oars) or round ships (with

sails). When the round ships (merchantmen) were adapted for war, small castles were added to the bow and stern for fighting at close quarters, and land tactics were used in sea battles. The crossbow had long been England's national weapon, but by Tudor times cannon were firing "broad-sides". Thus the ship became a floating battery. So decks had to be strengthened and vessels made more manœuvrable. To protect the sailors guns were fired through square apertures ("ports" the origin of the port-hole). The steering-oar, which had persisted since remote times, was replaced during the Middle Ages by the rudder. This gave better control of vessels, which were not only heavier but higher out of the water than the ships of early times.

Although the compass (stated to have been invented by the Chinese and introduced in Europe by the Arabs) came into use about this time, ships of the Middle Ages rarely ventured across unfamiliar seas.

THE SEA ROUTE TO INDIA



da Gama's outward voyage. Medieval trade routes to the East (thin lines) all had to pass overland and were slow and costly.

The "Sao Gabriel" which opened the sea route to India.

The Medieval Route to India. In the same year that the English lost Bordeaux the Turks captured Constantinople (1453) and threatened the only known route to India via the Mediterranean. The loss of our French possessions (and markets) seemed to the nobles and merchants of the time far more serious than the threat to trade with India, and no one could then foresee that richer markets would be gained in Asia than had been lost in Europe.

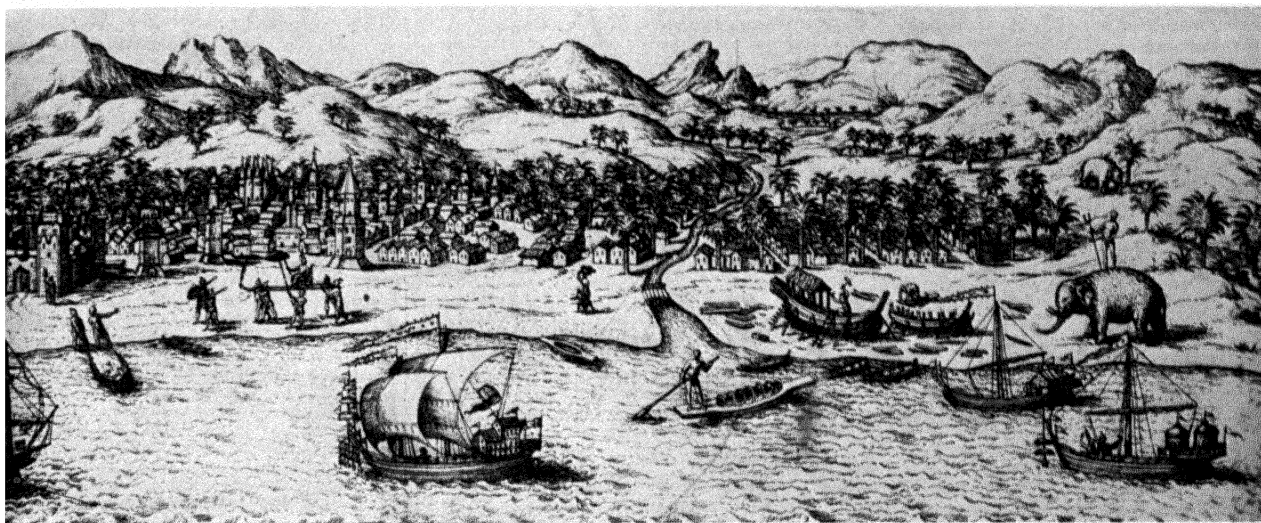
The Ottoman advance did not, as is sometimes said, completely sever the trade routes to the East, but there were pressing reasons for finding a direct sea passage to India. Medieval Europe had to pay for its spices and silks with gold and silver because its bulky products could not be taken overland by camel. The one-way trade impoverished Europe of its precious metals.

The land route, too, was costly. Calicut, of which

a contemporary print is shown above, was the chief Indian port, and the rich European trade was an Arab monopoly. Cargoes of fabulous worth were shipped in Arab dhows up the Red Sea.

Camel caravans completed the journey to Alexandria, from which the Venetians shipped their cargoes in carracks, large three-masters which the Mediterranean nations developed from the single-master of the north. Before the Venetians added their exorbitant profits, toll had been paid to Indians, Arabs, Abyssinians and Egyptians.

How the New Route was Found. By the end of the Middle Ages the leading geographers believed the earth to be a sphere and that India could be reached either by sailing westwards or by sailing round Africa. Among those holding this theory was Prince Henry the Navigator of Portugal (1394-1460). Inspired by the adventures of Marco Polo, he sent



Calicut, reached by da Gama in May 1498. An engraving from Braun's Civitates Orbis Terrarum.



Prince Henry the Navigator.



Castle built by the Portuguese at Elmina, W. Africa, in 1482.

many expeditions to find a way round Africa and so reach India by sea. Progressive Portuguese discoveries along the African coast included El Mina (The Mine) (1482), where their castle, pictured above, still stands. In 1487 Bartholomew Diaz skirted the length of Africa, but had to return because his crew mutinied. Finally in 1498 Vasco da Gama rounded the Cape, crossed the Indian Ocean and brought his ship to Calicut. The voyage took ten and a half months.

Results of da Gama's Discovery. In all countries facing the Atlantic there was a surge of new interest in navigation, map-making and shipbuilding. Ships sailing direct to India could carry a far larger bulk of goods than had passed along the overland routes. The direct route was also less costly because tolls were eliminated, but the most important result of all was that the centre of maritime trade had shifted

from the Mediterranean to the Atlantic. The power of Venice declined and the future of oceanic trade and discovery passed to those nations which had good harbours on the Atlantic seaboard.

da Gama's Ships. Although these were leaky, verminous, comfortless, and, by comparison with any ocean-going vessels of to-day, very small, they must have been well-founded, for they made voyages of thousands of miles across uncharted oceans. While ships sailed on inland seas or kept to coastal waters they developed slowly. But ships, like those of da Gama, built for ocean voyages, show a considerable advance on earlier vessels. For example, they had three masts instead of one, or two, and were fully-rigged. The foremast and mainmast were square-rigged, the mizzen or third mast carried a lateen (Latin) sail. The fully-rigged ship dates from the opening of the ocean routes.

COLUMBUS SAILS WESTWARDS IN SEARCH



(Above) The Hereford map (c. 1280) shows the world before Columbus.

(Right) The world after Columbus, according to contemporary ideas. America is not shown because its existence was not suspected. The newly-discovered islands were thought to be off the coast of Asia.

TERTIA in Indiam expeditione, Columbus
*Cubaguam appropinquans cum sinum na-
 quas edules effugiunt, vnde
 grediantur, ubi mulieres
 uant, quos uilibus rebus*

THE ISLAND OF PEARLS, SO CALLED FROM THE ABUNDANCE OF PEARLS FOUND THERE

"On his third expedition to India, Columbus, after entering the Gulf of Paria, came to Cubagua, which he himself named the Isle of Pearls, because when he was passing through that gulf in his ships, he noticed the Indians fishing for oysters from a boat. The Spaniards carried off the oysters to eat, but when they opened them they found them full of pearls, which occasioned them great rejoicing. They came to the shore and disembarked, where they saw Indian women wearing most beautiful pearls on their necks and arms. These they bought in return for articles of little value."

Why Columbus sailed Westwards. This picture of Columbus in the New World (1492) owes much to the imagination of the artist. Geography, at the beginning of the Age of Discovery, was a mixture of fable and fact. The scenery and the natives are wildly improbable, but the "Indians" diving for pearls and the boats filled with oyster shells were authentic. The description of the scene beneath the picture is a translation from medieval Latin.

What was the belief which brought Columbus on this daring expedition across the Atlantic, an ocean till then known as the Green Sea of Darkness?

Most people in the Middle Ages had thought that the world was flat and that the Mediterranean was at the centre. This belief is shown in the Hereford "Wheel" map (above). At the edge of this flat world were cataracts and sea monsters. But by the 15th century a theory that the earth might, after all, be round, inspired the imagination of all mariners whose dream it was to discover an ocean route to Cathay and Zipangu (China and Japan). It was known from Marco Polo's account of his journeys

that in these lands there were spices, jewels, pearls and precious metals. The prospects of this rich trade drew the thoughts of 15th- and 16th-century navigators to the uncharted Atlantic. Across this ocean, they thought, lay the fabulous lands, wealth and fame.

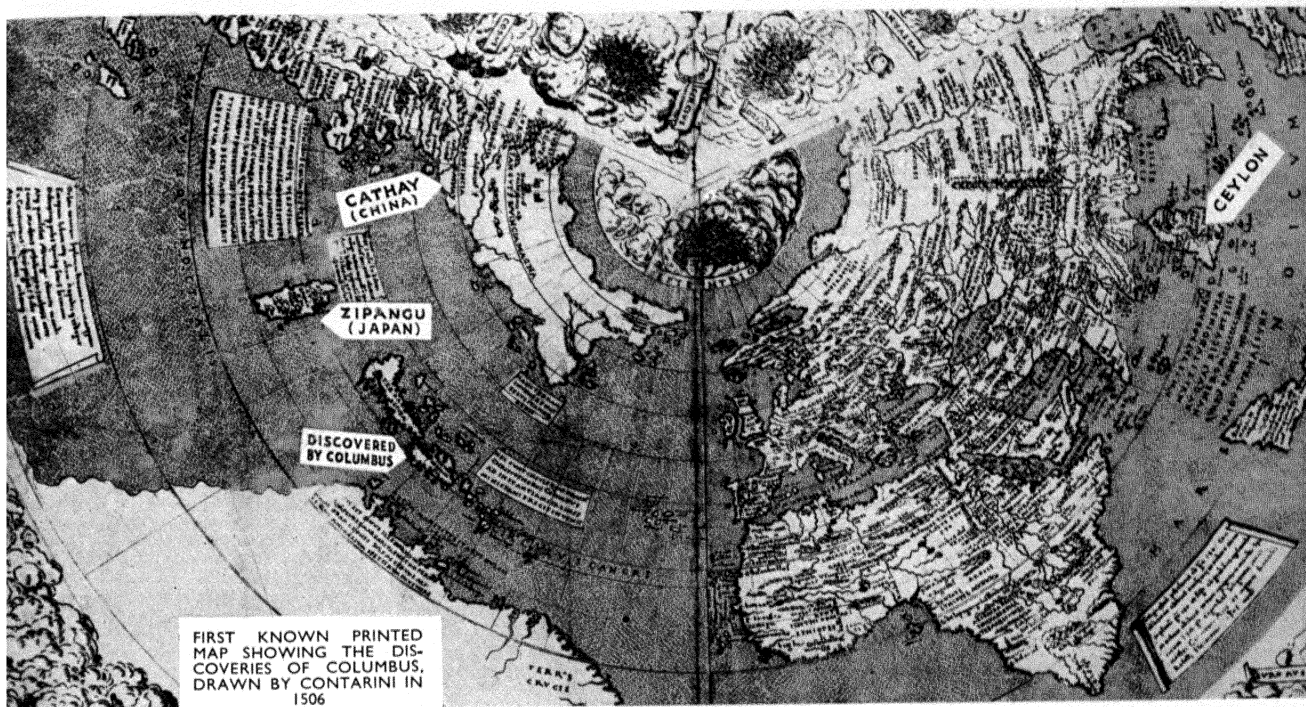
Portugal, committed to the African route, would not listen to Columbus who for eighteen years had vainly tried to persuade Europe that India and China lay across the Atlantic. England and France refused to encourage a man who wanted to reach the East by travelling towards the West. Spain grudgingly gave him three tiny ships in which to make the most momentous voyage in history.

On the 12th October, 1492, Columbus in his flag ship *Santa Maria*, 100 tons, made a landfall off the Bahamas. He passed from island to island, each one seeming an earthly paradise, but he failed to reach Cathay. On his second voyage he discovered instead



Ships of Columbus (about 50 tons) compared

OF THE EAST

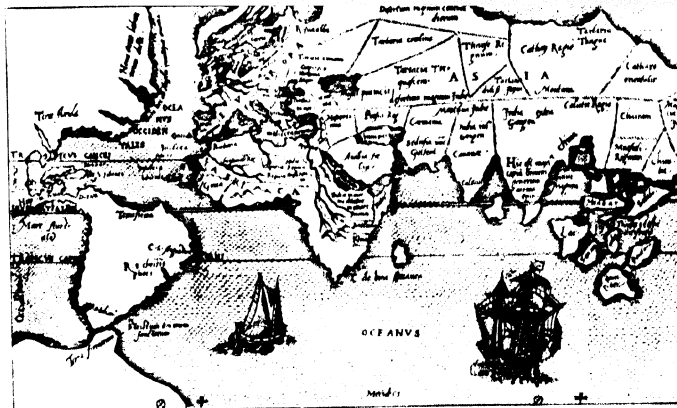


Map by Robert Thorne, 1527. Within thirty years of the Columbus discoveries much of the American coastline had been mapped. (Compare with Hereford map.)

of China, Jamaica; on his third, Trinidad; his fourth, Nicaragua and Panama. A handful of gold and a string of slaves were poor return for the merchants who had invested in the western voyage, and the rewards of Christopher Columbus, the greatest navigator of his time, were poverty and humiliation.

Early Maps. The Contarini map (top) is the first known map on which the discoveries of Columbus were recorded. The outlines of Europe are good, and so are those of Africa (known from Portuguese discoveries), but southern Asia is no more accurate than maps made from Ptolemy's calculations. We must remember, however, that when this map was first drawn Vasco da Gama had barely returned from the

first ocean voyage to India. The western portion of the map shows how the discoveries of Colum-

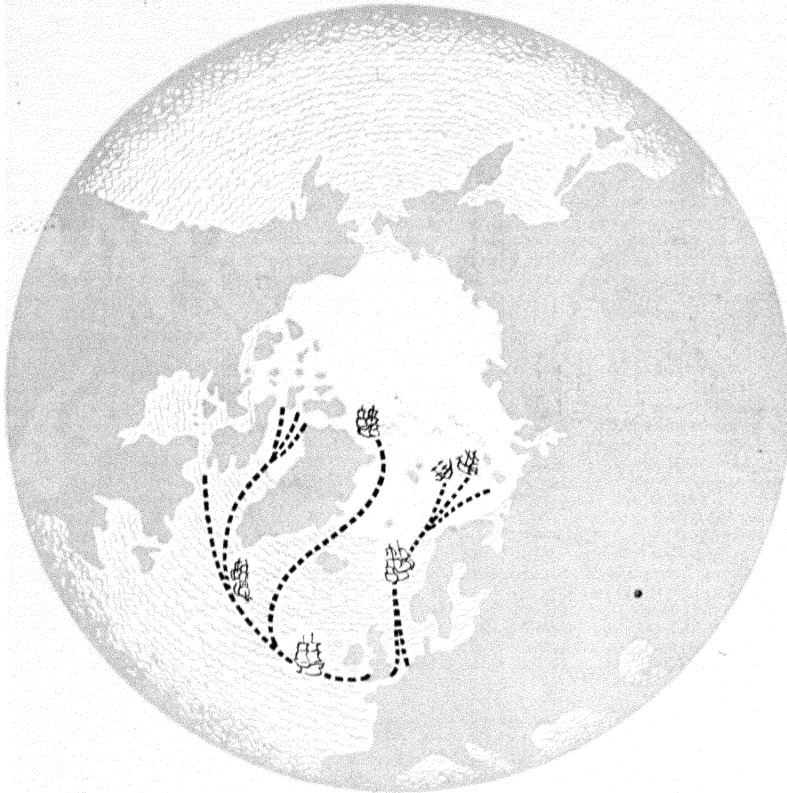


bus were interpreted. That a vast land-mass, stretching almost from pole to pole, lay between Europe and Asia was not suspected. Contarini, like Columbus, believed that the land on the north-west of the map was China, and indeed the large, single island, which is so prominent a feature of the Western Ocean, was marked Zipangu (Japan).

The Pacific was not sighted until 1513 and was not crossed until Magellan circumnavigated the globe (1519-22). It was thus that the geographers gradually became aware that instead of a new route to Asia a New World had been found. In 1527 Hakluyt published a map (above) by Robert Thorne which showed how the voyages of Columbus had led to a widening of the world.

with modern cargo vessel (about 3,000 tons).

BRITISH SAILORS SEEKING A NORTHERN ROUTE TO



FAILURE. *The search for North-east and North-west Passages to the East ended in the Arctic Wastes. (Right) Henry Hudson, cast adrift by his crew during an attempt to find a North-West Passage to Cathay.*

1497. Discovery of Newfoundland. Thoughts of the rich eastern trade in spices, pearls and silks dominated the minds of merchants and explorers at the end of the Middle Ages, and an Italian, John Cabot, who was living in Bristol during the reign of Henry VII, convinced the King that by sailing westwards across the north Atlantic, he could succeed where Columbus had failed, and reach the shores of Cathay (or China). After a six-weeks voyage Cabot thought that he had indeed reached Cathay: but nobody in 15th-century England was to benefit from his discoveries, for the Genoese had unknowingly discovered North America. The land was thinly peopled and there were no prospects of easy profits and therefore no enthusiasm over what was considered a worthless wilderness.

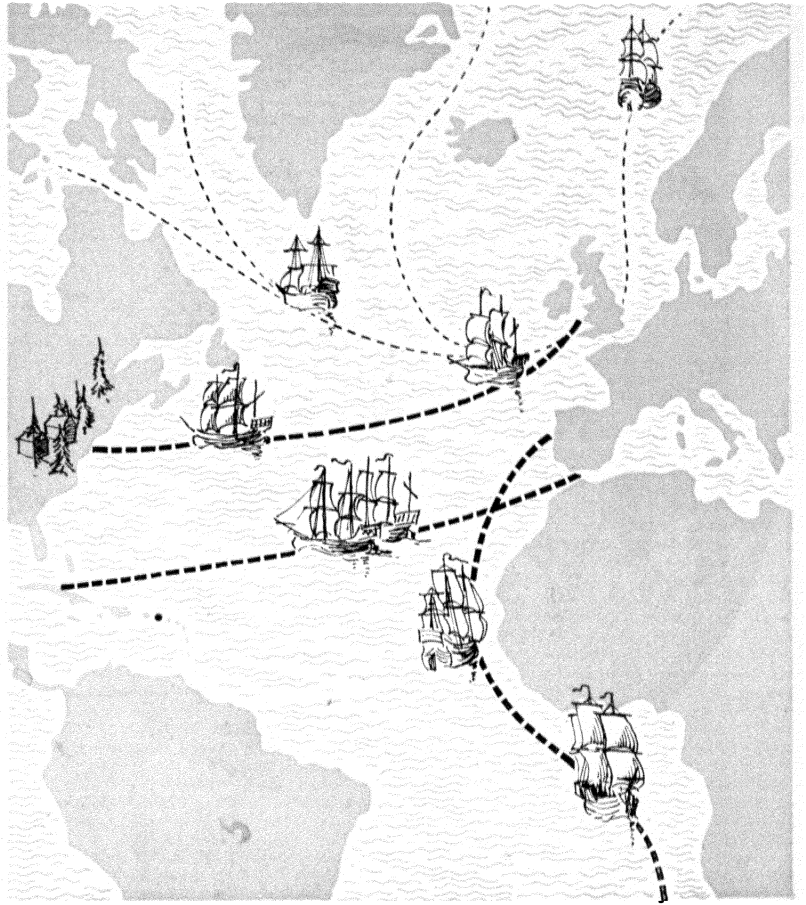
The results of Cabot's voyage were the discovery of Newfoundland, oldest of our Colonies (now a province of Canada) and the belief that if England was to have its own route to the trade of Asia this must lie through

the ice and snow of arctic regions, for the southern routes were monopolized by Spain and Portugal.

The Route that Ended in Failure. The map shows the routes of great Elizabethan sailors like Frobisher, Davis and Hudson, towards the ice-cap. In 1609 Henry Hudson discovered the Hudson River and in 1610 Hudson's Bay. The discipline of his crew broke under the strain of the cold and darkness of the Arctic winter. Fearing to go on through the ice-floes, they mutinied. With his small son, and sick members of the crew, Hudson was set adrift in a small open boat and never heard of again.

The fruitless search for a northern passage brought no tangible rewards, but it was a hard school of seamanship. We may see in the quest for the North-east and North-west passages England's apprenticeship in maritime skill, for at that time this country knew little of scientific navigation.

THE EAST, REACHED NORTH AMERICA



SUCCESS. (Left) The Pilgrim Fathers land from the "Mayflower" (1620). (Map) Portugal opens the ocean route to India, England in North America, and Spain in South America seek new empires by discovery, conquest and colonization.

Success : The Westward Crossing. It was, in part, this increased knowledge of seamanship and of shipbuilding which made possible the founding of colonies in America.

The colonies were spoken of as "plantations", for in the 17th century "to plant" meant to form a settlement. The early history of these colonies is a story of famine and pestilence because many of the expeditions were inadequately equipped for the hard winter of North America ; there was bitter fighting with the Indians, and frequently the colonists were unable to govern themselves.

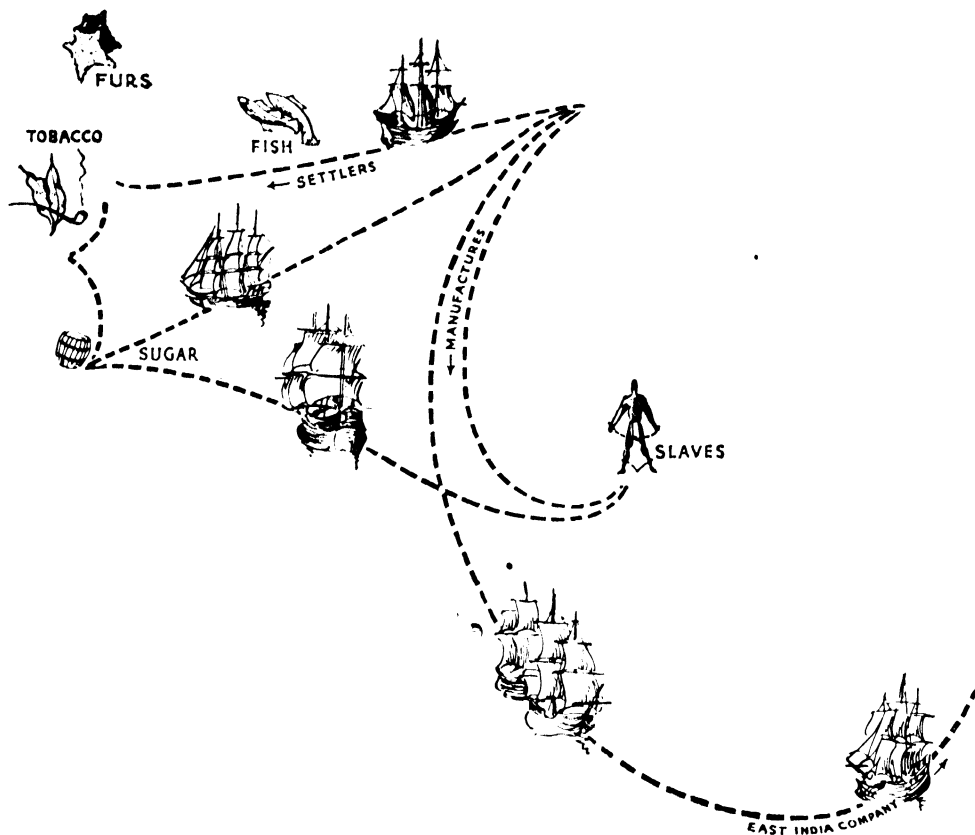
Most of the settlers in Virginia and Maryland had emigrated in the hope of obtaining free land, for during Elizabeth's reign there had been an increase in population and much social unrest. But in the year 1620 the *Mayflower* carried to North America a party of emigrants who sought freedom of religion. These were Puritans who had broken away from the

Established Church, for in the England of the Stuarts only one form of religion was tolerated. The Puritans who set out on the great adventure which was to lead to the founding of a new nation became known as the Pilgrim Fathers.

By hard work, courage, and wise leadership, New England prospered, and with the growth of its commerce needed the protection of the Royal Navy in the North Atlantic. This protection was forthcoming, but the English Government insisted that a large proportion of the trade should be carried in English ships, for it was held that the main purpose of colonies was to benefit the Mother Country.

Thus England, who a few centuries before had been a small island on the edge of the world, began her career of colonial expansion. In a comparatively short time, helped by her fortunate geographical position, this country became the foremost nation of the world in maritime enterprise.

TRADE ROUTES OF THE 17TH AND 18TH



Map of chief trade routes, 17th and 18th centuries, showing also Britain's fortunate geographical position between the old world and the new. The development of the Atlantic trading area (notice the triangle) and of the powerful East India Company, and the first settlements in North America followed the geographical discoveries of the 15th and 16th centuries.

British Expansion: Opportunities and Motives. The alteration in England's geographical position, following the discoveries of the 15th and 16th centuries, provided opportunities for expansion by colonization and oceanic trade. The motives were in part religious and political, but there were sound commercial reasons, too, for colonization. It was hoped to create in America markets for cotton goods, cloth and hardware, and receive in exchange sugar, raw cotton, and tobacco. England also needed gold and silver for her international trade—timber, cordage and canvas for her ships and, from India, luxuries such as spices, sugar and silk.

The East India Company. In Elizabethan times the State shared the profits, but not the risks or the responsibilities of overseas enterprise. The powerful East India Company (founded, 1600) built, equipped and manned its own ships, fought battles and defended

its interests against pirates and commercial rivals (especially against the Portuguese and French). One result of the Company's enterprise was that the East India captains, making 10,000-mile voyages, had every opportunity for learning the art of seamanship. Their crews, unlike those of the Royal Navy, were protected from the dreadful ravages of scurvy by being given lime-juice to drink.

The West Indies, and America. In the 17th and 18th centuries the West Indies were at once a valuable source of raw materials (sugar, cotton, tobacco) and a market for manufactures (especially cotton goods). Unlike the Spanish in South America, the British settlers found no quick and easy way to wealth. They had to grow the raw materials which could be exchanged for clothes and tools. From Virginia came tobacco, from the West Indies cotton and sugar. These needed an inexhaustible supply of cheap labour.

CENTURIES



EAST INDIA WHARF AT LONDON BRIDGE

From a contemporary painting by Peter Monamy.

The great East Indiamen which have just dropped anchor are loaded with spices, silks, tea and coffee. This picture should be compared with the aerial view of the London Docks on page 47.

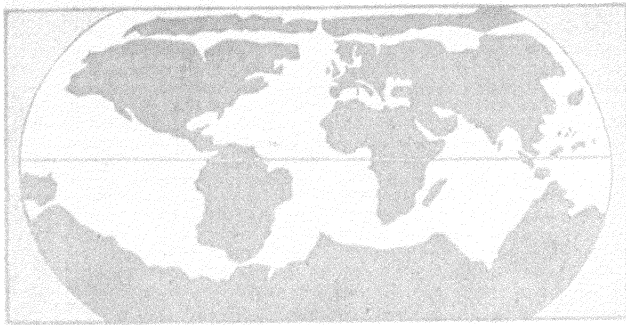
Thus was developed the triangular trade (see map) whereby "slavers" carried finished cotton goods to West Africa, exchanged them for slaves, traded these in the West Indies and at the ports of the American mainland for raw cotton, tobacco and sugar which, completing the triangle, were brought back to England.

Canada. The most northerly curve of the trade routes linked Canada with Britain. At this period the Empire consisted of strips of land in the coastal areas of North America, various islands in the Caribbean, and trading posts in India. Large areas of Canada were opened by water transport, and penetration to a depth of two thousand miles was made possible by the St. Lawrence and the Great Lakes. Hudson's Bay was the northern gateway to the continent. Blankets, pots and pans, beads, hatchets, knives, guns, powder and traps were bartered for

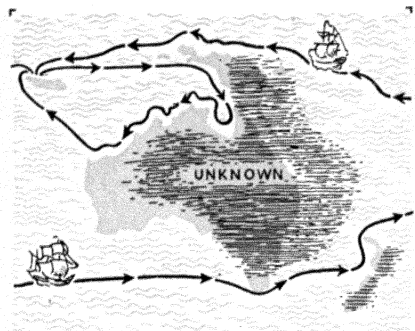
furs, and so great were the profits of the trade that agriculture was neglected, and furs were to remain the principal export of Canada until the railway age.

Some Results of Trade and Colonization. As a result of the development of overseas trading not only was there a vast increase in shipping but at home the diet and even the dress of the average Englishman were changed. Tea, coffee, spices and silks were in the holds of the great East Indiamen which sailed up the Thames. The rise of the cotton industry, which was further to expand our export trade, was one of the results of our trade with America and the West Indies. From the New World, too, came the potato, which was to occupy an important place in the social history of England (and Ireland) when cheap food was needed for a growing population.

THE FORGOTTEN CONTINENT



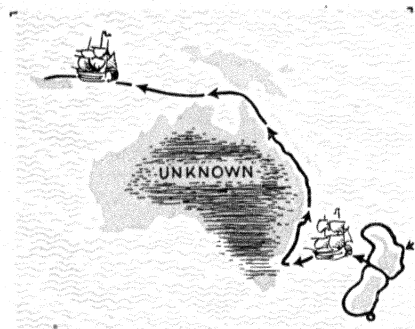
A 16th-century map showing a southern continent which did not exist.



Tasman discovered the island which bears his name and thought New Zealand part of this southern continent. The voyages of Tasman only revealed the inhospitable western coastline of Australia.



Captain Cook's "Resolution" and "Adventure" at Tahiti.



Cook discovered and surveyed the fertile eastern shores and proved that New Zealand was two islands.

Terra Australis Incognita. The name "Australia" comes from "Terra Australis Incognita"—Unknown Land of the South. It was called thus by 16th-century map-makers (top left), who wrongly imagined that a vast continent stretched across the whole breadth of the Southern Ocean reaching to the South Pole. Why was Australia so long unknown and how came it to be called "The Forgotten Continent"?

One reason was the isolation of the island continent in the wide expanse of the Pacific, as shown in the larger map. Northwards the East India Archipelago barred the approach to the northern shores, for the islands were infested by pirates. The western coasts were barren and waterless. No ships made landfalls on the eastern shores because of the south-west trade winds and the Barrier Reef.

In 1642 and 1644 Tasman, the great Dutch navigator, mapped the western coast of Australia. The

Dutch, however, saw little prospect of rich rewards to be won in that arid waste. Their interest was in trade and profit, not geographical exploration. They preferred to exploit the more accessible riches of the Spice Islands to the north. So, for over a century after its discovery there was no scientific exploration of the Australian coastline. The continent was apparently forgotten.

The Achievements of Captain Cook. In 1768 the Royal Society fitted out an expedition, under the command of Captain James Cook, to observe the transit of Venus in the South Pacific. Cook was the greatest navigator of the age and the real object of his voyage was to chart the coasts of Australia and New Zealand. Cook made three voyages: 1768-71, 1772-75, 1776-80. On his first he sailed round New Zealand (which Tasman had thought part of the



Emigrants leaving their ship in Sydney Cove, N.S.W. (c. 1850). The discovery of the great grasslands and also of gold attracted thousands of settlers in the mid-19th century.

southern continent), thus proving that it consisted of two islands. Then, on his return northwards, Captain Cook explored the fertile eastern coast of Australia. The picture (left) shows his ships *Resolution* and *Adventure*. In these Cook made his second voyage, during which he discovered many island groups in the South Seas and proved that the continent did not, as had once been imagined, stretch southwards to the Pole.

Not only was Cook a great sailor but he did much to improve the lot of the common seaman. He kept his crews healthy, banishing scurvy by ensuring ample supplies of fresh fruit and vegetables. Among his proudest boasts was that after a thousand days at sea only one man out of a ship's company of more than a hundred died of scurvy.

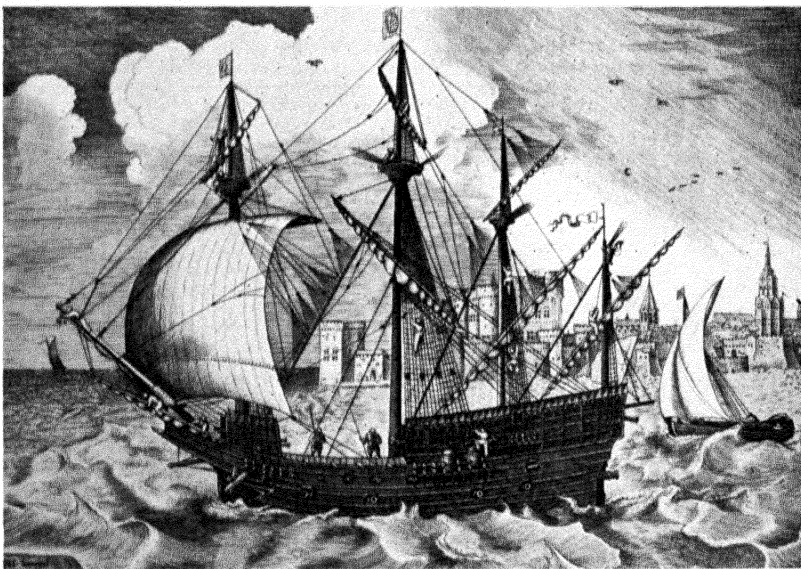
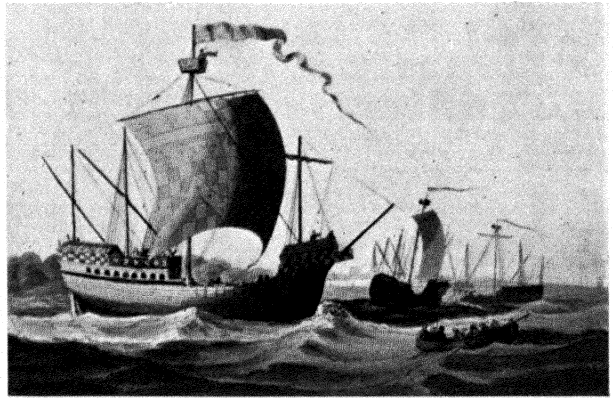
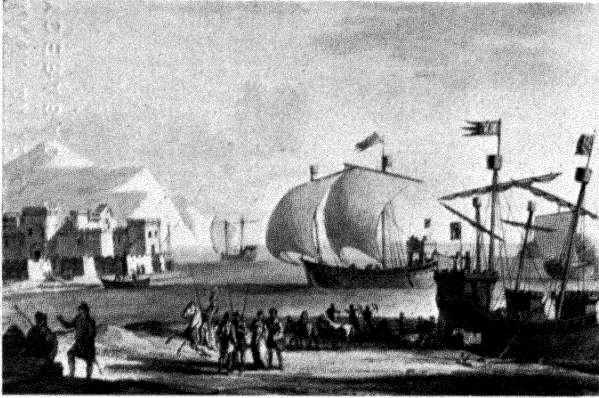
Why the British Colonized Australia. In the 18th century every European power wanted colonies which

would produce valuable export crops, particularly sugar and tobacco. It was thought that these could be grown in the tropical north of Australia and that if we failed to take the opportunity the French might forestall us.

There were two other reasons which led to the colonization of Australia. One was the loss of the American colonies, as a result of which Britain diverted her colonizing energies to the newly-discovered continent. The other was the need for a settlement to which the victims of harsh 18th-century criminal laws could be transported.

Transportation ended in the 1840's, but by that time the grasslands of Australia were discovered. Australian wool crops and wheat harvests and, in the middle of the century, the discovery of gold, hastened the development of the fastest of all sailing ships. This was the clipper.

THE DEVELOPMENT OF THE SAILING SHIP



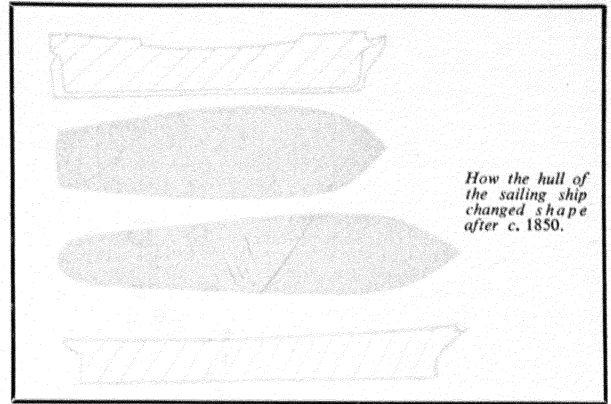
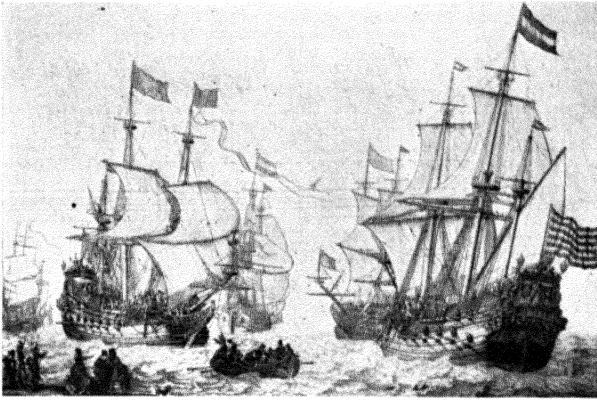
(Top left) At the time of the first Crusades ships had steering-oars and wooden "castles" at bow and stern for the fighting men. By the 15th century these castles had become part of the structure of the ship (top right). So ships had to carry a greater area of sail and more masts. They were higher out of the water and steering was now by rudder. The addition of guns (left) led to the building of vessels with several decks.

Medieval Ships. The change in the various ship-types illustrated on this page came about from two main causes. Firstly, and most obviously, there was the gradual improvement in tools and the increasing skill in shipbuilding. Secondly, there was the progress of geographical discovery and the extension of trade. Trade and discovery provided the impetus for the shipwrights to build bigger, faster, and more specialized vessels.

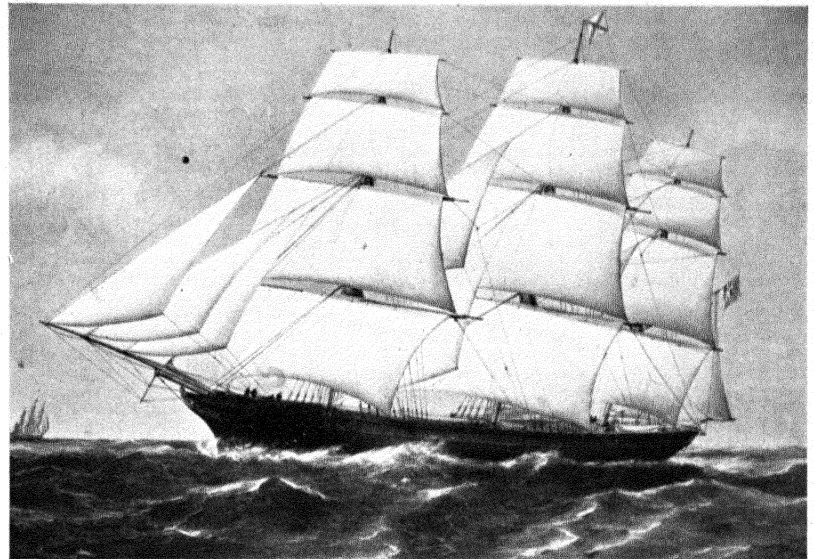
The first picture, drawn from a 13th-century manuscript, shows one of the ships which made the voyage to the Holy Land during the Crusades. The small wooden "castles" at bow and stern were for the use of fighting men. In those days soldiers were more important on warships than sailors, and land tactics were used for fighting at sea. In the second picture, drawn from a 15th-century manuscript in the British Museum, it is clear that the "castles"

had by then become a permanent feature of the ship. Hence the term "forecastle", or "fo'c'sle", still in use. So the hull was strengthened; thus a greater area of sail (and therefore more masts) were necessary. Probably the most important maritime invention of the Middle Ages—the rudder—is shown in this second picture.

Gunpowder and Galleons. The third picture shows a ship of the size and period of the *Golden Hind*, the famous ship of Sir Francis Drake. It is not a large vessel, for these ships had to be manœuvrable in order to make use of their fire-power and avoid that of the enemy. At first, guns were fired from the side of the decks, but afterwards (as in this picture) they were placed on lower decks where the gunners were less exposed to danger. The number of guns on a ship was increased by mounting them in tiers, one deck



(Top left) Dutch East Indiaman. These fully-rigged ships were developed partly as a result of long ocean voyages, partly as a result of the "broadside" technique which necessitated greater manœuvrability. (Top right) How the fast sailing ship, no longer armed with tiers of guns, changed shape after about 1850. Diagram compares clipper with earlier sailing ships. (Right) The famous Clipper "Taeping".



above another. The Spaniards developed the galleon as a heavy, powerfully-gunned ship, which tended to be unmanœuvrable. The English preferred smaller, faster vessels. The two types opposed each other in the Armada.

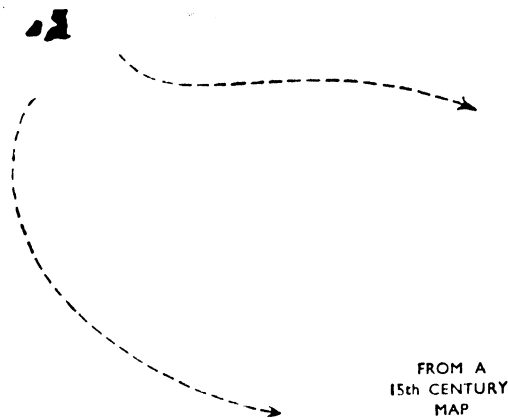
The Indiamen. The ship illustrated is Dutch, reminding us that Holland was once the foremost maritime power in Europe. This ship, which traded to the Dutch East Indies, is fully-rigged. As a result of the development of the "broadside" technique, ships by this time had more decks, therefore more sails and more rigging. Thus the sailor's job had become highly specialized, and soldiers on board ship became less important as ships came to look less like the floating castles of medieval and Elizabethan times.

The Clipper. With the Clippers, loveliest of all ships, the sailing ship reached the furthest point in

its evolution. The name "Clipper" may have come about when these ships "clipped" days off record sailing times, or it may refer to the way in which the fine lines of these ships were clipped towards the stern.

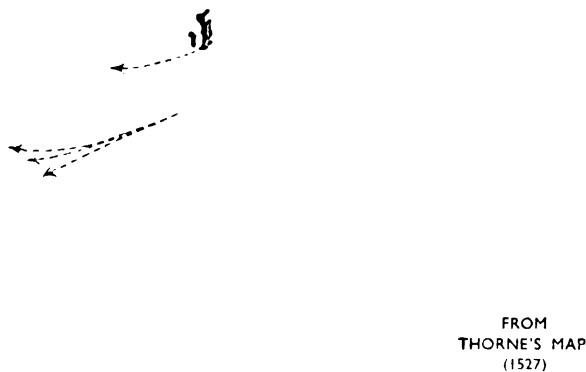
The job of the Clippers was to carry valuable cargoes (for instance, the tea crop) over long distances at high speeds, and for years they were superior to the steamships of the mid-19th century. Among the many forces behind the perfection of Clippers were the gold rushes to California and Australia and competition in the China tea trade and the Australian wool trade, for the first cargoes of the new season's crops to reach port fetched the highest prices. Competition with steam was also an incentive to builders of fast sailing ships, and the use of iron instead of wood made possible the building of lighter vessels.

THE DEPENDENCE OF OCEAN ROUTES ON



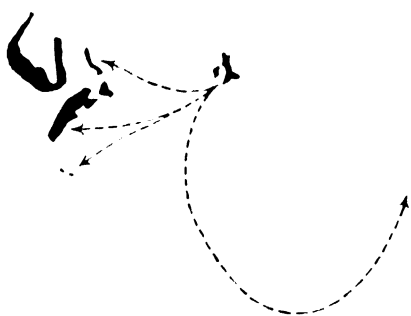
FROM A
15th CENTURY
MAP

Fifteenth century. Britain on the edge of the world.

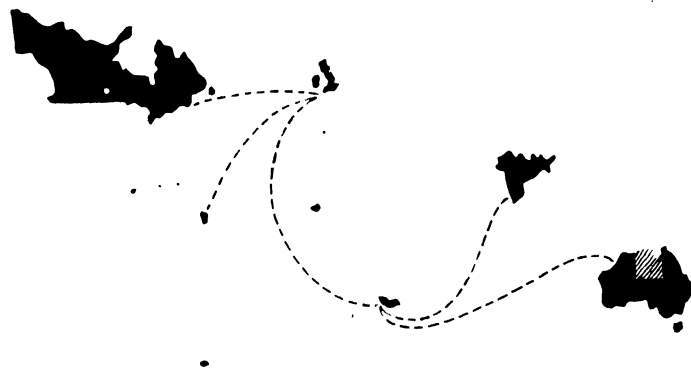


FROM
THORNE'S MAP
(1527)

During the Age of Discovery. Britain is now in the centre of the maritime world.



Britain and the Empire (1714) with ocean trade routes mainly to American colonies and India.



Britain and the Empire (1837) with longer trade routes to expanding colonies.

Britain at Centre of Sea Routes. The chief results of the great voyages which pushed back the frontiers of geographical knowledge are shown in our maps. The weight of sea-power had shifted from the Mediterranean to the Atlantic and England was no longer on the edge of the world (first map) but at the centre (second map). All the countries on the Atlantic seaboard, especially Portugal, Spain, England, France and Holland, fought for the glittering prizes which were the reward of maritime enterprise.

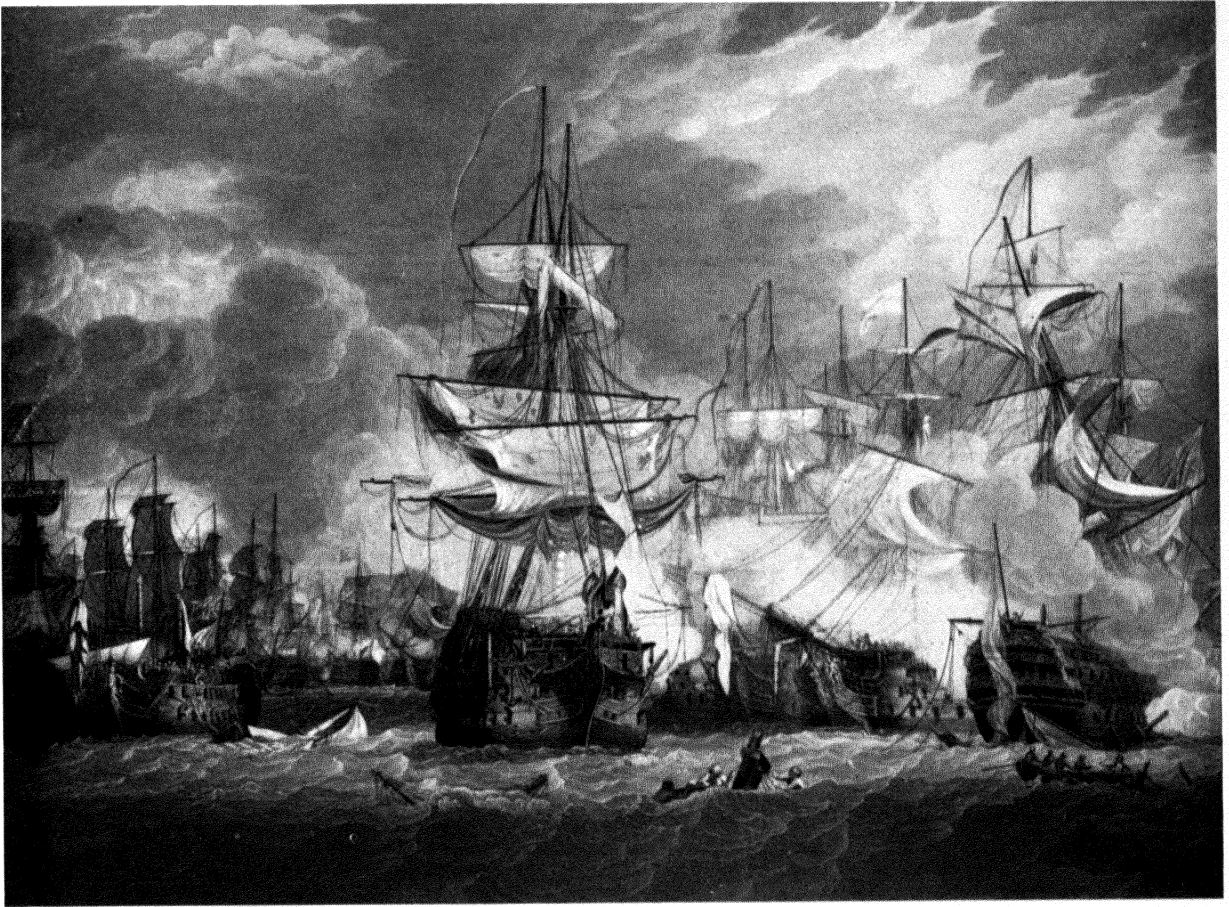
England, a small country, poor in resources and population, eyed with envy the heavily-laden Spanish treasure ships. While the conquistadors were ransacking an empire, Henry VIII was fitting more powerful guns to faster ships and his sailors were learning how to use the broadside. The Armada was battered into dispersal and a single English ship, *Revenge*, fought the Spanish fleet throughout a day and a night. Guns were not all that this nation

possessed. There were also good oak, deep harbours and a long experience of the sea.

The Fight for Naval Supremacy. Throughout the 17th century British supremacy at sea was challenged by the Dutch, who were our rivals not only in the Atlantic trade but in the Indies. The Dutch were the chief carriers of salt, grain, and timber, and were the foremost whalers of their day, besides specializing in the long-distance run to the East. The Navigation Act of 1651, which decreed that all imports to England and into English colonies must be carried in English ships, was a crippling blow to the Dutch and led to a war. The British seizure of the Dutch colony of New Amsterdam, which was re-named New York, led to a second war, and it was this which resulted in Holland losing her American colonies to Great Britain.

After Wolfe's victory in Canada (to which the

SEA POWER



*Trafalgar, which decided Britain's naval supremacy, and was the last big battle in which sailing ships fought.
From the painting by Hellyer.*

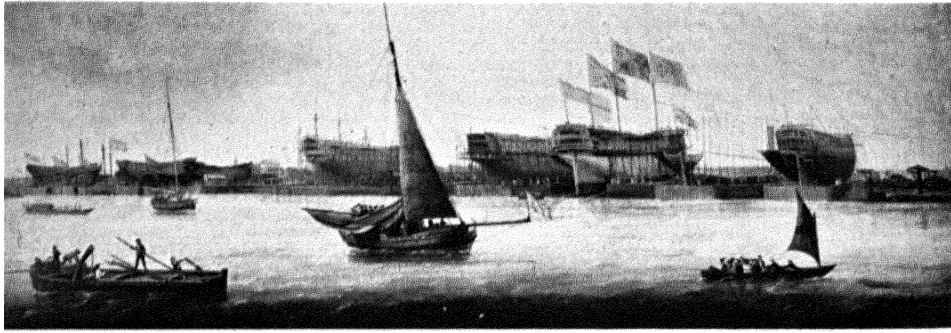
Navy contributed by preventing the landing of French reinforcements) there was bitter rivalry with France. Early in the 19th century this rivalry led to the titanic struggle between the greatest land-power and greatest sea-power in the world. Napoleon held all Europe from the coast of Portugal to the Russian steppes. Britain held the seas. At Trafalgar the issue was decided, and for almost the last time in the long history of battles at sea, the ships were manœuvred to their fighting quarters under sail.

Results of Sea Power. During the Napoleonic wars, which lasted almost twenty years, while invasions, levies, conscriptions and blockades stifled all economic and industrial progress on the continent, British ships were taking British goods all over the world. Under the protection of the fleet there was a vast increase in shipping, but this increase was a natural growth arising from the surplus goods we

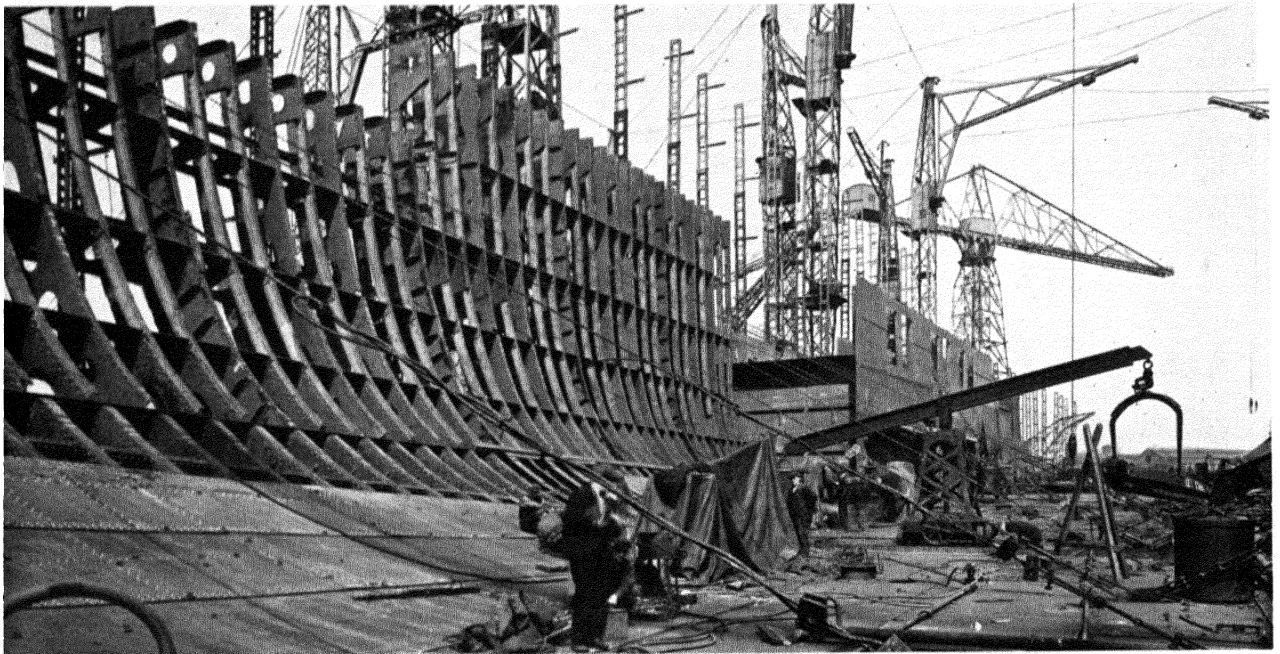
had to export. The investments in new industries were made from the accumulated profits of past trading. This increase in trade was not the only result of our naval strength. It was naval supremacy which made possible the growth of our colonies, and which preserved us from the recurrent invasions which have devastated the Continent throughout the centuries.

On the other hand, the colonies can claim to have helped the development of the navy. They were at first obliged to take manufactured goods from the Mother Country in exchange for their raw materials. From the great volume of shipping which resulted, Britain built up her sea-power, which defended not only this island but also the colonies themselves. With the loss of the American colonies (1783) the old colonial system came to an end, and it seemed as though the world's greatest trading nation would pass into oblivion. But other and greater changes were on the way.

WOOD TO IRON



(Left) The oldest privately-owned shipyard in the world. Green's Yard, Blackwall, as it was in the 18th century, with wooden ships on the stocks. (Below) The "Queen Elizabeth", the world's largest liner, under construction. The building of even one big ship is a vast enterprise involving many industries and scores of different trades.

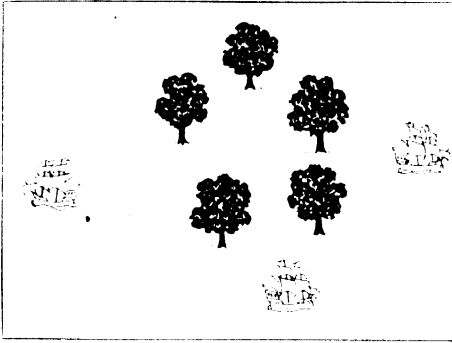


Why Wooden Ships were Doomed. From the earliest times shipbuilders had made their ships with wood, but early in the 19th century supplies of durable hard wood began to run short and experiments were made with iron ships. The transition from wood to iron, however, showed no sudden break with tradition. Many of the last clippers were of composite construction, iron frames and wooden planking.

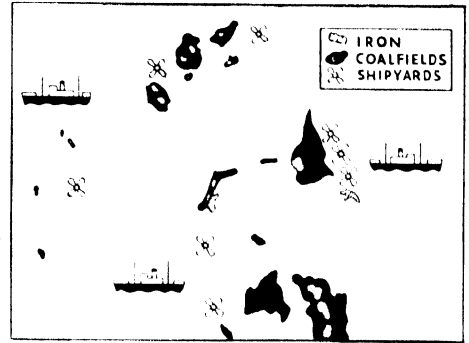
The iron ship was the forerunner of great changes, not merely in trade and shipping but in the everyday lives of people everywhere. The coming of the factory system in the cotton industry, the discovery of how to make cheap iron by smelting with coal, and the introduction of steam power, heralded the Industrial Revolution. By the middle of the 19th century England was producing half the world's pig iron, and since there were obvious advantages in building iron ships in yards close to the coalfields and ironworks, shipbuilding, like many other indus-

tries, moved from the wooded south to the coal- and iron-bearing north.

Advantages of Iron Ships. The demand for bigger and bigger ships to keep pace with the needs of trade could never have been met by wooden sailing ships. Bigger wooden hulls could have been built, but the size of spars and sail was limited to the handling capacity of the crew. So bigger ships might have meant slower ships. Since iron is much heavier than wood, why was not a larger sail area needed for iron ships? The answer is that the greater strength of iron allowed much thinner hulls to be built. Hulls made with half-inch iron plates gave a greater cargo capacity than hulls of comparable dimensions built of twelve-inch oak, and were only about two-thirds of the weight. There were other advantages in iron ships. They were easier to handle and therefore more economical; in iron ships there was less risk of fire



These maps show how shipbuilding moved from south to north. For centuries ships were built along southern rivers, bays and estuaries near to woodlands which ultimately became exhausted. When iron replaced wood for shipbuilding, new shipyards were opened close to the coal and iron deposits of the north.



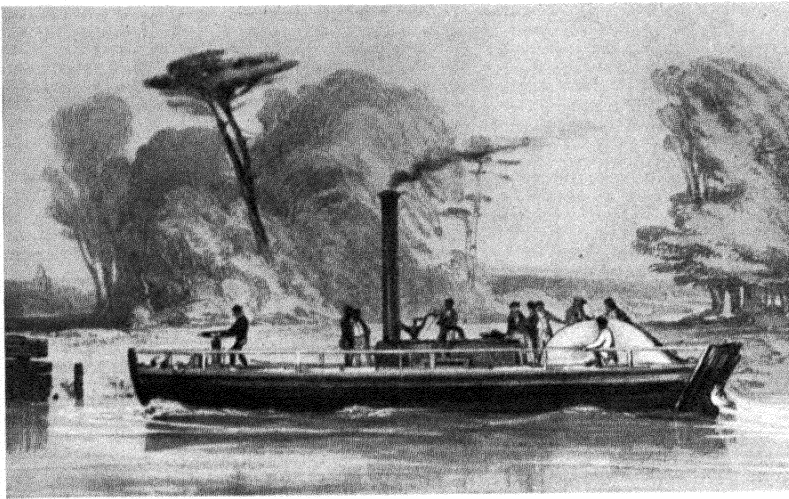
and so insurance cost less for iron than for wooden ships ; and when an iron ship ran aground or was involved in collision there was less chance of her breaking up. Finally, the steam engine could never have been completely successful in wooden ships.

Why Shipbuilding Industry Moved to North. As our maps show, the shipbuilding industry was transferred by degrees from sheltered reaches of the southern coasts to Clydeside, Tyneside and the coast of Durham, where there was already a tradition of mechanical skill growing up beside the coalfields and in the ironworks. Green's at Blackwall, the oldest privately-owned shipbuilding yard in the world, is the subject of the small picture. This shows the yard as it was in the 18th century. The large picture, of the liner *Queen Elizabeth*, under construction, suggests the great changes in shipbuilding which have come about since the days of wooden hulls.

The Growth of Shipping. After the revolt of the American colonies British shipowners feared that they would lose trade to the colonists. But Americans turned their attention to the opening up of their own continent. Competition from European nations was ended by the Napoleonic wars. So British manufacturers and shipowners were free to distribute the products of British industry to every continent.

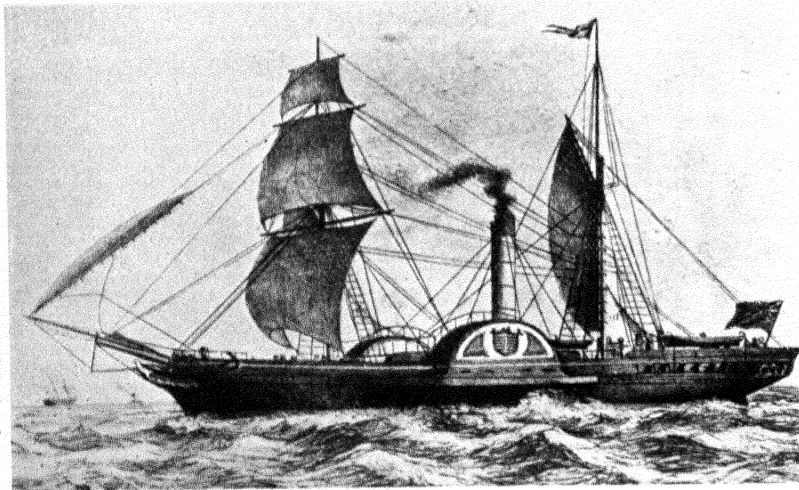
British cotton and woollen goods clothed the world at this time, but the nation depended more and more on foreign food as the population grew too large to be supported by its dwindling farmlands. British ships, therefore, were needed not only to carry manufactured products but to bring in wheat from the prairie lands of the American Middle West and Canada, tea from India and China and meat from Australia and New Zealand, besides cotton and wool for the mills of Lancashire and Yorkshire.

SAIL TO STEAM



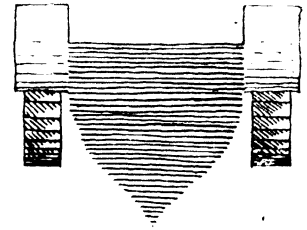
"Charlotte Dundas" (1801), Britain's first steamboat on the Firth and Clyde Canal.

The "Sirius" (1838), which crossed the Atlantic entirely under steam in 19 days.

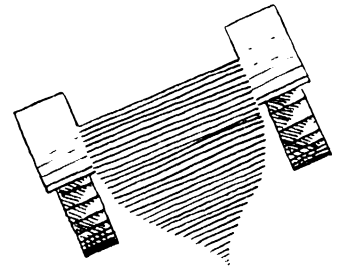


More Trade, More Shipping. On land the steam-engine was replacing water-power and wind-power by the end of the 18th century. One of the results was the Industrial Revolution and a vast increase in foreign trade, which, together with emigrant traffic to America, made great demands on shipping. Fast American ships were at that time competing with British. It was largely to meet this competition and the need for more shipping that steamships were developed.

The First Steamboats Sailed on Inland Waterways. At the beginning of the 19th century rivers and canals were the main highways for heavy goods transport, and the trials of the *Charlotte Dundas*, Britain's first steamboat, took place on the Firth and Clyde Canal (1801). They were so successful that the directors of



The disadvantage of paddles. When a ship heels over one is submerged and the other becomes useless.

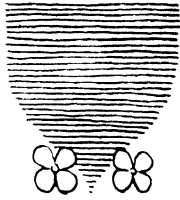


the canal, fearing that the wash from the three-mile-an-hour vessel might damage the banks, forbade further trials. In America, however, progress in steam navigation on the rivers was rapid and in 1807 the *Clermont* opened the world's first passenger steamship service between New York and Albany. Had the Americans then possessed abundant cheap iron and coal, and enough skilled mechanics, shipping supremacy

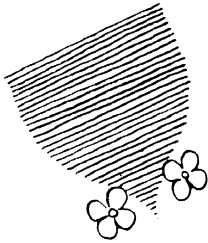
might have passed to them. But these they lacked, and modern shipbuilding really began where skilled men and materials were plentiful—in Scotland and northern England.

Steamboats were soon venturing across the English Channel, but few people during the first quarter of the 19th century believed that they would ever cross the Atlantic without sails because their engines consumed so much coal. It seemed certain that the usefulness of the steamboat would be confined to inland and coastal waters.

Across the Ocean. In 1819 the *Savannah* made the first Atlantic crossing by a ship fitted with steam-engines, but in 29 days' sailing she was propelled by her paddles for only 80 hours, having by then burnt all her coal.



Screw propulsion is far more efficient than paddles because the propellers can work in the calm waters of the stern. Screws, however, needed much more powerful engines than paddles.

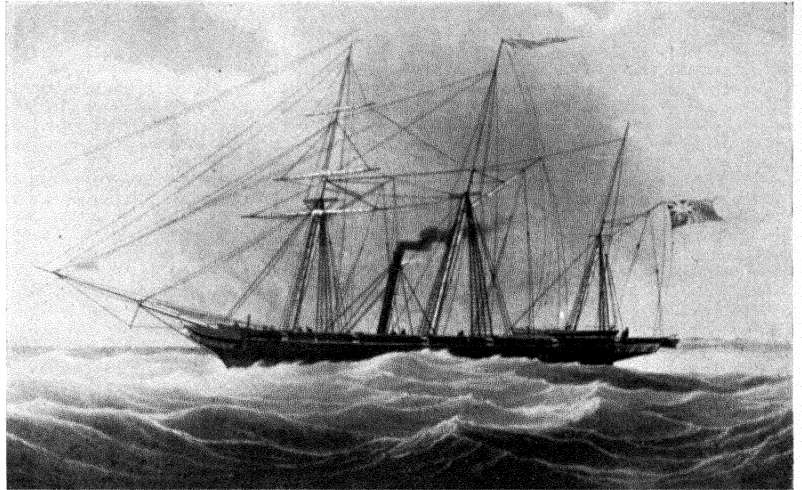


The *Sirius* which crossed from Cork to New York (1838) in 19 days, entirely under steam, burned not only all her coal but some of her furniture, and so much of her space had been taken up by fuel that there was little to spare for passengers.

The next step was to devise a more economical method of propulsion. The main disadvantage of paddles was that they were liable to damage in a heavy sea and, when the ship heeled over (see diagram), one paddle would be submerged while the other beat the air. (Also, from the Navy's point of view, large paddles were a particularly vulnerable target.)

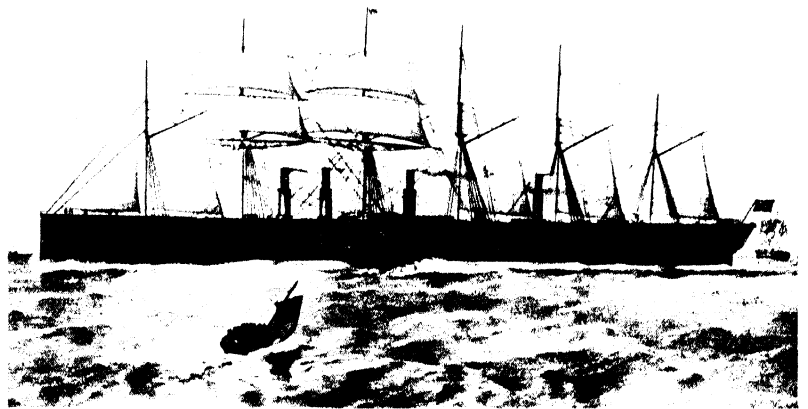
Screw Propulsion. The principle of screw propulsion was known to Archimedes, a Greek (b. 287 B.C.) after whom one of the first screw-driven vessels (above) was named. The advantage of propellers over paddles is that they work efficiently in the calm waters at the stern. In 1844 the Atlantic was crossed for the first time by an iron vessel, the *Great Britain*, but it was not for many years that paddles and sails disappeared from Atlantic steamers because the simple steam-engines then in use were not powerful enough for screw-propulsion.

The Great Eastern. The great engineer Brunel



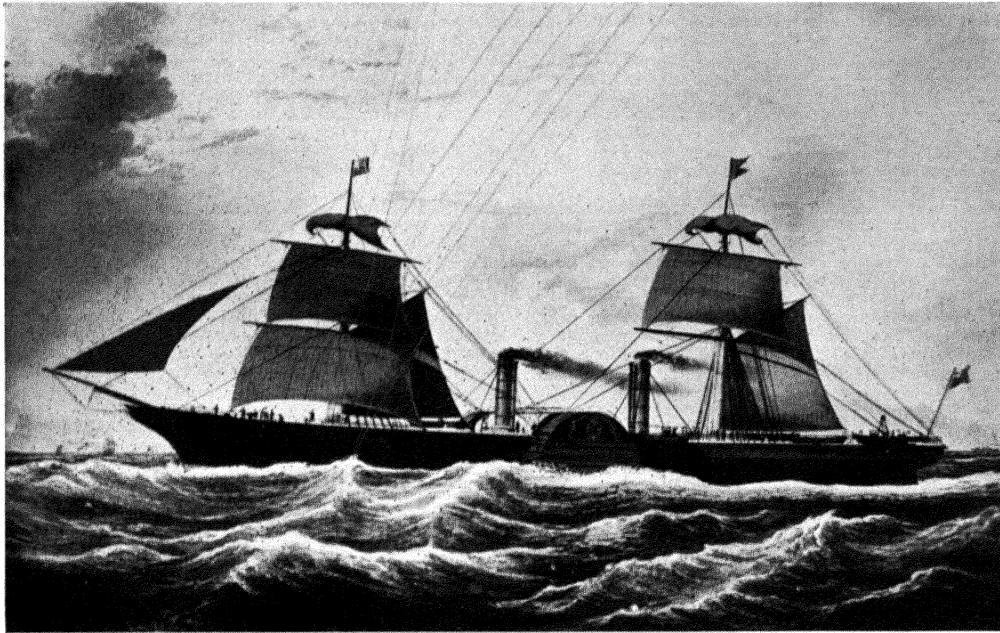
The "Archimedes" (1839), one of the first screw-driven vessels. For many years, however, paddles and sails continued in use.

The "Great Eastern" (1858) was fitted with screws, paddles and sails.



(1806-59) thought that the delayed victory of the steamship could be achieved by building a vessel so large that she could take the most powerful marine engines ever constructed, carry enough coal for a prolonged voyage, and sufficient passengers to make her pay. So the *Great Eastern* was built (1854-58). She was five or six times larger than any other vessel then afloat, with accommodation for 4,000 passengers, and was fitted not only with a screw but with paddles and, in addition, carried 6,500 square yards of sail. The financial failure of this famous ship was in part due to wasteful engines, proving that merely to increase the size of steam vessels was not in itself a guarantee of success. The *Great Eastern* was also built before her time. The day of the busy Transatlantic ferry had not yet arrived.

WHY THE TRIUMPH OF THE STEAMSHIP WAS



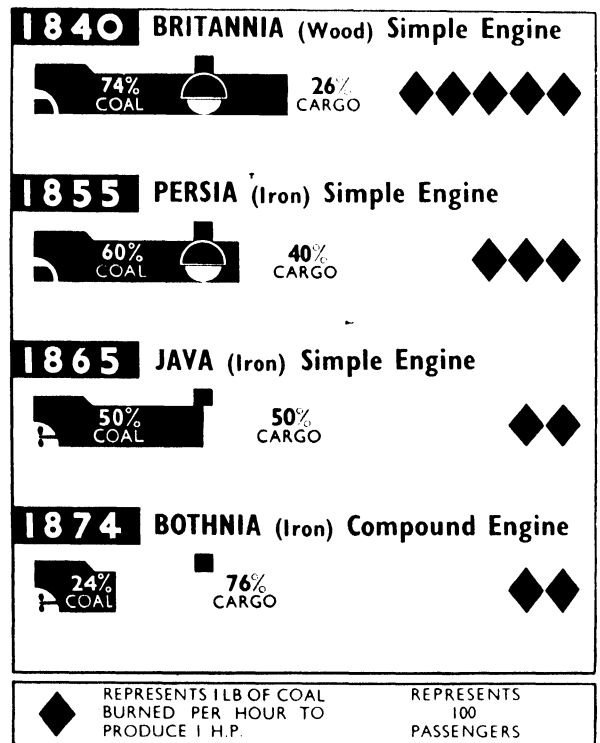
The "Persia" (1856) built of iron, with simple engines, used sails as well as paddles, but nearly three-quarters of her capacity was needed for fuel.

Chart showing how, by the development of more efficient engines, the proportion of pay-load was gradually increased.

The Problem of Carrying Sufficient Fuel. The victory of steam was swifter and more complete on land than on the sea, and by 1840 the chief ports were connected by rail to the coalfields and most of the big towns. One of the reasons for the quicker success of power locomotion on land was that land routes were shorter than sea routes, and locomotives could make frequent stops for fuel. The railways, too, had only to establish their superiority over the stage-coach and the canal boat, whereas steamships had to compete with the fast new Clipper ships.

The Sailing Ship's Final Bid. With the advent of the Clipper the speed of sailing ships so improved that they were able to complete the London-Melbourne run in sixty-three days. Such feats were beyond the capacity of the early steamers which were unable to carry enough coal for long voyages. On the Australian run, in particular, the steamer was at a disadvantage compared with the cheaper sailing ships, and the grain trade between the western coast of North America and Europe was a sailing ship monopoly until the 'eighties.

The pictures above of the *Persia* (1856) and the *Bothnia* (1874) show the development of the steamer over twenty years. The *Persia*, unlike the earliest steamships, which were of wood, was built of iron. She was driven by a simple side-lever engine and paddles, but depended also on sails. The *Bothnia*, too, was an iron ship, but screw-driven, and, with her compound engine,



scarcely needed sails, which were only carried in case of a broken propeller-shaft. The simple side-lever engine had one cylinder and the compound engine had several and produced more power for less fuel.

DELAYED

The "Bothnia" (1874), built of iron with compound engines and screw. (Sails were only carried in case of a broken propeller-shaft.) Only a quarter of her capacity was needed for fuel.

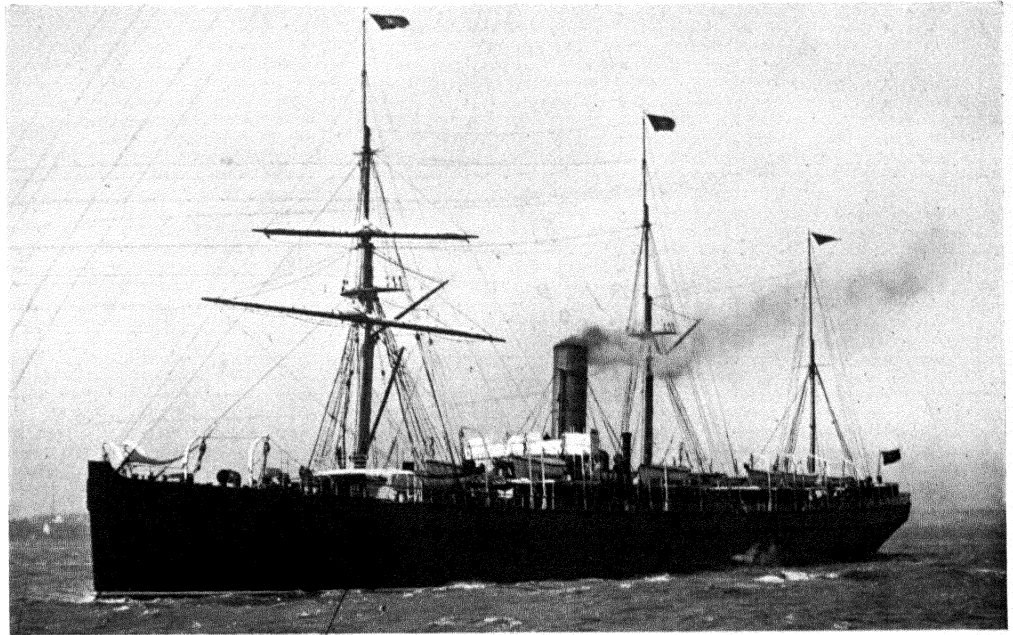
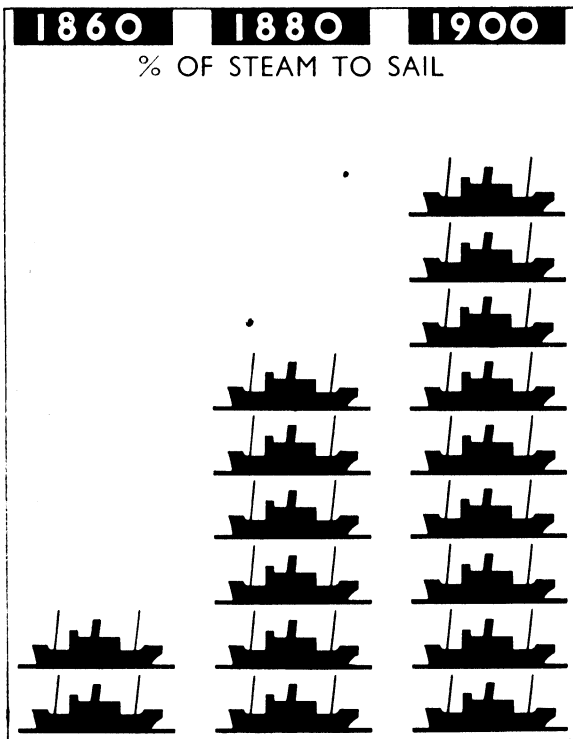


Chart showing the gradually increasing proportion of steam to sail up to 1900. The final triumph of the steamship was not in sight until the late 'sixties.



How the Fuel Problem was Overcome and Cargo Space Increased. A modern coal-burning tramp, four times the size of the largest steamers of a hundred years ago, needs less than half the amount of coal to do the same speed.

The first chart shows how the fuel problem of the early steamships was overcome in stages. The *Britannia* (1840), for example, burned five pounds of fuel every hour per horse-power generated. The *Persia* burned slightly more than three pounds, the *Java* slightly less. The *Bothnia* was screw-driven and her compound engines needed only two pounds of coal an hour (per h.p.) to produce sufficient power to drive the vessel at 13 knots as against the 8 knots of the *Britannia*.

From this chart it can also be seen that, as a result of more economical engines, the proportion of cargo space was gradually increased, and, when coaling stations had been established at strategic points on the world's trade routes, the triumph of steam was not long delayed. The gradual change from sail to steam (see chart to left) meant that voyages could be planned with regularity, and the great increase in goods and passenger traffic, which accompanied the social and industrial changes of the 19th century, could be carried without a corresponding increase in the number of ships. But for the steamship there could have been no large-scale emigration from Europe to the world's thinly-populated areas.

The last regular use of the sailing ship was on the Australian and far-eastern routes. After the opening of the Suez Canal (1869), which could only be used by steamships, the sailing ship captains acknowledged defeat. Nevertheless, as the chart on this page shows, it was not until the 'eighties that steamships represented even a half of the available carrying power on ocean routes.

FASTER, LARGER LINERS HAVE BROUGHT ENGLAND

BRITANNIA 1840



BOTHNIA 1874



CARMANIA 1905



QUEEN ELIZABETH 1940



Each figure = 200 persons.

Each wave = 1 day.

Each square = 2,000 h.p.

A New Ship-Type. The transatlantic liner is a new ship-type, for its great steel hull, among the largest structures made by man, forms the walls of a floating city. Inside are air-conditioned public rooms, restaurants, hospitals, theatres and shops. We are concerned here, however, not with the luxuries of liners, but with the reasons behind their development. Why, for example, are liners much larger than cargo-carrying vessels?

Size and Speed of the Modern Liner. We know that as shipbuilders changed from wood to iron, and from iron to steel, it became possible to build stronger and, therefore, bigger hulls. The replacement of the paddles by screws and the introduction of turbine engines (1905) greatly increased the running speed of ships. The chief results of these changes are seen in our chart. The time for the Atlantic crossing, by sea, has been shortened from twelve-and-a-half days to four-and-a-half days in a hundred years, and the number of passengers which can be accommodated has grown from just over 100 to nearly 3,000. The

approximate speed of the *Britannia* (1840) was 8.5 knots and that of the *Queen Elizabeth* (1946) is 28 knots. The horse-power of the liner, however, has been stepped up, as the chart shows, from 740 to 160,000, in order to achieve this. The most modern liner is, in fact, only three times faster than the steamers of 1840, but its engines are two hundred times more powerful.

One reason for the great increase in power is the increase in passenger space and the inclusion of all the luxuries and refinements to which ocean travellers have grown accustomed. The disproportion between increases in power and speed was apparent in the early days of coal-burning ships, when it was found that doubling the amount of fuel consumed only increased the speed of a ship by a third.

There is no space to tell here of how marine engineers have striven to increase power and, at the same time, decrease the amount of fuel required and the size of the engine. Simple steam engines were followed by compound engines and these gave place to triple- and quadruple-expansion engines, and

AND AMERICA CLOSER TOGETHER



“Queen Elizabeth” (launched 1938, commissioned 1940) entering New York harbour and (inset) “Britannia” (1840) on exactly the same scale.

ultimately to turbines and diesels. The object has always been greater efficiency for less fuel and less bulk and, therefore, a bigger pay-load.

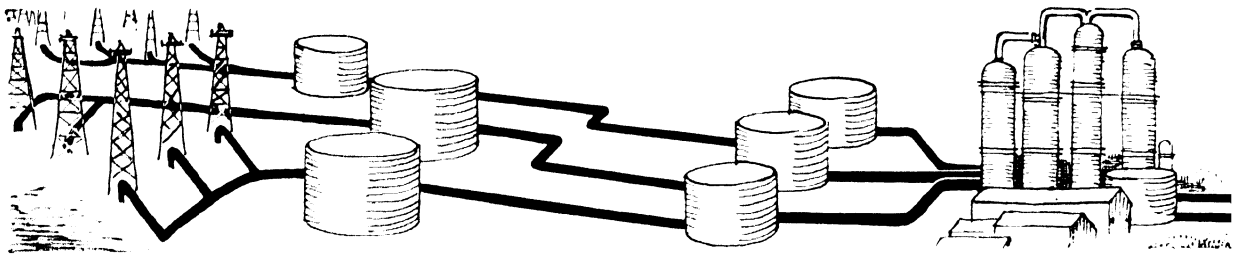
The Reason for “Mammoth” Ships. In the picture above the *Queen Elizabeth*, the world’s largest passenger liner, is compared with the *Britannia* of a hundred years ago. The comparison suggests obvious differences in, for example, size and also shape. We may even discover in the curved and sweeping lines of the *Queen Elizabeth* the influence of the aeroplane designer. Our chief impression, nevertheless, must be the immense size of the modern ship, and this would appear to be even greater but for the gracefully streamlined hull. Why are the *Queen Elizabeth* and her sister ship the *Queen Mary* of such great dimensions? Were they built to this scale for the sake of speed, or luxury, or for reasons of national prestige, or is sheer size a result of the natural evolution of the liner?

The answer is that the liner, like the tramp or the whaler or the oil-tanker, was built to do a special

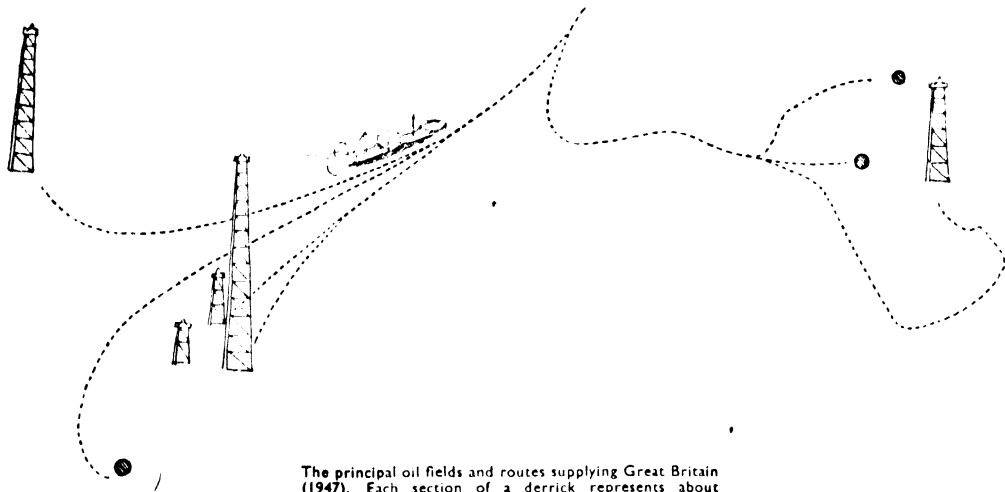
job, in this instance to ferry passengers quickly across the Atlantic. Her size and shape, like the size and shape of tankers or colliers, are the outcome of specialization. A few years ago, three liners (*Aquitania*, *Mauretania*, and *Berengaria*) maintained a weekly Atlantic ferry service. It was reasoned by the owners, builders and designers, that it would be cheaper to run two liners than three. These new liners had, therefore, to be faster than the old and cross in just over four days, and so allow for re-fuelling, re-victualling and “turning round”. They also had to be larger than former liners to accommodate more passengers and machinery.

The speed of the two Queens was determined by the time necessary to provide a regular weekly service on the Atlantic crossing at all times of the year, in both directions, and also by the number of hours needed for “turn-round”. Size was determined by the necessity to provide sufficient passenger accommodation for a two-ship service. These ships, large and fast as they are, are the smallest and slowest which could fulfil these conditions.

COAL TO OIL



From oil-field storage tanks oil flows or is pumped along pipe-lines (which may stretch for hundreds of miles) to the ocean port. There it may be refined or partly refined. The oil products are next



The principal oil fields and routes supplying Great Britain (1947). Each section of a derrick represents about 100,000 tons of oil.

The Advantages of Oil over Coal. As wood gave way to iron, and sail to steam, so, in our own day, coal is giving way to oil. The sketch across the top of this page does not pretend to explain all the intricate processes through which crude oil passes but only to illustrate the supreme advantage of oil over coal—its flexibility. It can be poured and pumped with little effort. Oil flows. Coal must be hauled, and dumped, and stacked, with infinite labour.

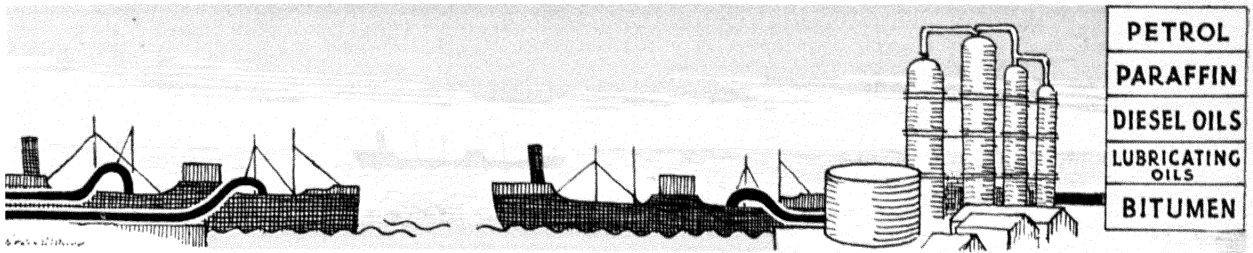
The disadvantage of oil (from Britain's point of view) is that, unlike coal, it is not found in our own islands (or even in very large quantities within the Commonwealth or Empire), but must be brought from far-distant regions of the world.

Oil (crude petroleum) is a viscous fluid which, as will be seen from the sketch, can be transported by pipe-line from oil wells to storage tanks, pumped into tankers and sucked into refineries. From these it flows, or is pumped, into rail-borne or road-borne tanks which take it to the distributing points for factories, locomotives, ships, generating plants, diesel

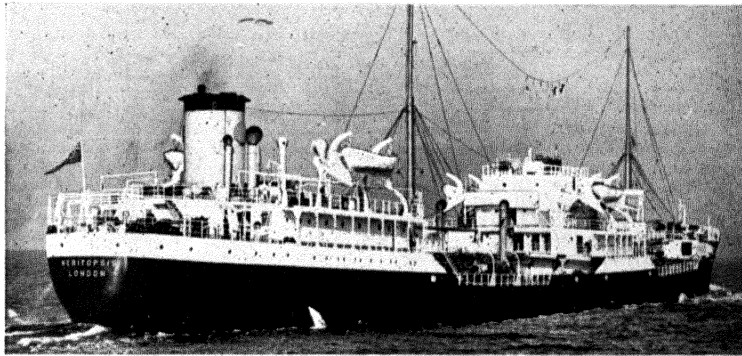
engines, tractors, aircraft and motor-cars. Less than a lifetime distant, the principal use for oil was as a lubricant for machinery. To-day it is the source of power for forms of transport which have changed our world.

Sources. Crude petroleum is found in many parts of the world, but the main flow comes from two areas. The first is the U.S.A., Central and South America and the West Indies, and the second is the Iranian, Burma and East Indies group. On our map are marked the main routes along which oil flows to Britain. As the size of the symbols suggests, Britain depends largely on the Netherlands West Indies (refining crude oil produced in Venezuela), the U.S.A., Iran and the British West Indies for her oil supplies.

The Design of Tankers. Unlike most other ships, those specially built for the transport of oil carry no other cargo. About 1860 oil was shipped across the



pumped aboard a tanker. On arrival in this country they flow into storage tanks. Crude oil passes to the refinery, is distilled and then distributed. (Below) Modern tanker.



Section and side elevation to show "cellular" construction of a modern tanker.

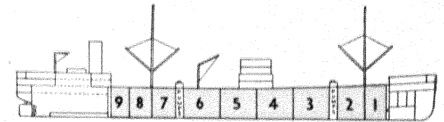
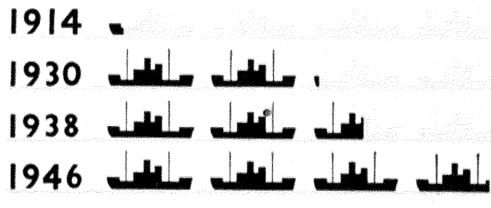
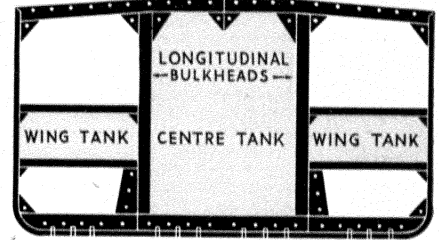


Chart showing growing percentage of merchant vessels using fuel oil. Each ship equals 20% of total.

Atlantic in wooden barrels. But this was costly and laborious, so oil was then carried in bulk, in the holds of wooden ships lined with felt or cement. This was so unsafe that special ships for the transport of oil were then developed. The design of tankers has continued to improve and most of them are built on the lines indicated in the diagrams above, with two longitudinal bulkheads. Besides reducing the risk of fire, this division of the hull makes tankers exceptionally seaworthy.

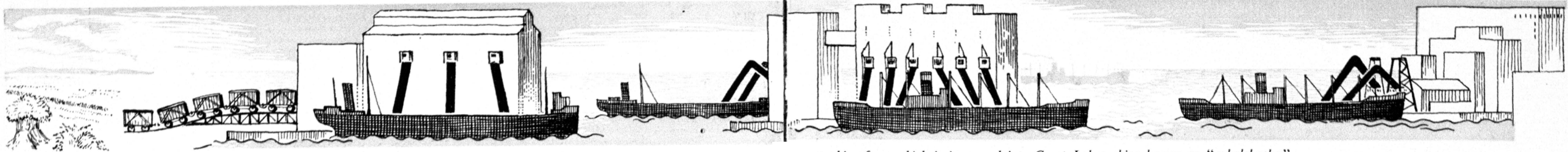
The side elevation of the tanker shows that the particular ship illustrated (which is typical) is divided naturally into nine great tanks. The cross-section shows that each great tank is divided by the longitudinal bulkheads from wing tanks on either side. The tanker is, therefore, a vast "honeycomb", or cellular structure. Notice the pumps with which the cargo can be shifted from one tank to another or discharged in port.

The Increase in Oil-burning Ships. Within the last

twenty or thirty years there has been a great increase in oil-burning ships (see chart above). Why do our ships burn fuel oil and diesel oil from abroad when we have an inexhaustible source of power in our own coalmines? Part of the answer is that while it may take days to coal a ship, fuel oil can be loaded at the rate of a thousand tons an hour for each hose used. Then, in oil-burning ships there is no stokehold and, therefore, a great saving of labour. Oil is also easier to store than coal, especially in the anti-rolling tanks of big ships, and a ton of oil gives far more power than a ton of coal. Finally, the machinery in an oil-burning ship takes up less space, proportionately, than that in a coal-burning ship and so leaves a greater area for pay-load.

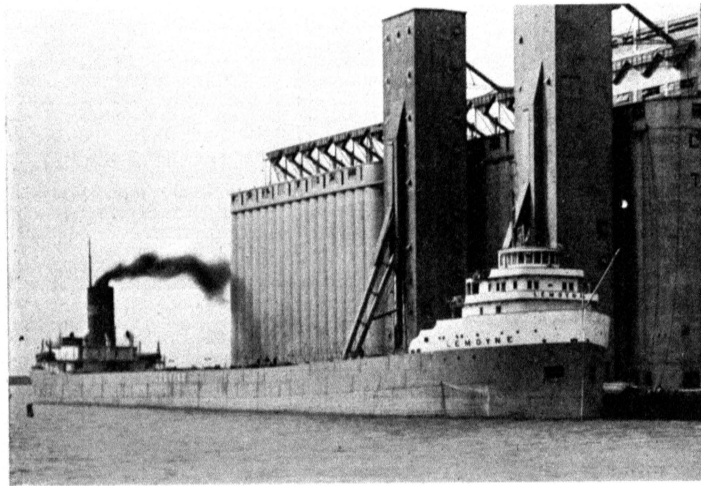
The growth in the importance of oil can be measured by the increase in the number of tankers. Since 1914 the world's merchant supply tonnage has about doubled, but tanker tonnage has been multiplied by ten, and at the beginning of 1949 one ship in every three being built in British yards was a tanker.

SOME SPECIALIZED SHIPS

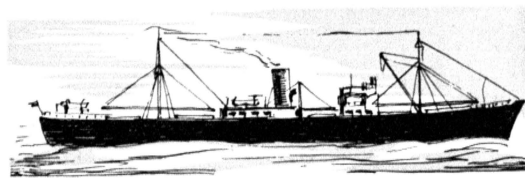


Wheat is treated as a liquid cargo and flows from continent to continent. On arrival at the wheat store (elevator) in Canada the grain wagon (on raised tracks) is tipped and the grain flows into a pool of wheat. This is elevated into

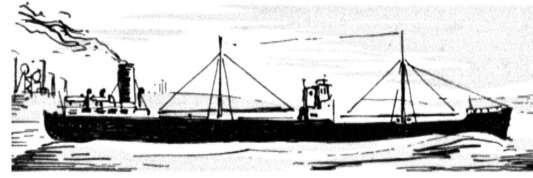
bins from which it is poured into Great Lakes ships known as "whalebacks". These carry it to the ocean port. There it is sucked from the "whalebacks" into an elevator or into the hold of an ocean-going ship.



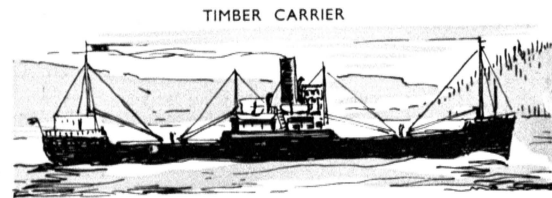
A Great Lakes bulk freighter ("whaleback") being loaded from an elevator.



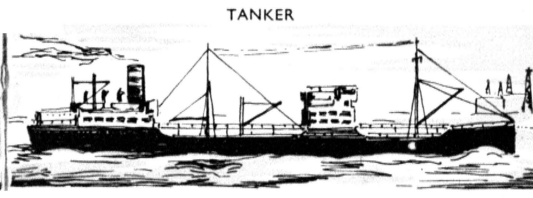
TRAMP



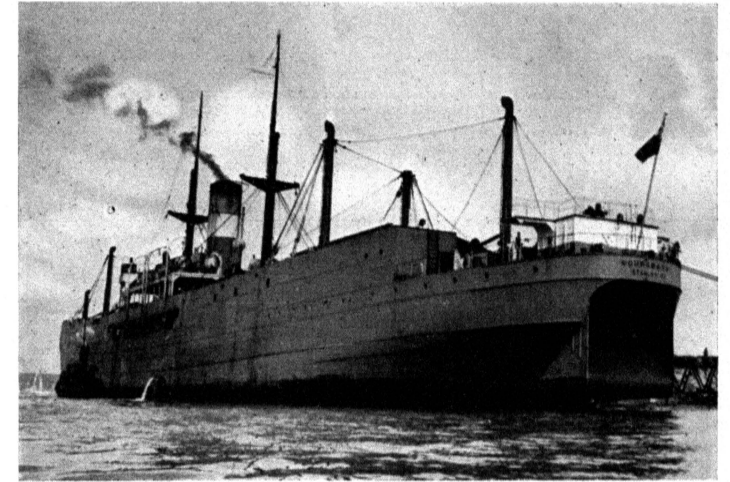
COLLIER



TIMBER CARRIER



TANKER



Whale factory ship, showing slipway through which whales are hauled.

Great Lakes Grain Ships. Wheat can be unloaded by suction and pumping, and may thus be classed as a liquid cargo, like oil. From the prairie wheatfield grain flows down a spout into railway wagons which haul it to a local elevator. Here the wagons are tipped and the grain flows into a pool. From the pool it is elevated into bins which pour it into ships known on the Great Lakes as "whalebacks" (see picture). These vessels carry the grain to the port and there it is sucked from the whalebacks either into a grain elevator or direct into the hold of an ocean-going ship. Grain thus flows from continent to continent.

In most Great Lakes ships grain is interchangeable with other bulk cargoes (e.g. iron ore, limestone and coal, the chief natural products of the Great Lakes region). A bulk cargo is one that cannot be handled piece by piece. It is loaded and unloaded by gravity, mechanical grab, by pumping or suction. The box-like structure, with machinery aft and accommodation

forward, gives clear holds and wide hatches and, therefore, the maximum cargo capacity and speed in loading and unloading.

The Tramp. In contrast to ships specially built for one particular trade or one particular route, tramps take all sorts of cargoes everywhere—coal (outwards), grain (inwards), salt, chrome ore, iron ore, linseed, lumber, iron rails or sugar. The tramp shown spends much of her time in the grain trade but carries coal or iron ore between seasons. The clean lines denote clear decks and wide hatchways, for ease in loading bulky cargo. When carrying grain the holds are fitted with centre-line shifting boards to prevent the cargo pouring from side to side in a heavy sea.

Timber. Timber is usually carried on short sea routes (e.g. North Sea and Baltic) and consists of short lengths such as pit props, whereas lumber

(bulky wood) is an ocean trade. The timber carrier illustrated is a Baltic type with machinery amidship and a high forecastle which gives two deep wells and these, in addition to the holds, can be stacked with timber.

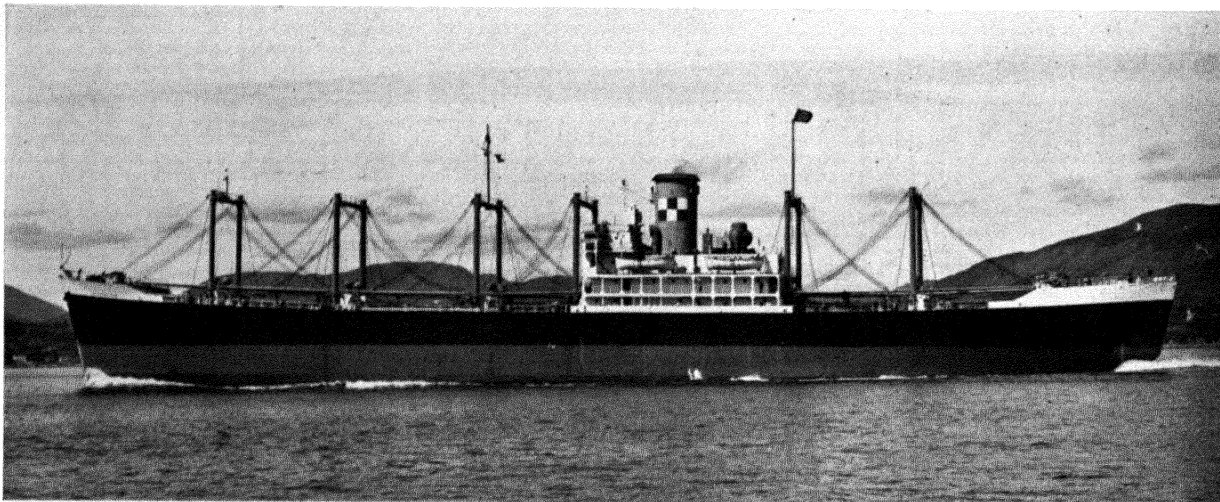
The Collier. Colliers sail from the Forth, Tynes and Weir, Glasgow, Cardiff and Swansea with coal for foreign railways, factories, and for bunker stations on the Empire sea-ways. (Typical coaling stations are St. Vincent, Madeira, The Azores, Capetown, and Colombo.) The machinery of the ship illustrated (as with many specialized ships) is placed aft for trim, and ease of loading, and practically the whole of the hull is fitted with wide, clear holds.

Tanker. Most tankers carry either crude or refined petroleum, but it must not be forgotten that there

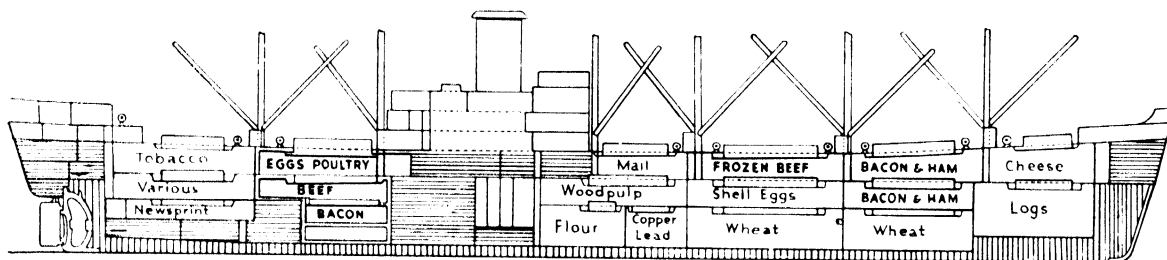
are other important oils in commerce, including vegetable oil (olive, coconut, palm oil, and copra) and the fish oils (whale, menhaden, and cod liver). The oil tanker, as can be seen from the silhouette, is a long, low vessel. It consists of a series of tanks, some of which may be empty and others full. Thus the structure is subject to great strain; so horizontal strength from bow to stern is a characteristic of this vessel.

The Whale Factory Ship. The modern whaler is a sea-going factory built in the form of a ship. The gap at the stern is a slipway through which whales are hauled. On board there is machinery and apparatus, not only for killing the whale and hauling it through the slipway but for stripping the blubber and converting it into oil. The Whaler, and all the other specialized vessels briefly described on this page, show how the shape of a ship is influenced by the special purpose for which it is built.

REFRIGERATION SHIPS



(Above) A "Beaver" ship, one of the most modern refrigerated steamers. It operates between this country and Canada.
 (Below) A profile plan (reverse of photograph) showing cargo holds. Those insulated are coloured blue.



How Social Changes led to Food Preservation.
 For centuries food could only be preserved by salting, drying, smoking or pickling. (See page 14, Middle Ages.) By the early 19th century, however, several social changes had made it necessary to invent more certain methods of food preservation.

The first of these changes was the increase in population from about seven millions to over twelve millions (1760-1821). The second was the growth of large towns. Liverpool, Manchester and Bradford, for example, doubled their population in twenty years. The long voyage of the emigrant ships and the victualing of large armies also made food preservation on a large scale a problem of vital importance. By 1820 it was possible to preserve meat, salmon and vegetables in tins, and by the end of the century the diet of the British people included large quantities of tinned foods.

How Refrigeration led to a New Type of Ship.
 The next stage was refrigeration, made possible by the invention of the ammonia-freezing plant in 1867.

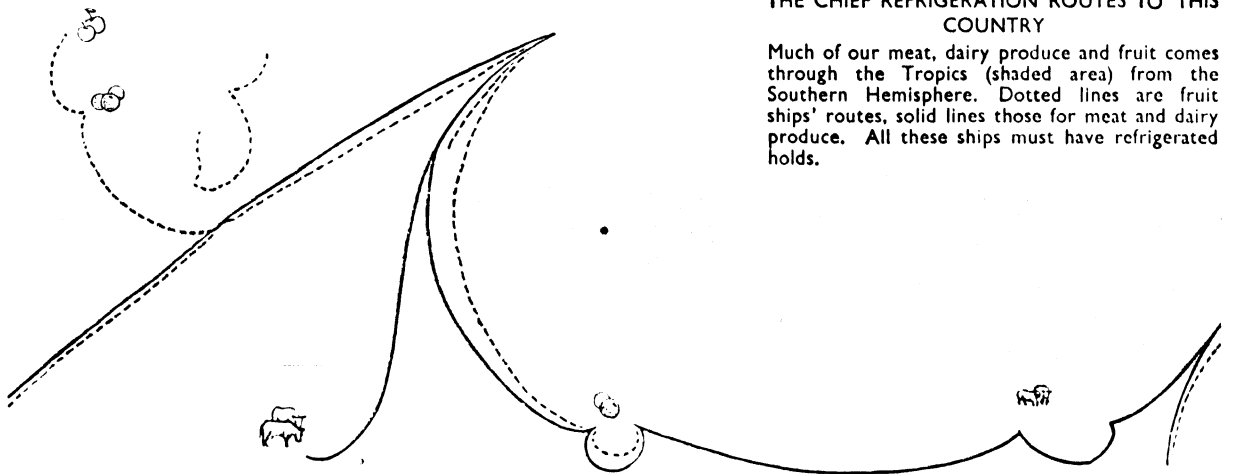
In January 1880, the S.S. *Strathleven* from Sydney, Australia, brought to England the first cargo of frozen mutton, and within a comparatively few years an industrialized Britain was relying on the farmlands of the Empire and the plantations of the tropics for a large proportion of her meat, dairy produce and fruit. Indeed, so complete was our reliance on food from abroad that our own farmlands were neglected.

Refrigeration led to a new type of ship. Hitherto, merchant ships had consisted of a watertight hull, enclosing passenger or cargo space, and the necessary engines. But a refrigeration ship, such as that pictured above, is an elaborate mechanism which, in addition to its power plant, includes electric winches



THE CHIEF REFRIGERATION ROUTES TO THIS COUNTRY

Much of our meat, dairy produce and fruit comes through the Tropics (shaded area) from the Southern Hemisphere. Dotted lines are fruit ships' routes, solid lines those for meat and dairy produce. All these ships must have refrigerated holds.



and derricks and devices for controlling and registering the air temperature of the holds. Observe the compact grouping of the funnel and upper structure, amidships. It is here that passenger accommodation is concentrated so that the interior of the hull can be used for cargo. The decks and hatches are thus left free of all obstruction so that the derricks have plenty of working space.

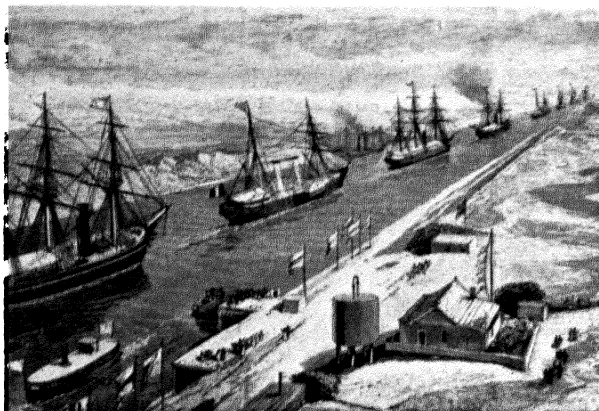
Empire Food Ships and Fruit Ships. After the invention of refrigeration, ships which specialized in emigrant traffic loaded meat into refrigerated holds on the return run. From these vessels have been evolved two types of ships known as Empire Food Ships and Fruit Ships.

The Food Ships are specially designed for regulated runs and are intermediate in size and speed between large passenger-mail liners and cargo liners. They

carry up to about forty passengers and have about half a million cubic feet of refrigerated space. The Canadian Pacific "Beaver" ships (left) sail between London and Montreal, but the routes followed by most refrigeration ships take them through the tropics (see map). The greater part of our meat supply is brought over the equator.

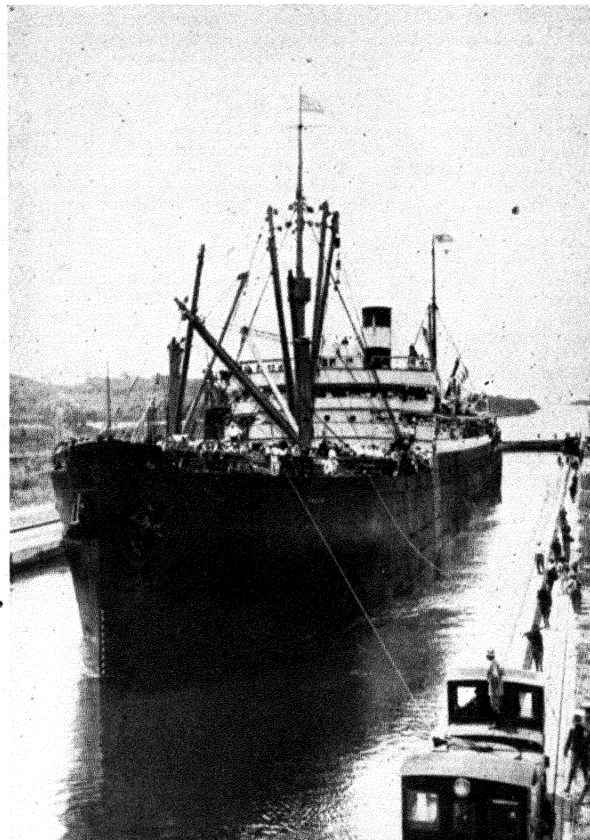
Fruit Ships, which are smaller than Food Ships, have been developed from banana carriers, one of the first refrigeration vessels specially constructed. The typical fruit ship has to be fast, for it carries a valuable and perishable cargo demanding constant vigilance. Because of their speed and fine lines fruit ships are sometimes called commercial yachts. They spend a great deal of time in tropical seas, and their hulls are painted white, often with a brightly-coloured waterline. They have fine yacht-like lines and have limited but luxurious passenger accommodation.

HOW THE SUEZ AND PANAMA CANALS CHANGED



(Top) The opening of the Suez Canal, 1869.

(Bottom) Steamers passing each other in the Suez Canal.



Ship being hauled through Gatun lock, Panama Canal.

The Route to India. From the time of da Gama until 1840, the Mediterranean ceased to be a "main-line" seaway. It became, so to speak, a "local line" of secondary importance. The only practical route to India lay round the Cape, a voyage of nearly 11,000 miles, which, in the final days of the sailing ship, occupied 125-150 days.

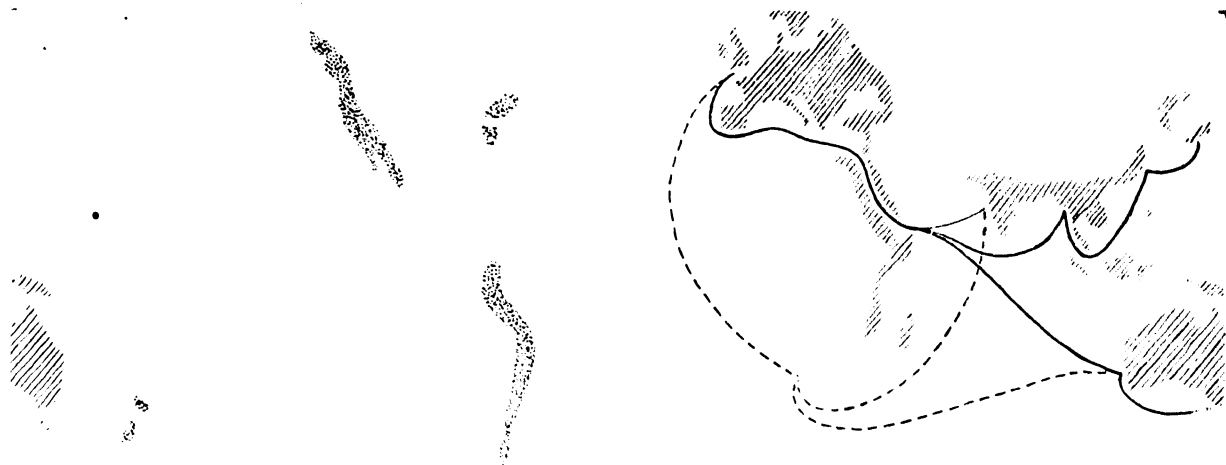
After 1840, the increasing importance of the sea-route linking Europe, and especially Britain, to the East, led to attempts at shortening the sea passage. This was done by reverting to the Mediterranean route, which meant transshipment at Alexandria and travelling a hundred miles across the desert to Suez, on the Red Sea. There was no railway, and the journey, which was both costly and uncomfortable, was never more than a passenger and mail route. Camels carried the heavy baggage of travellers taking the "short cut", and all merchandise continued to be shipped round the Cape.

The Isthmus Pierced. The ancient Egyptians had

constructed a canal linking the Nile with the Red Sea. It was in use for a thousand years and early in the 19th century the project was again discussed. Although by this time the commerce in spices and jewels had become less important than in medieval times, trade now flowed both ways, for Europe had bulky manufactures to sell. This country, as the foremost builder of railways in the world, advocated a railway between the Mediterranean and the Red Sea. But transshipment would have been costly, and ultimately the bolder enterprise of a maritime canal was launched by a Frenchman, Ferdinand de Lesseps. His name must be remembered with those of da Gama and Magellan as the pioneer of a new ocean route.

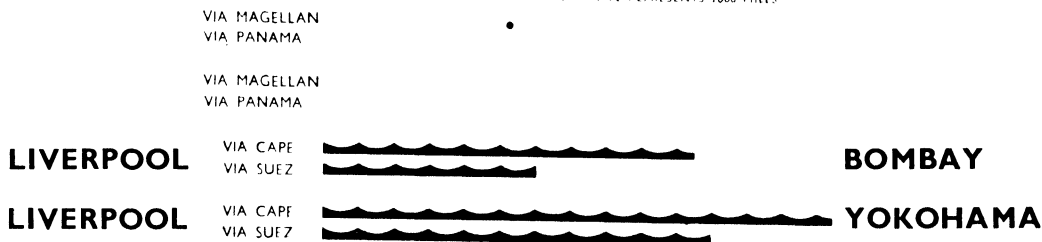
The Suez Canal was opened in 1869. At that time it was widely believed that the canal would never pay, because sailing ships could not use it. In 1875, however, Disraeli purchased a large proportion of the shares for the British Government, to the great benefit of British shipping ever since.

WORLD TRADE ROUTES



DISTANCES SAVED BY CANAL ROUTES

OLD ROUTES..... REGIONS BENEFITTING FROM SUEZ
 NEW ROUTES—— REGIONS BENEFITTING FROM PANAMA
 EACH WAVE REPRESENTS 1000 MILES



The Atlantic and Pacific joined by the Panama Canal. In 1914 the narrow isthmus of Panama, linking North and South America, was severed, and the Atlantic was joined to the Pacific. In accomplishing this a range of mountains was pierced and yellow fever was conquered. The canal had to be lifted over high ground by gigantic locks, one of which, Gatun, is seen in the picture. On arrival in the locks, ships are hauled through by electric locomotives (one of which can just be seen in the illustration) for ships could not, of course, move under their own power in such limited space.

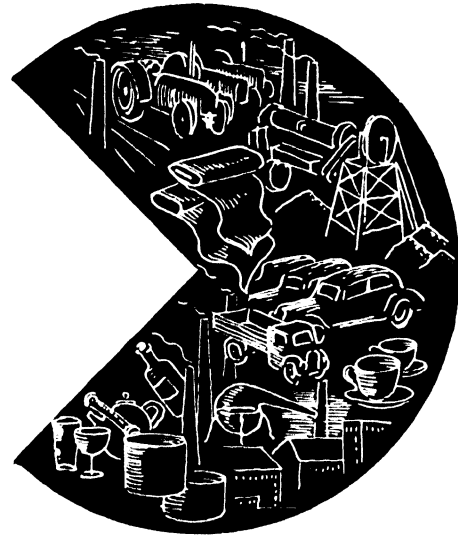
Results of Building Ship Canals. Firstly, as with the building of a bridge across an important river (see *Transport by Land* in this series), a fresh stream of traffic is started. Two streams converge, and cross-ways are established. That is particularly true of the Suez, which has become a cross-ways between Europe, Africa and Asia. Secondly (see chart) distances are

shortened. Thirdly, the importance of ports on the route is increased. The Mediterranean ports, for example, benefited as a result of the success of the Suez Canal, and, after the opening of the Panama Canal, the western coast of South America and the ports of San Francisco and Vancouver were brought thousands of miles nearer to New York and to Europe.

In addition, the modification of world trade routes has brought commercial gains to many countries. The areas chiefly benefiting from the Panama Canal are all those on the Asiatic shore of the Pacific Ocean and (see map) on the eastern seaboard of the American continent.

The Suez Canal increased the trade and prosperity, not only of England (the chief user of the canal) but of northern Europe, Egypt, East Africa and the Middle East, India and the Far East. Also, as shown in a previous section, the success of the Suez Canal hastened the decline of the sailing ship.

BRITAIN'S DEPENDENCE ON SEA-BORNE



BRITAIN DEPENDS ON SHIPS FOR A QUARTER OF HER DAILY NEEDS



ALL HER PETROL, COTTON, RUBBER, TEA, TOBACCO, AND HALF HER FOOD



TO PAY FOR THESE WE SEND ABROAD OUR MANUFACTURES

The portion of the circle which is cut away represents the proportion of our everyday needs coming from abroad.

Britain Imports Food, Raw Materials and Manufactures. For the food to feed our fifty million people and the raw materials for our factories we depend, more than any other nation, on foreign trade. Imagine that Britain's needs are represented by the circle in the chart. The part of the circle to the left, equal to a quarter of its area, represents that proportion of our needs which comes to us in ships. The part to the right stands for the food, raw materials and manufactured goods which we produce ourselves.

If foreign trade ceased would it be possible for us to live on three-quarters of our present needs? The answer is that unless the two parts of this circle, representing foreign trade and home production, are fitted together, we cannot continue to live as we do now, or feed so many people on our small island.

Proportion of Foreign Trade to Home Production. Of our food, about a half comes to us in ships,

but this half includes *all* our tea, coffee and cocoa, oranges and bananas, and the greater part of our meat, wheat and dairy produce. This food is brought from other countries in exchange for the products of our mills, mines and factories. These industries could not function without raw materials from abroad. The raw materials include all our rubber, all our petrol, all Lancashire's cotton and more than three-quarters of Yorkshire's wool. They include, too, three-quarters of the timber needed for mining, building and furniture-making, and more than half the leather for our shoes. We must import, too, copper, tin and iron ore.

Although only about a quarter of the manufactured goods we use have to be bought from other countries, they include machinery, engineers' tools, paper, agricultural machinery, chemicals, dyes and drugs, which are vital to many of our industries.

How we Pay. To buy all these commodities from

TRADE



One of the docks in the world's largest port—the Port of London.

abroad costs far more money than we receive in exchange for our manufactures. The gap between what we spend and what we get for our manufactured goods is normally made up by "invisible exports"—exports which cannot be seen because they are in the form of services. These include shipping, banking and insurance. The profits on invisible exports, together with interest on our foreign investments, are normally sufficient to make up the balance of what we owe abroad. As a result of world-shortages since the war the prices of food, and other things which we buy from abroad, have greatly increased, and we can only bridge the gap by using our reserves of gold, saved in times of prosperity, and by Marshall Aid from America. Britain cannot "keep house" by running into debt, however, and the ultimate answer to our problem is to make more and more goods in our factories and mills and send them abroad in our ships.

The Port of London. The aerial view, which typifies the importance of shipping in the life of the nation, shows one of the many docks in the Port of London, the world's largest port. In the right background can be seen the sweep of the Thames, whose tidal ebb and flow assists vessels in and out of the port, but which is not so swift that it hinders navigation. At the sides of the dock are the wharves and warehouses, and beyond these the roads and railways which link the port with inland towns. Each of the ships seen moored at the wharves, whether she brings grain, meat, wool, dairy produce, sugar, fruit, hardwood, rubber or oil, has affected in some degree every industry and every family in Britain. The departing ships carry British goods to the ends of the earth.

SOURCE OF ILLUSTRATIONS

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BIBLIOGRAPHY

A bibliography of ships and sailors and trade by sea would fill many books of this size. We list below only those which have been consulted frequently in the preparation of this book, and acknowledgment is made to the authors.

<i>A History of Geographical Discovery and Exploration</i>	Baker
<i>Ships and Men</i>	Bassett-Lowke
<i>What really happened in History</i>	Childe
<i>World Shipping</i>	Fayle
<i>World Shipping</i>	Hardy
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<i>Ships</i>	Van Loon
<i>Ancient Ships</i>	Torr
<i>Social History of England</i>	Trevelyan
<i>Short History of British Expansion</i>	Williamson

