Section C

FITTINGS

Fittings are defined here as items or assemblies which are fitted to ships, as distinct from the hull itself. Some such as rudders and masts are kept fixed in place during normal operation, others such as fishing gear, some weapons and large parts of the rigging are easily removable if needed. Some are general to many different ships and are part of the technology of seafaring – sails and rigging, anchors, engines and so on. Others are essential to the function of the vessel, for example fishing gear or the weapons of a warship.

Anchors are used by nearly all vessels, although in different forms. They are useful museum objects, designed to be robust so can be displayed almost anywhere, and in their traditional form they are one of the best-known symbols of maritime affairs.

Propulsion naturally falls into two categories, natural and mechanical power. Of the first, rowing is relatively simple and needs only basic equipment. Sailing, on the other hand, involves rigs which might appear quite simple, but are often of great complexity. Both extremes have a wide appeal. The simple rig of a dinghy or yacht evokes a reaction from the people who sail them or even the people on the beach or river bank who might watch them. The highly complex and finely-tuned rig of the clipper ship, or of a great warship, evokes much of the romance of the sea. A knowledge of rig types can be very useful for identifying individual ships, or the period of a photograph or painting, or in some cases the region where it was taken. Rigging items such as blocks and deadeyes are quite easy to handle in a museum context, and they can add atmosphere and verisimilitude to a display.

Marine engines are more neglected in many museums and are often less well known and understood by the public (in service they were usually hidden away below decks – and in general there tend to be fewer personal accounts of life at sea by engineers than sailors). Many engines are very large and difficult to store, but can tell the story of the development of the steam engine through its simple, compound, triple expansion, turbine and eventually nuclear forms, as well as its general replacement by diesels and gas turbines.

Weapons and fishing gear are both common examples of removable fittings, and both can be controversial in different ways. Fishing gear, especially when used for whaling, might be taken to celebrate the depletion of ocean stocks, though in most cases it is more likely to commemorate the hard but productive lives of fishing communities. Weapons inspire fascination in some and revulsion in others, but again they are essential to tell the story of sea travel and warfare. They were not just used on warships: until well into the 19th century most merchant ships carried guns, and today they are beginning to reappear in different forms as anti-piracy devices on modern ships. Weapons come in a great variety of sizes, from the 15-inch guns which dominate the entrance to the Imperial War Museum, to hand-held guns and swords (though strictly these should not be included as fittings). In the middle of the range, smooth-bore cannon are almost as robust as anchors and therefore are suitable for outdoor display – although their original wooden carriages rarely survive and usually have to be reconstructed.

1

DECK FITTINGS AND DECKHOUSES

BY MIKE STAMMERS, FORMER KEEPER OF MERSEYSIDE MARITIME MUSEUM

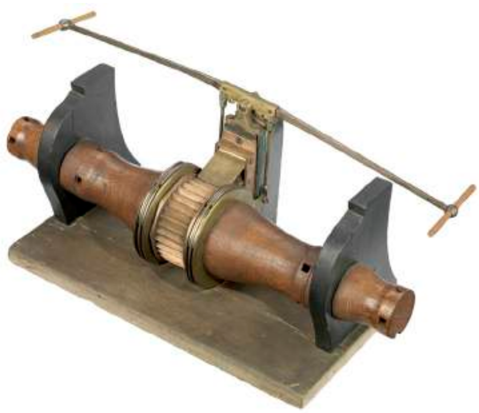
Deck fittings cover a wide range of equipment used to assist the functioning of the vessel such as anchoring, tying up to a quay, cargo handling and launching boats over the side. There are also fixtures such as the apertures that give access to the cargo holds (hatches) and crew or passenger accommodation (companionways). There are also ventilators and skylights that provide air or light to spaces below deck. Deck houses are structures built on deck to house a variety of uses such as the ship's kitchen (the galley), crew or passenger cabins, workshops and auxiliary engines for cargo and anchor handling.

It is unlikely that most collections will contain many full size examples of deck fittings let alone deck houses. But there are some. Because they were strongly built independent structures deck houses often survived the scrapping of the vessel and found a new use ashore perhaps as a summerhouse. Models of deck fittings also exist, perhaps to demonstrate a new invention or patent. They are also prominent features of most ship models and so it is important to be aware of their main types and their purposes and evolution.

Sailing ships and powered vessels (whether steam or diesel) need equipment to perform the basic operations outlined above. While the functions might be the same the differences are profound. Human muscle was the only source of power on most sailing vessels until the latter part of the 19th century when the very large iron and steel bulk sailing ships were equipped with deck mounted auxiliary steam engines. The 20th century also saw huge changes of size of vessel and the change over from steam as a power source to electricity. This is generated by auxiliary diesel engines down below in the engine room and applied directly to electric motors in the deck equipment or indirectly via hydraulic pumps that power sealed oil hydraulic pistons or motors.

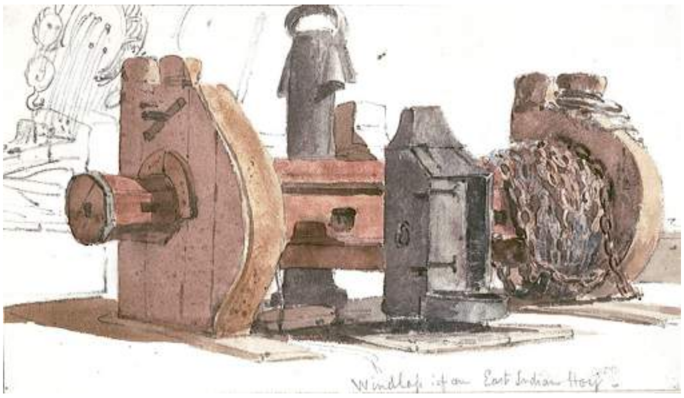
ANCHORING AND MOORING EQUIPMENT

All vessels, apart from the smallest, need a winch to hoist up their anchors. In sailing times this was a horizontal winch permanently fixed in the bows called a windlass. This was no more than a wooden barrel fitted with a pawl and ratchet to ensure the cable did not slip backwards when being hauled in. There were holes for inserting levers to turn the windlass.



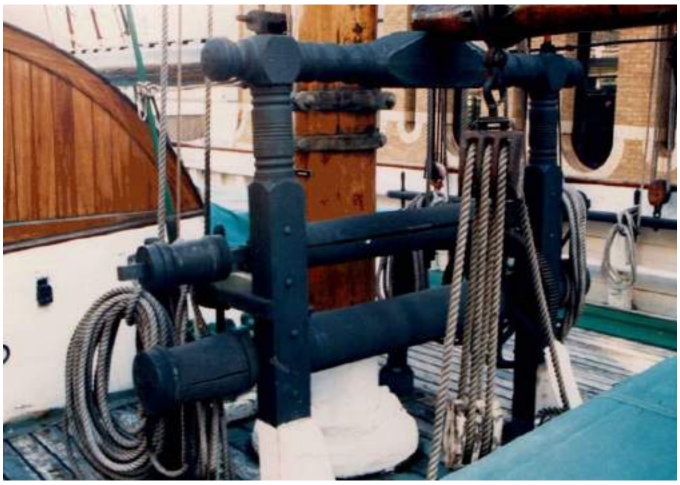
A pump-action windlass of 1845

SLR 2418 © National Maritime Museum, Greenwich, London

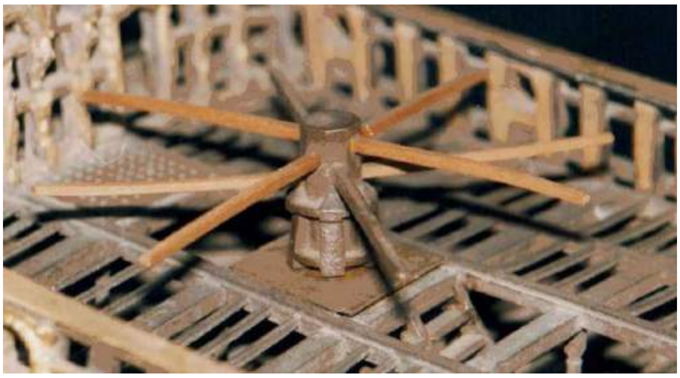


A watercolour of a windlass on a hoy, a small craft used on the River Thames, by EW Cooke.
PAE6362 © National Maritime Museum, Greenwich, London

In the early 19th century a ratchet device was invented that enabled four or more men to use horizontal handles in a pumping action. Some coastal craft such as the Thames barge had a geared windlass by which two men could heave up the anchor using two crank handles.

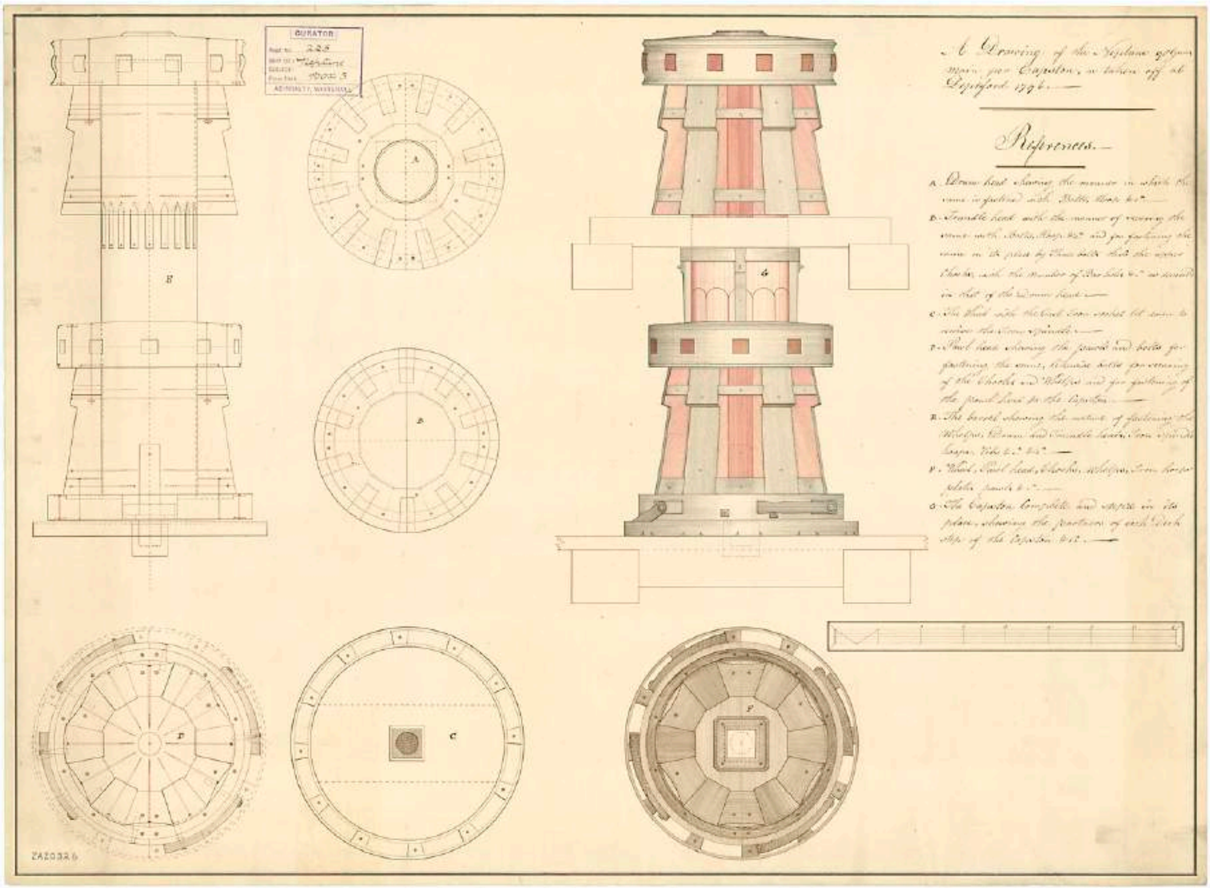


The windlass of the schooner Kathleen and May of 1900
© Brian Lavery with kind permission of Kathleen and May



17th-century capstans had bars running all the way through, so they had to be set at different heights.
© Brian Lavery, with kind permission of National Maritime Museum, Greenwich, London, (SLR0217)

With the 'drumhead' capstan, each bar was set in a socket so they could all be kept at the same height.
© Brian Lavery



Plans of the double capstan for the 98-gun Neptune of 1797
ZAZ0326 © National Maritime Museum, Greenwich, London

The lower part of the double capstan on HMS Victory
© Brian Lavery

Naval sailing vessels, with their greater size and larger crews, used capstans in the centre of the ship instead of the windlass. A capstan was a vertically mounted winch with pawls and a ratchet at the bottom to stop slipping and holes at the top for capstan bars to turn it. It could have been found on larger medieval ships. It was used for a wide variety of heavy hauling jobs such as installing masts, raising heavy spars to set the sails, or handling anchors. If there was only one on board it tended to be positioned midway along the ship. Large steel sailing ships tended to have several including one on the forecastle deck which was geared to the windlass below. There were different patent varieties some with two gear ratios and two sets of holes for the capstan bars. They were also fitted on quays to assist with hauling ships in and out of dock and some of these were powered by high-pressure water hydraulic systems.

Some large steel sailing ships, especially those built by the Germans, also had more specialised winches such as halyard winches for hoisting spars, and brace winches for changing the angle of their spars (yards). But these and all the other devices all relied on human muscle. Hauling on the windlass or pushing round and round on a capstan bar could be tedious and tiring and many sea shanties (work songs) were composed to help the crew work together.

Steamships had windlasses which were driven by steam, usually with a miniature steam engine geared to the barrel of the windlass. The windlass was also fitted with gearing to allow the cable to run out freely when anchoring and also to mesh in with the rope drums at each end of the windlass. These could be used to haul in mooring ropes. Ships today still need windlasses but the age of steam or manpower has long since passed.

Steam could be applied to capstans. The Elliott & Garrood patent steam capstan, first used in 1884, had a small engine built on top of the capstan itself. It was very popular for hauling drift nets and was installed on sailing and steam fishing boats.

Coming alongside at Port Mahon in the cruise ship Minerva, showing the winches on the forecastle.
© Brian Lavery

When a vessel comes alongside a wharf or a quay it has to be tied up securely (moored) using its own ropes. These need to passed through fairleads in the bulwarks to ensure they are not damaged by chafing. They are secured on the ship to large horizontal wooden cleats (kevels) on the inside of the bulwarks of a wooden vessel or on vertical iron posts usually in pairs (bollards).

An open fairlead and a roller fairlead on HMS Gannet
© Brian Lavery, with kind permission of Chatham Historic Dockyard Trust

A fairlead on the Cutty Sark
© Brian Lavery, with kind permission of Royal Museums Greenwich

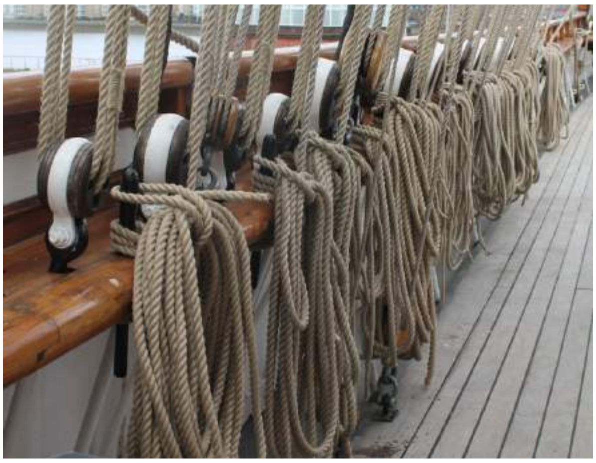
Larger vessels need wire ropes to secure them and these are stored on reels, while fibre ropes are usually stowed below while at sea. Modern vessels have mooring winches that are used for a single mooring wire wound on a reel – much quicker in these days of small crews. Modern tugs also have large winches for their towing wires instead of towing hooks. These are self-tensioning to ensure that the towing wire is not put under a sudden strain that might break it.

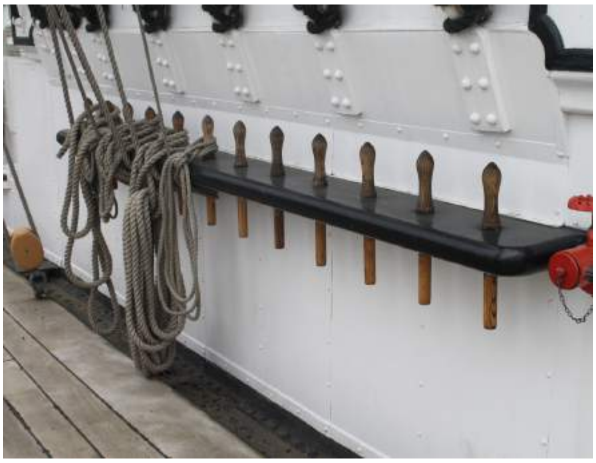
The bitts on the lower deck of an 18th-century ship, used to secure the anchor cable in the severest weather.
© Brian Lavery, with kind permission of National Maritime Museum, Greenwich, London (SLR0440)

A bitt used for the chain cable of HMS Warrior of 1860.
© Brian Lavery, with kind permission of Warrior Preservation Trust

FITTINGS PARTICULAR TO SAILING SHIPS

Sailing ships, especially the square rigged types, had a large amount of running rigging to control their sails. This had to be fastened down when hauling had been completed and there were pin rails on the inside of the bulwarks and fife rails around the masts. These had holes in them to take wood or metal belaying pins around which the ropes could be temporarily fastened and loosed off at a moment's notice.





Pin rails on the Cutty Sark (above left) and Gannet (above right)
© Brian Lavery, with kind permission of Royal Museums Greenwich and Chatham Historic Dockyard Trust respectively


A cleat and a bitt pin with sheaves on the Gannet.

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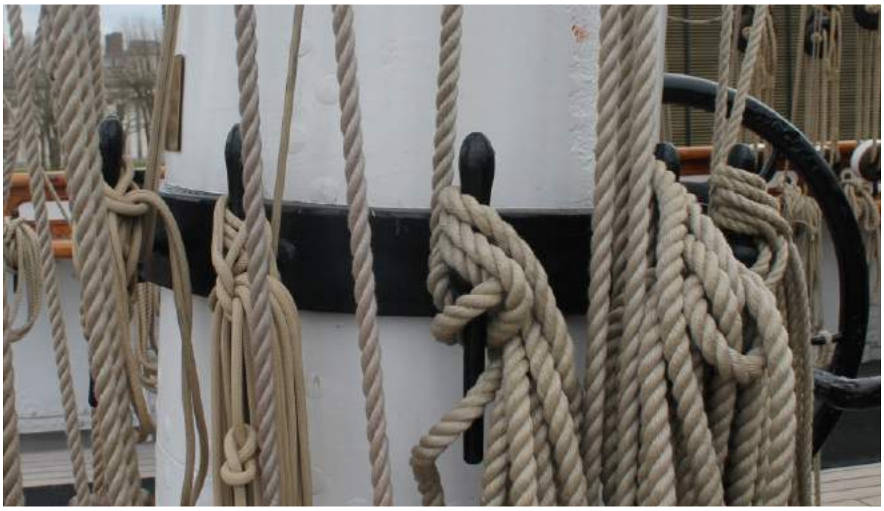

A fife rail round the mast on the Cutty Sark.

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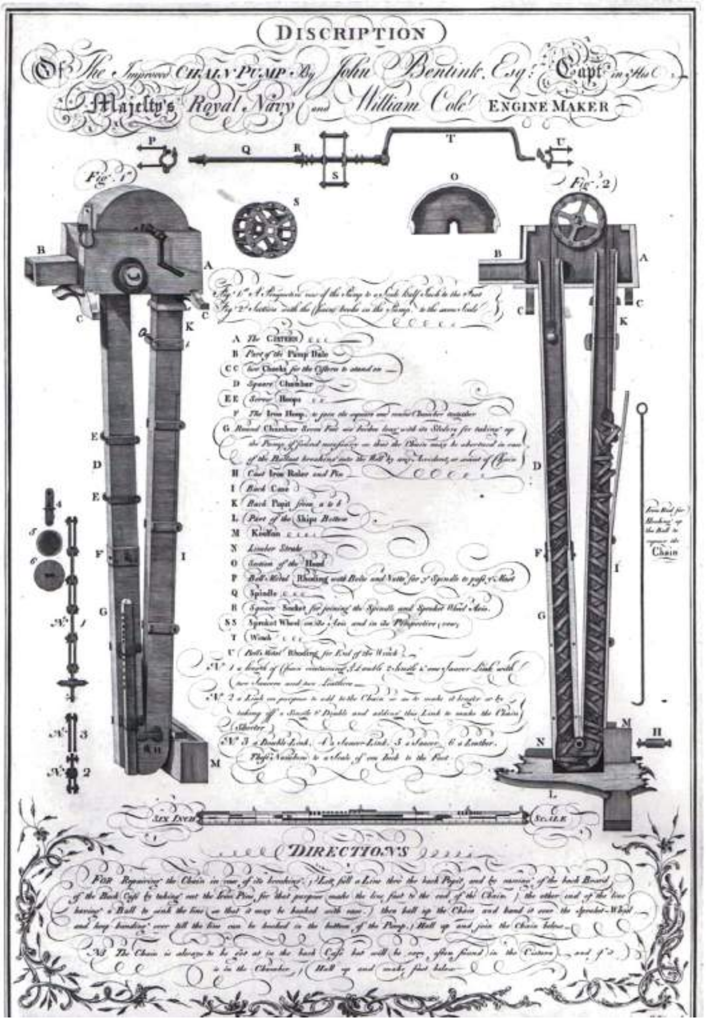
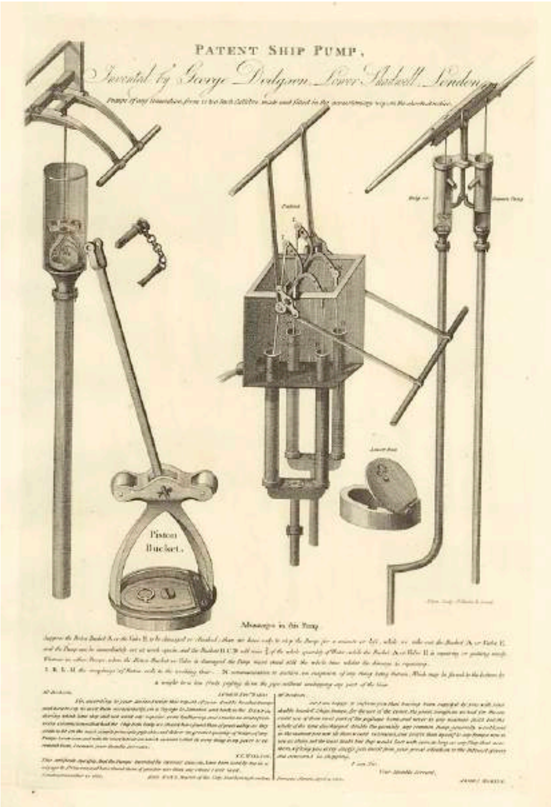
PUMPS

Sailing ships also tended to have their pumps on deck. Smaller vessels would have several simple pumps with the barrel cast in iron or bored out of an elm tree trunk and a pump plunger with a leather flap valve worked by a wooden lever. Larger ones might have bigger pumps with two or more barrels worked by a pair of large wheels connected by cranks. They usually had their steering gear fitted on deck behind the ship's wheel. This might be a series of pulleys which transmitted the wheel's turning to the rudder's tiller below or later a more elaborate geared system. In many ships this apparatus was protected by a wheelbox. This was well constructed, usually varnished and often carrying the ship's name. A compass for steering was placed in front of the wheel. This might be a small wooden box with a lamp to illuminate the compass in earlier vessels and in later ones it could be free-standing and often very ornamental. A design incorporating three dolphins with their tails supporting the compass was a good example.



The design of the Coles-Bentinck pump which became standard in the Royal Navy in the later 18th century.
In SPB/33 © National Maritime Museum, Greenwich, London

The pump handles of HMS Victory. The elaborate decoration was added during the 19th century.
© Brian Lavery

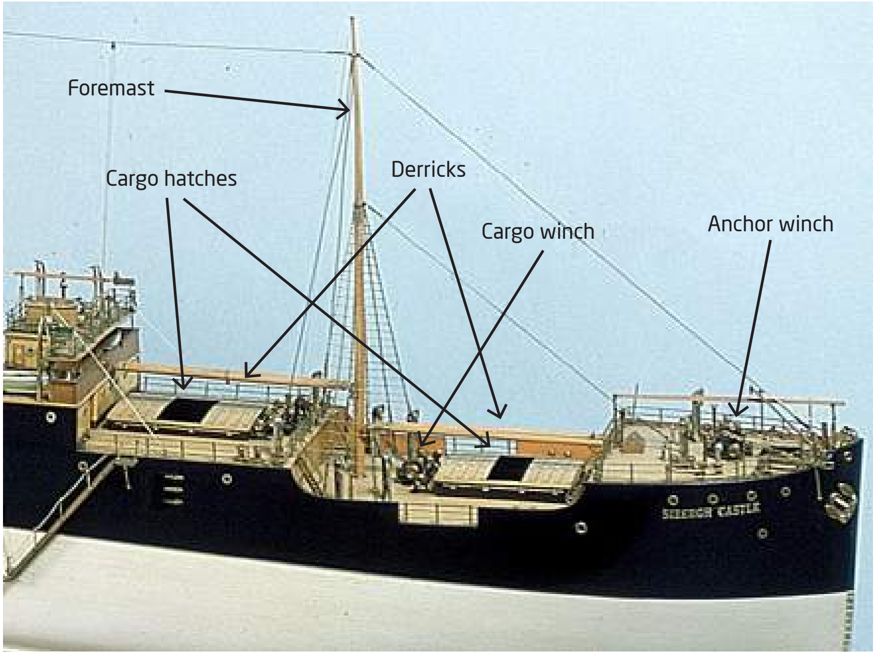


A melodramatic Victorian view of the function of ships' pumps, entitled 'Short-handed', painted by Lionel Smythe in 1874.
BHC 4163

Ships pumps inspired many would-be inventors, such as this one from around 1800, Dodgson's double-headed ship pump.
ZAZ 6846.2
Both images above © National Maritime Museum, Greenwich , London

HANDLING CARGO AND BOATS

Most cargoes are not easily carried on board by hand except where there is plenty of cheap labour. As a ship does not earn money whilst loading or unloading in port there is every incentive to devise means to move cargo quickly. Most sailing ships discharged using their own equipment and this consisted of no more than a hand winch or hand winches with a single pulley block tied in the rigging. The main winch was usually positioned at the aft side of the main hatch. Although specialised shore cranes existed before the 19th century the development of steam and water-powered hydraulics enabled ports to develop shore side cargo handling equipment to handle cargo. Ships, however, also had to call at non mechanised ports or discharge at anchor into barges and this course meant they needed their own equipment. Steam winches were positioned close to the cargo hatches and worked derricks. These are pivoted spars that can be raised and swung to and from the quays with ropes attached to the steam winches to raise or lower batches of cargo. Most steamships tended to carry a full set to work all their hatches and perhaps additional ones for special jobs such as lifting heavy single pieces such as railway locomotives. Their design has become progressively more complex over time and more modern models might be fitted with patent designs such as Velle or Stulcken types. Of course later ones have electric or hydraulic winches.



Cargo handling arrangements on the Sizergh Castle of 1903
SLR0054 © National Maritime Museum, Greenwich, London

The alternative to a derrick was a crane with a jib that swung without complex rigging. They were, however, more complex, expensive and limited in size. As a result they first appeared on passenger liners and cross channel steamers where keeping to a timetable was vital. Since the 1960s, improved designs have seen them replace derricks on many bulk-carrying ships. A 'handymax' bulk carrier of up to 50,000 tons will tend to have seven hatches served by five cranes. Some container ships also have to carry large cranes because they serve ports without the necessary shore-side cranes. Many cargo ships rely on shore cranes but still need some lifting capacity: tankers need cranes or derricks to lift the huge hoses needed to pump their liquid cargoes. Ships have heavy stores such as drums of lubricating oil, which need to be lifted aboard. Naval supply ships have specialised derricks to enable them to supply fuel, water, and dry stores to warships steaming alongside them.

The lifeboats of the Queen Mary 2
© Brian Lavery

DECK OPENINGS

An open hatch used for a ladderway, with several hatches covered by gratings behind, on a mid-18th-century warship.

© Brian Lavery with kind permission of National Maritime Museum

Every ship with a fixed deck or decks needs to have openings to allow access to cargo, machinery, and accommodation spaces. Openings also make a vessel vulnerable to ingress of the sea and before the time of modern steel vessels cargo openings were made as small as possible to minimise the risks. The sides and ends of hatches ('coamings' and 'head-ledges') are raised clear of the deck. In modern ships such as 'box hold' coasters these can be of considerable height to maximise cargo capacity. The hatch opening was originally covered with wooden hatch boards that could be lifted out on arrival in port. At sea they were covered with sturdy canvas tarpaulins wedged all round. On deep-sea voyages they might also reinforce the timber hatch coverings – such was the danger of a big wave damaging the hatch coverings and damaging the cargo or even sinking the ship.

The hatches on a late-19th-century steamship model.

© Brian Lavery with kind permission of National Maritime Museum

A hatch on the destroyer Cavalier of 1944

© Brian Lavery, with kind permission of Chatham Historic Dockyard Trust

Modern vessels have steel hatch covers, which can be folded up concertina fashion. Steam ships also had special hatches for taking on coal supplies. These were often circular manholes fitted in the deck and went direct to the coal-bunkers. Steamers also needed small hatches into the boiler rooms to allow for the disposal of ashes. Warships tended to minimise the number of openings not only because of sea risks but also to improve defence. The possibility of nuclear, chemical, or biological attack means that a modern warship needs openings that can protect its crew against these new hazards. Modern vessels can also be vulnerable to the ingress of seawater not because of stability but because it can damage the vessel's electrical systems.

A companionway on the schooner Kathleen and May of 1900

© Brian Lavery with kind permission of Kathleen and May

Of course, vessels also have to have openings to allow crew and passengers below decks. In the past these were wooden structures, often with a sliding top and two opening doors. Access into the interior of later ships was usually through deck structures. There also have to be inspection apertures, for example, to allow surveyors to inspect tanks and enclosed spaces. There also had to be openings to allow for ventilation. This was especially important on voyages to hot climates and in boiler rooms. They were often canvas tubes known as windsails – temporarily rigged – in sailing ships. In steamers they were vertical metal structures with a bell mouth – often having large dimensions. Later vessels were fitted with forced ventilation systems, which needed electric fans that needed deck fittings. Modern vessels often have air conditioning systems, which are built into their superstructures. Cargo holds may need ventilation depending on the cargo. Coal and oil, for example, both give off explosive vapours, which needed to be vented to the outside.

DECKHOUSES

Wooden sailing ships had very little superstructure (i.e. constructions above the main deck) except for larger ones, which have a raised forecastle in the bow and a poop or quarterdeck at the stern. Deckhouses were found on merchant ships to house the ship's kitchen (galley). Quite often this was simply a small box but with a coal range, lashed to the deck just behind the foremast. Later deckhouses were built into the deck to house not only the galley but also other workshops, the crew or at least the trainee officers and possibly the auxiliary ('donkey') boiler and engine. If not accommodated in the forecastle and the poop it was quite common, especially on coasters, to have a small deckhouse to house a lavatory.

A deckhouse on the Cutty Sark

© Brian Lavery, with kind permission of Royal Museums Greenwich

Passenger-carrying ships sometimes had deckhouse accommodation for the first class or possibly a dining saloon. The poop might also house a chart house, sometimes with access to the officer's accommodation below and a wheelhouse which was open at the front but afforded some shelter to the helmsman. Enclosed wheelhouses either at the stern or as part of a bridge amidships were considered to hamper vision and alertness and many steam ships continued to have an open steering position well into the 20th century. Small wheelhouses and deckhouses have sometimes survived the scrapping of the vessel and been sold for further use ashore. On liners up to the *Oceanic* of 1871 deckhouses gradually merged into one long continuous accommodation along the length of the main deck. The *Oceanic* was the first to have passenger accommodation that stretched the full width of the deck. Deckhouses are not so evident on modern vessels, but tankers often have separate housings for pump rooms or, in the case of tankers working to single buoy moorings, a small control room right up in the bows.

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2 MASTS, SPARS, AND RIGGING

A COMPILATION BY CAPTAIN CHRIS YOUNG RN

The subject is vast, with a whole vocabulary of its own (see glossary). Fortunately, there are many good and readily available texts on these topics. The present article is concerned with:

- Making an intelligent assessment of any images of ships.
- Initial dealing with any collected or found material.

Square sails as seen from the deck
© Brian Lavery

With square rigging it is usually necessary for crew to go aloft to loose and furl the sails.
© Brian Lavery

MASTS

Masts existed primarily to support sails for propulsion. From a very early stage, they were also used to display flags and to give a superior look-out position, and, where sails disappeared, masts remained for those purposes, and increasingly came to carry lights, aerials, and electronic devices of many kinds. For centuries masts were made from a single fir tree, typically a Douglas fir, but, as sizes increased, single trees were not big enough, and they were made by joining several pieces of timber together. Iron masts had a short era, until steel overtook iron in the 1870s, and non-corroding alloys have now largely superseded steel. Large sailing masts were in two, three or more parts: lower mast, topmast, topgallant mast, etc. The sections overlapped, and were held together by irons which wrapped round both parts. They were fitted so that the upper part could be lowered down alongside the lower part (housed) when necessary, and re-hoisted when needed.

A boat or ship can have anything from one to six (possibly more) masts. Naming the masts was simple enough up to a three-master: the biggest and most central mast was the mainmast, obviously enough; if there was a mast forward of the mainmast, it was the foremast, and a mast abaft the mainmast was called the mizzen mast. For numbers above three, names differed widely. In general the first three were called fore, main and mizzen, and then names like jigger, spanker, spencer, and driver were used for any others.

The foot of a mast generally stood on the keelson (the main longitudinal strength member along the centreline just on top of the keel), and the decks helped to support it in a vertical (or nearly vertical – see Rake) position, together with the standing rigging (see section below). Sometimes masts were stepped on the deck, rather than the keel, but this needed a very strong deck reinforcement to support the huge downward force of the mast and all its paraphernalia.

SPARS

Spars are long timbers used in a ship, mainly as part of the sailing rig, but the term is also applied to things like boat booms or any long timber used to hold something out from the ship's side. Spars as part of the sailing rig include yards, which support the head (top edge) of square sails (sails carried athwartships i.e. across the fore and aft line of the vessel, or hauled round to either side, but not in the fore and aft line); gaffs, which support the top of a conventional fore and aft sail (a sail mounted along the fore and aft line, but which can be bellied out either side); and booms, which keep taut the foot (lower edge) of a sail, or push it out in a desired direction. There are many other varieties, such as a lug, and staffs, which hold up a flag or fitting above the deck. Vitally, also, there is the bowsprit, often extended by fitting a jib-boom, which allows extra sail to be carried by pushing them out ahead of the bow. These sails are of great importance to sailing performance, especially when sailing close to the wind (attempting to make progress in the direction from which the wind is coming).

To distinguish between yards, gaffs and booms, remember the following:

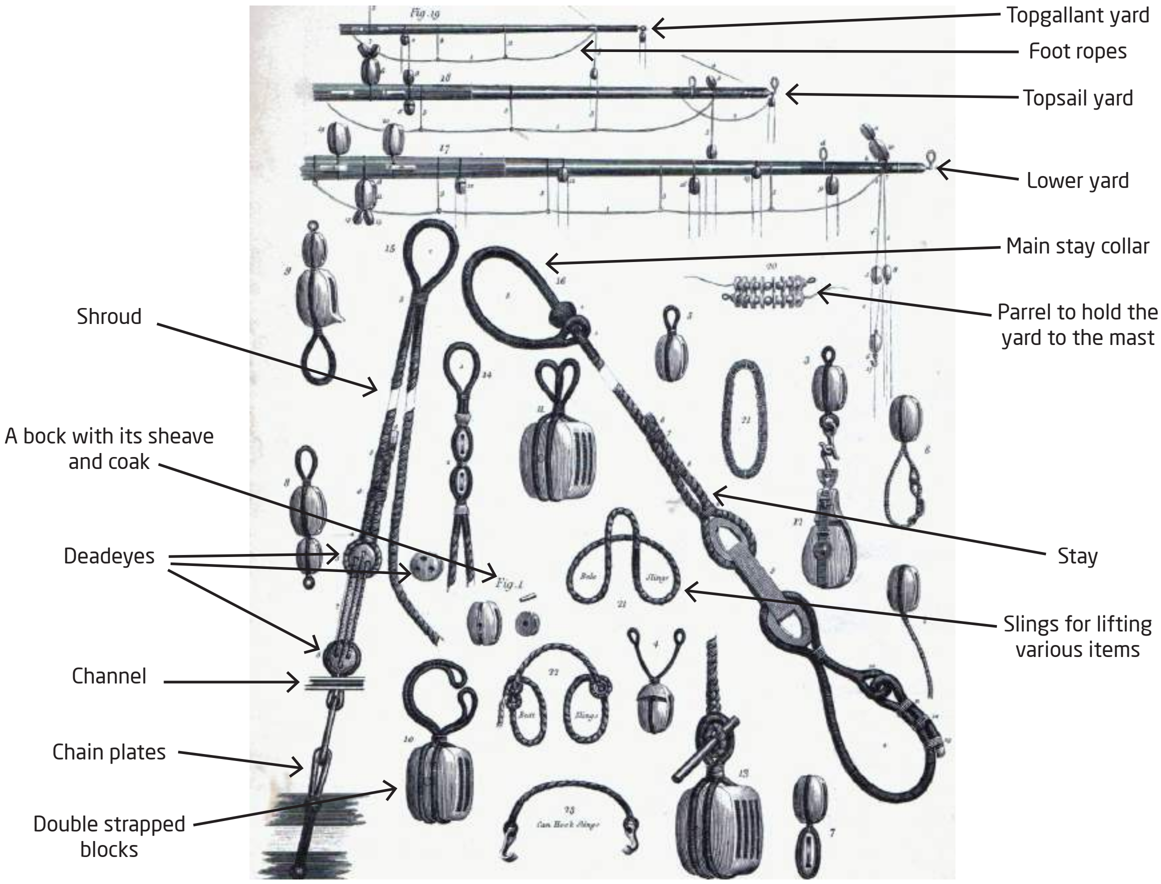
- **Yards –** normally horizontal, attached by their centre at some height up a mast. They may be at right angles to the fore and aft line, or pulled round hard to either side. In harbour they were sometimes cocked-up to allow ships to berth alongside one another without tangling yards, since they usually projected beyond the ship's side. They are also seen sent down (lowered from their normal place onto the deck) again usually in harbour. They could be over 30m long. Some of the biggest were made of iron or steel, rivetted or welded. Studding-sail, or stunsail booms, were extensions to the yards to allow extra areas of sail to be set in light weather. They were stowed underneath the yard and run out when needed.

- **Booms –** again mostly horizontal, and usually with one end attached to a mast on a swivel, and the other attached to a corner of a sail, whose foot may also be laced or otherwise secured along the boom.
- **Gaffs –** one end attached to the after side of a mast by a swivel, the other to the top corner of a sail. They were normally tilted up at an angle of around 40°, but the angle could be varied, and the gaff could also be lowered until it lay on top of the corresponding boom, if any.
- **Sprits –** A large diagonal spar rising from a swivel at the foot of the mast to the top outer corner of a fore and aft sail, and supporting the whole sail.

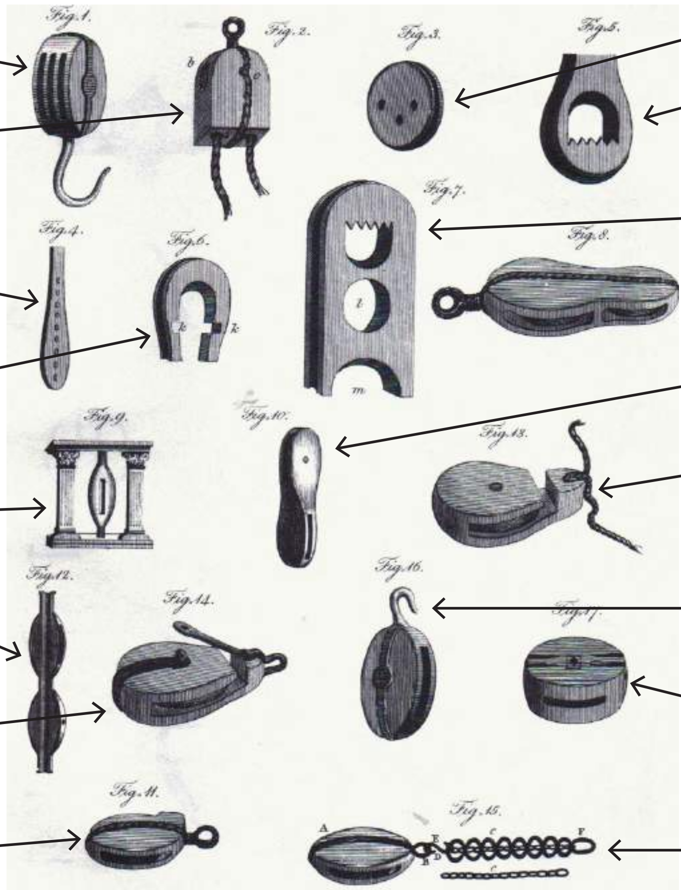
All spars have gone through the same sequence of materials as masts – timber, iron, steel and alloy (even plastic).

RIGGING

Rigging is classified into two groups: standing rigging, which is more or less fixed, mainly to support masts, and running rigging, used to hoist, lower, move or constrain spars and/or sails. See the glossary and diagrams for the main types of each. Both were conventionally made of natural fibre rope, mostly hemp, but later iron wire, steel wire, cotton and polymer fibre, especially polypropylene, have been used. Sisal rope was generally regarded as inferior. Rigging was always worked hard to its limit, so the best materials which the owner could afford were fitted. Iron and steel were used only for standing rigging initially, but steel came into use for running rigging when specially strong and flexible steel wire rope became available. Iron wire was never really popular. Although strong for its size it could fail without warning, in contrast to natural fibre ropes which to the seaman's eye gave unmistakable warning when they had had enough.

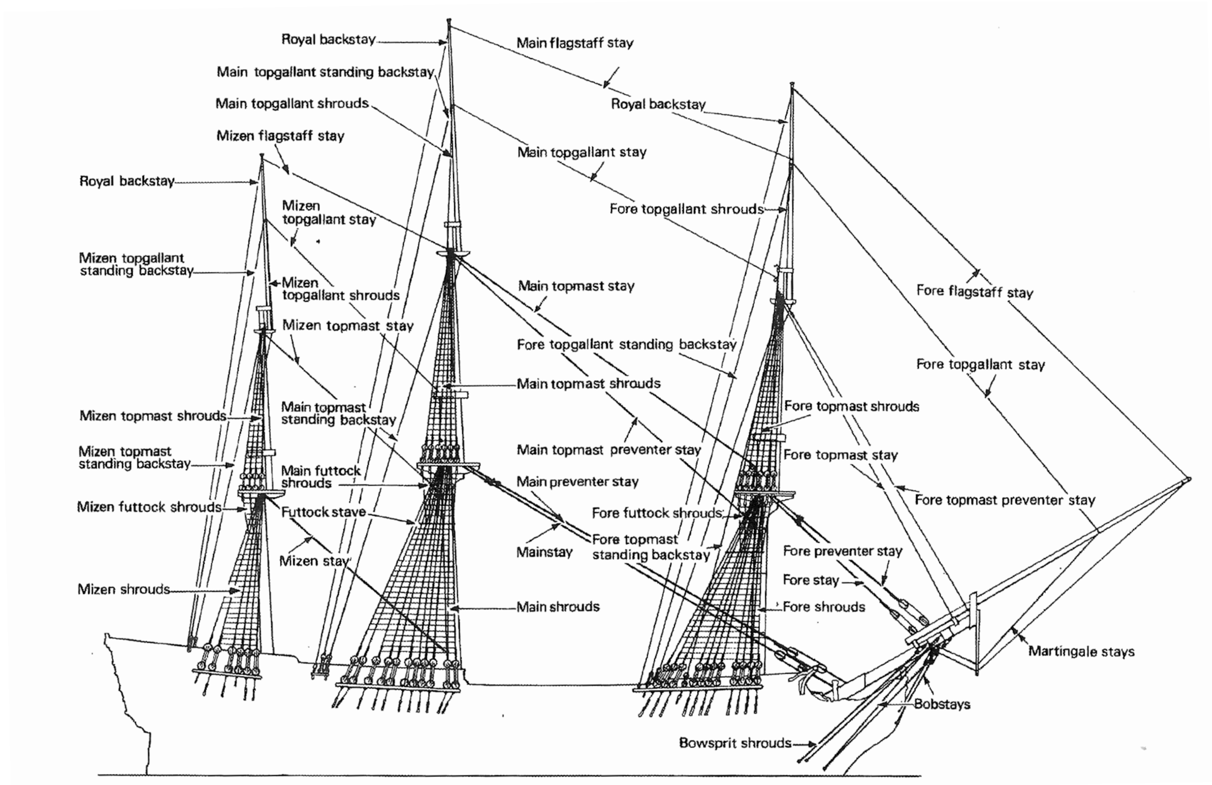


Various rigging items from Rees's Cyclopedia, c 1819.

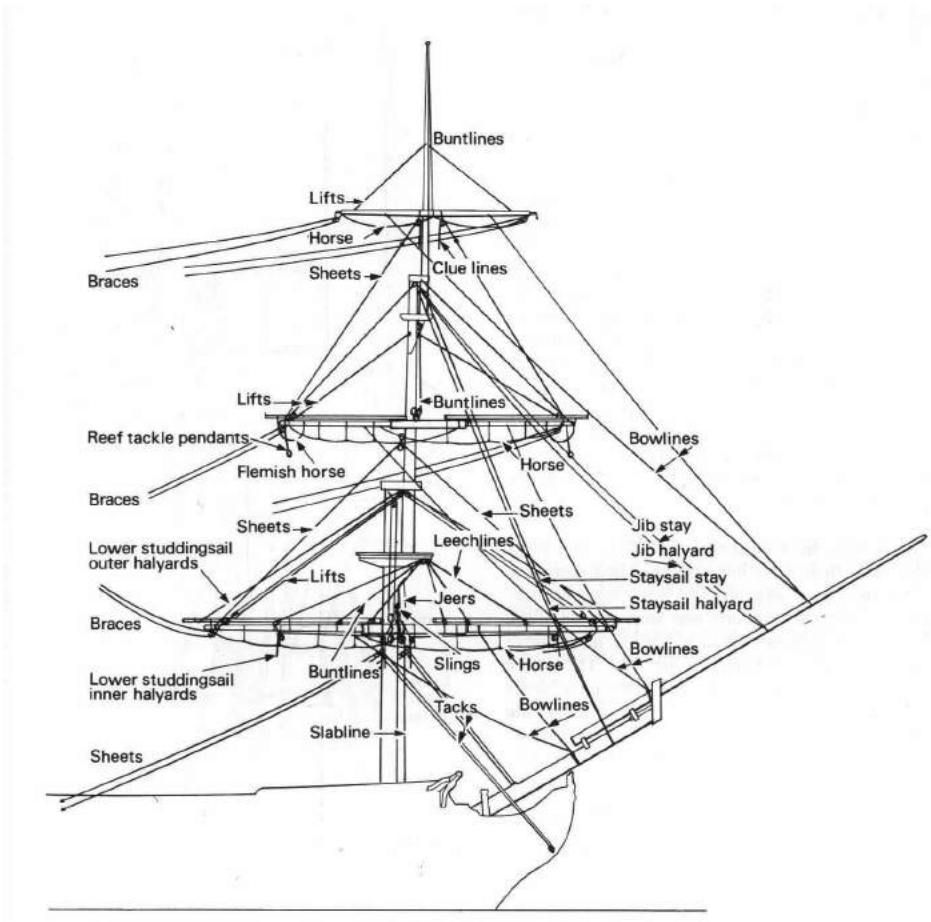


Various rigging items from New Universal Dictionary of the Marine, 1815 by William Burney.

There is a multitude of smaller rigging items which may be encountered. The commonest are blocks (pulley blocks used to change the direction of a rope, or grouped in a tackle, which multiplies the force exerted at its end) made of wood or metal, and fitted with hard wood or metal rotating wheels or sheaves inside. These are sometimes massive. One special kind is the deadeye, which was attached between a shroud and the shroud plates to tension the shroud correctly. These do not have any sheave inside – they are just solid lumps with carved holes through them to take the rope. Each shroud would have two of these, and the shroud would be tensioned by tightening the line that joins the two deadeyes.



Standing rigging



Running rigging

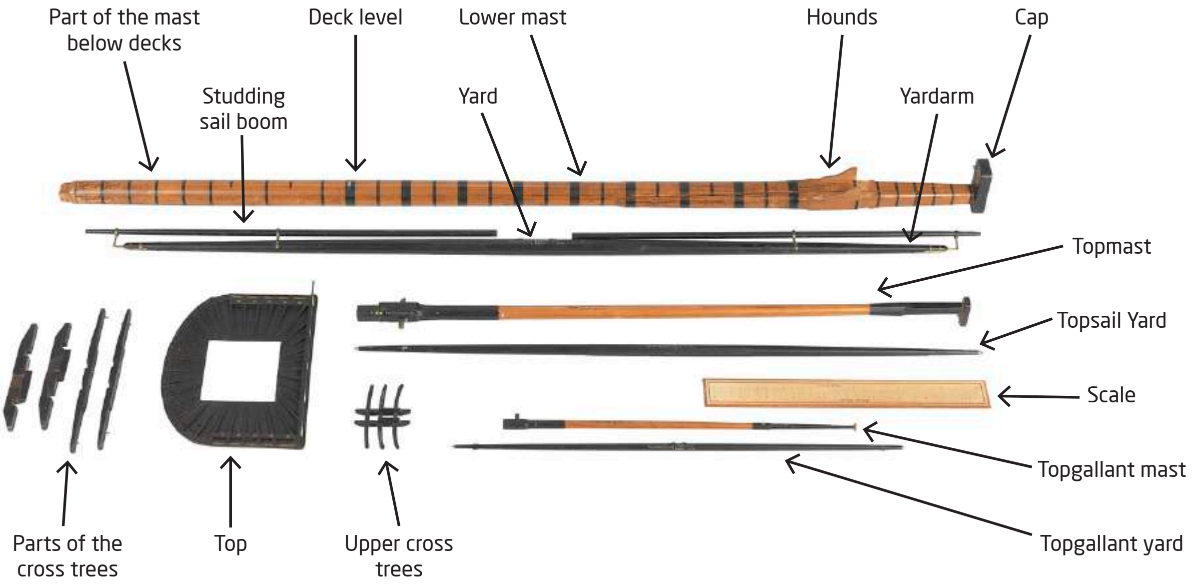
READING A SAILING SHIP PICTURE

Interpreting what is happening in a picture can be quite a skilled business. Start by deciding what the wind is doing. Often the sea surface gives you this, with ripples or waves at right angles to the wind direction. A well-handled ship's sails should have the leading edge of every sail just catching the wind. Look at the foresails in particular, as these did a lot of the work when close to the wind. Yards, booms and gaffs will be hauled back on one side if the vessel is trying to get to windward, and will be out at a greater angle to the centreline if the wind is free (on the beam or abaft). The smoke from any steamships in the picture will help, as will any prominent flags. The strength of the wind is shown by the sea surface, by the heeling (lateral tilting) of the ship, and by whether the sail has been shortened (sails reduced in number or area) to reduce the strain on masts and rigging. Sometimes the sails are not full and pulling at all. This may simply mean she is anchored and only drying her sails on a quiet day (a common image likely to be seen is a sailing ship in harbour on a quiet day festooned with sails hauled up to dry in order to prevent rot in the canvas), or she may be becalmed, but it may mean she is in the process of going about or tacking (passing the bow across the direction of the wind) or gybing (passing the stern across the direction of the wind), which means she is changing course to put the wind on the starboard side instead of port, or vice-versa. A further possibility is to have the square sails being blown back against the mast. This can happen in two ways – it may be done deliberately to take way of the ship (slow down or stop her), or the unfortunate crew may have failed to get her to go about and got stuck 'in irons' between the port and starboard tacks with the wind straight ahead. This was not at all uncommon, but painters and photographers were not often so unkind as to portray it. Sometimes images may show a vessel that has 'hove to'. To 'heave to' some sails will be set to pull forward in the normal manner, while others will be set aback to act as a brake. In this way a vessel can be held virtually stationary in the water despite the strength of the wind.

CARE AND CONSERVATION

Care and conservation are to a large extent the same as for the same materials from a non-maritime source. Masts and spars can occasionally be very large – up to twenty tonnes for a lower mast, or four tonnes for a mainyard, and their length means that moving them needs expert slinging and very careful planning. Getting a 25m mast round a corner on a trailer can be a nightmare! Remember that timber from a maritime environment may have lasted a hundred years because salt has protected it from the spores of rot. When you remove it from its natural environment, you will probably need to take advice on the application of an alternative fungicide. Be cautious about coatings or surface treatments, such as varnishes, paints or patent mixtures, particularly if it is to be exposed to the weather and/or UV. Timber which has been immersed for a very long period needs serious expert treatment – the first principle is not to let it dry out abruptly.

Wrought iron is something of a rarity, but will also need expert treatment as it will probably be full of hidden chloride ions eating it away happily.



The parts of the foremast of a model of a first rate warship, c 1745
SLR2755 © National Maritime Museum, Greenwich, London

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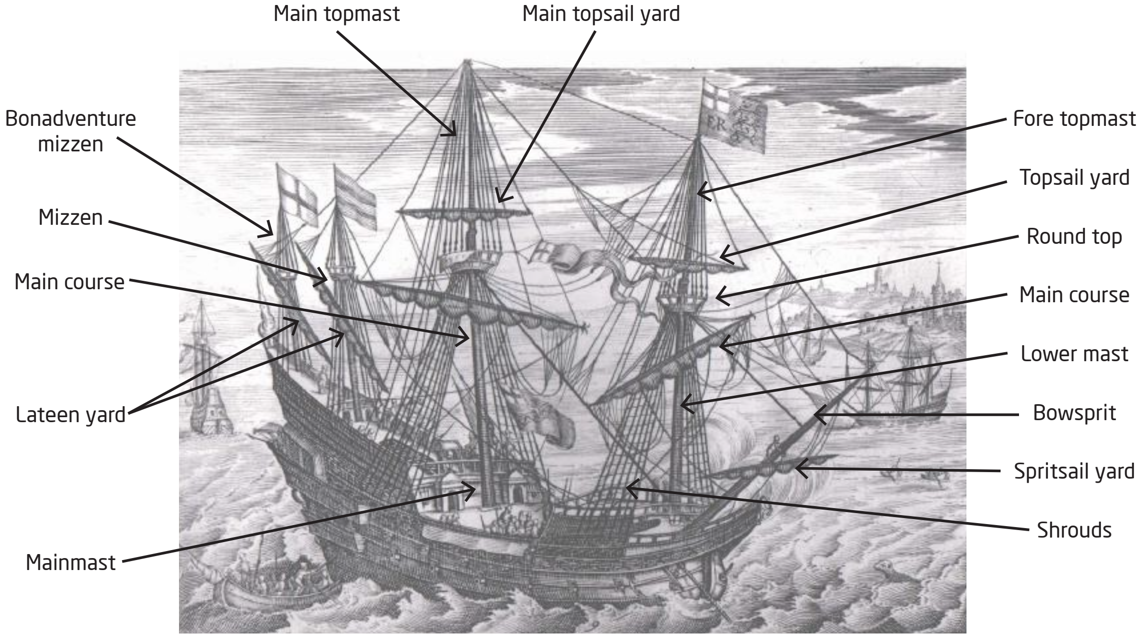
3 IDENTIFYING SAILING SHIP RIGS

BY DAVID MACGREGOR, HISTORIAN, AUTHOR, AND ARTIST

At the end of the 16th century, the majority of sea-going ships were fitted with three masts on which were set six sails as follows: a spritsail under the bowsprit; two square sails on the foremast and another two on the mainmast, the lower called a 'course' and the upper one a 'topsail'; and on the mizzen there was a fore and aft sail set on a diagonal 'lateen yard'. Jibs were not to be seen for over one hundred years, as will be described later. A few of the larger warships had a smaller fourth mast called a 'bonaventure mizzen' stepped at the after end of the poop; in addition, these larger ships had a small square sail called a 'topgallant' fitted above the topsail. The crew had to work in the rigging and as there were no footropes to stand on, they were obliged to sit astride the yards. No reef points were provided and to reduce sail area, the 'bonnet' was unlaced from the foot of each course. The yards were often lowered to the deck in order to furl the lower sails.

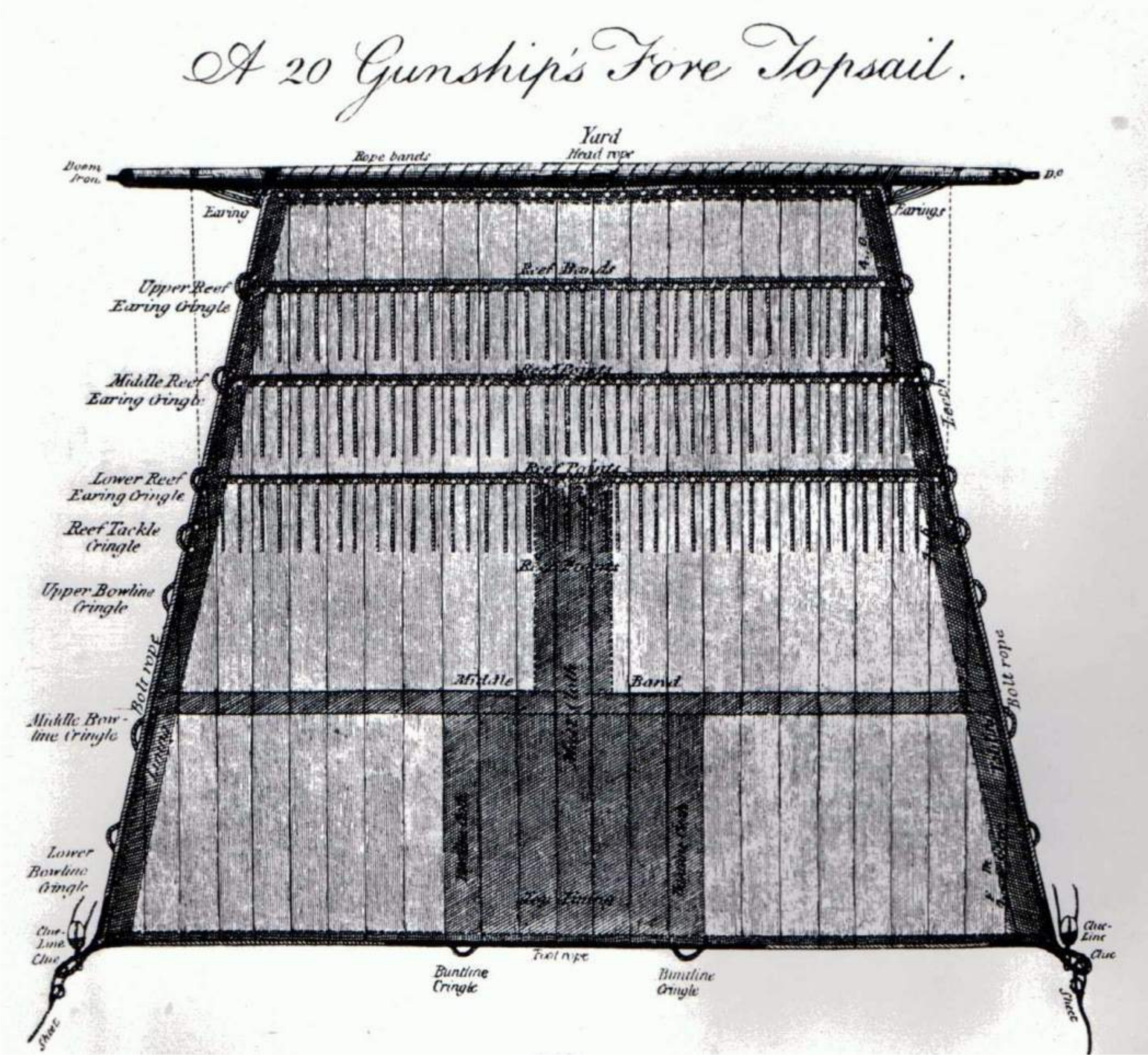


Rigging, c 1590
© National Maritime Museum, Greenwich, London

During the second decade of the 17th century, a second square sail called a 'spritsail topsail' was fitted on the bowsprit by means of a topmast erected at the outer end, and this remained in use until about 1730. In bad weather it was a liability and was often removed during the winter.

The spritsail topmast at the end of the bowsprit on a Navy Board model of c 1675.
SLR0003 © National Maritime Museum, Greenwich, London

The crossing of more yards on the masts was made possible by improvements in the rigging so that the masts were no longer in one single length, but instead the topmasts and topgallant masts were separate spars which overlapped or ‘doubled’ the other one. This arrangement proved most satisfactory and has remained the normal fitting down to the present day. It should be noted that the names of sails were prefixed by the name of the mast on which they were set.



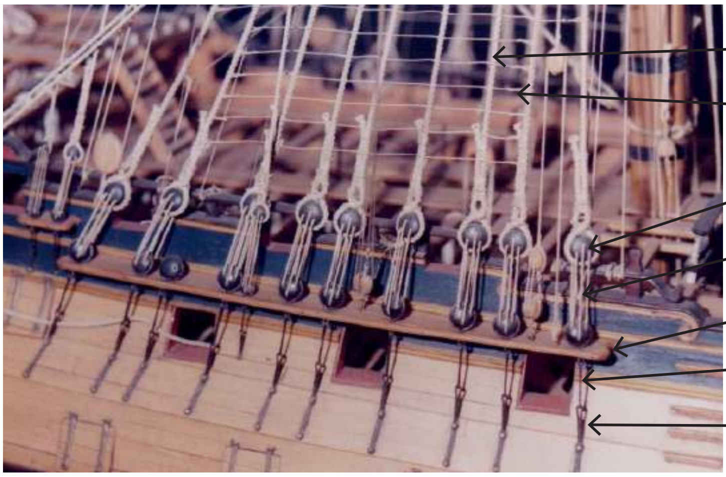
A typical topsail, c 1800 from The Elements and Practice of Rigging and Seamanship, by David Steel, 1794.

Although all but the largest spars were from single pieces of timber, the fore and main lower masts were ‘made’ or ‘built’ masts; that is to say, they were composed of several pieces of timber dowelled together. To strengthen them heavy rope ‘wooldings’ were lashed around them at intervals. These lashings were tarred; due to their distinctiveness, artists often pick them out in their paintings. A feature of the lower masts was the large circular ‘top’ on which soldiers could be stationed in battle. By about 1710, the shape of the top had altered, the after side becoming square-cut while the fore side remained rounded, a shape which persisted into the next century.

A round top on a model of c 1675
SLR0003 © National Maritime Museum, Greenwich, London

A top on the modern replica of Captain Cook's Endeavour of 1768.
© Brian Lavery

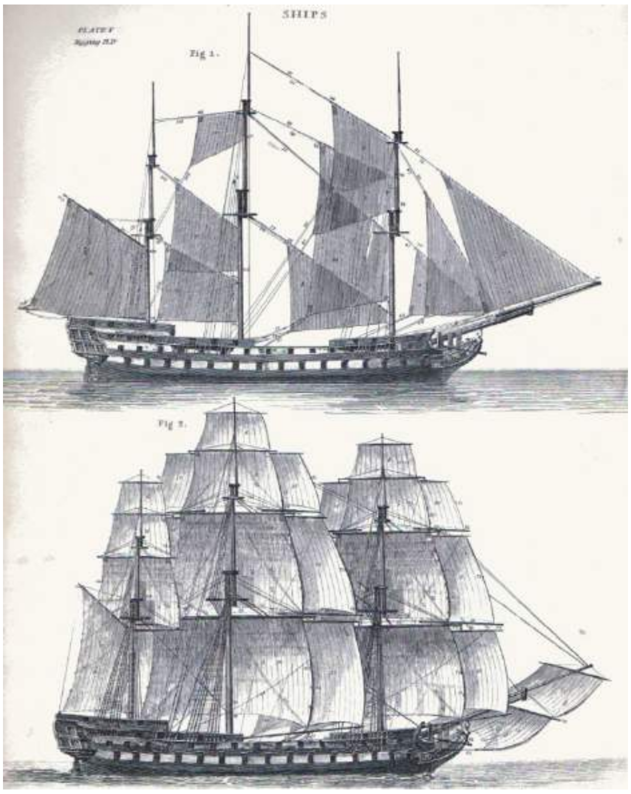
Contemporary drawings and some rigged models illustrate the sort of rigging being put on the larger warships, where the lower masts remained tall and vertical with ten or twelve shrouds each side for support. The shrouds were set up with deadeyes and lanyards on long channels that extended along the side of the hull, about halfway down to the waterline. The spacing of the shrouds was staggered in order to avoid the numerous gunports.



The shrouds of a model, showing how they are spaced to avoid the gunports.
© Brian Lavery, with kind permission of National Maritime Museum (SLR0310)

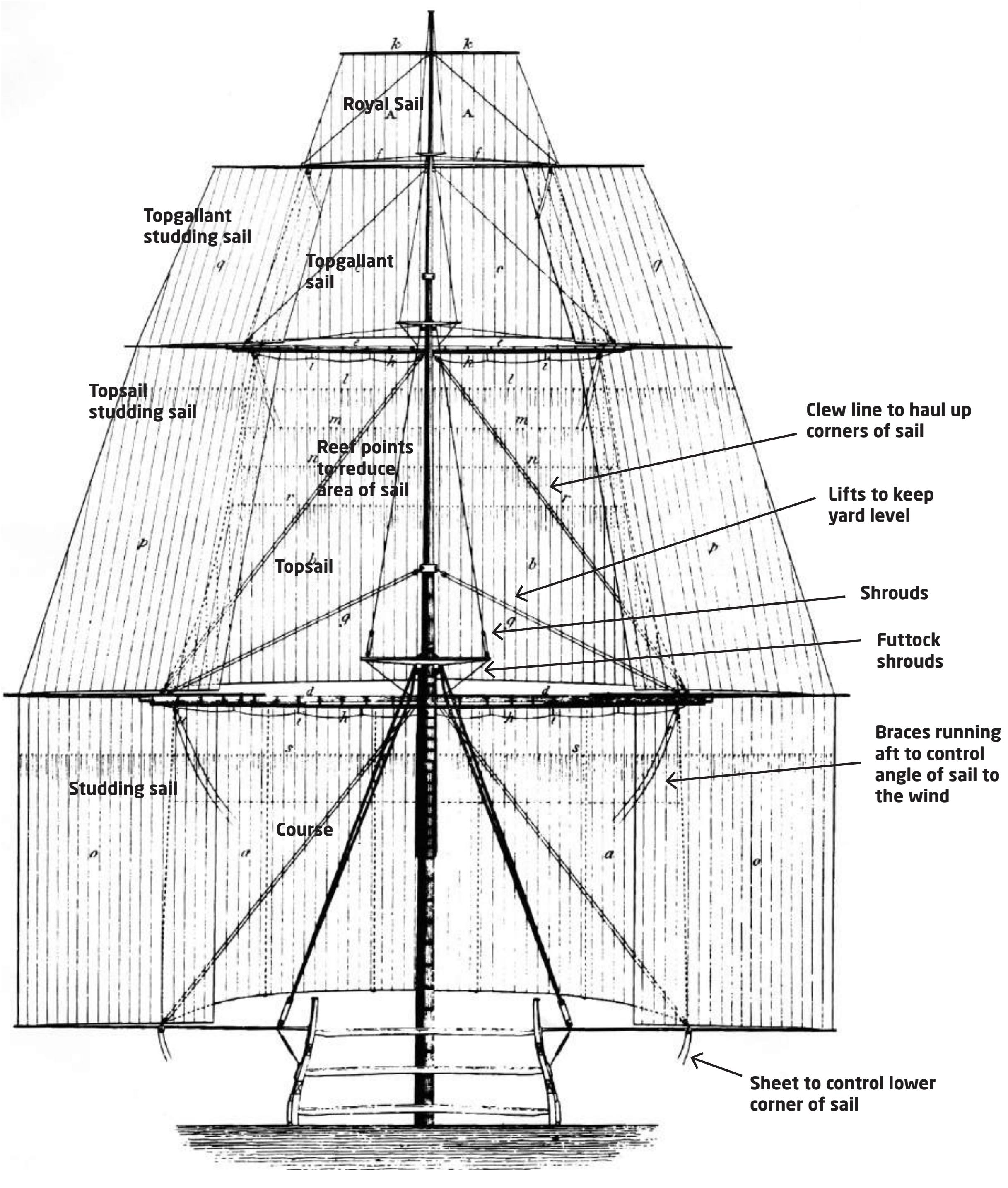
The mizzen course was set on a long lateen yard which was termed the mizzen yard, and so another name had to be given to the other yard on the mizzen on which square sails could be set; it was dubbed the 'crossjack yard', a term which lingered on into the 20th century, even though the lateen yard had been dispensed with in the last twenty years of the 18th century.

An important alteration to sail plans was the introduction of staysails which first appeared in three-masted vessels in about the 1680s, and within twenty years were being set on the bowsprit. In this position they were collectively known as 'headsails' and certain ones were termed 'jibs'. By about 1710 these newer sails began taking the place of the spritsail topmast in ships of less than 60 guns. However, the larger men-of-war, such as three-deckers, retained them as late as 1745, even though jibs had also been added. The use of jibs allowed ships to tack more efficiently and sail more easily to windward, but many vessels continued to cross a spritsail yard below the bowsprit.



A 74-gun ship of c 1800, showing its fore and aft sails set in the top picture (though it is unlikely that this would be done in practice) and the square sails, including studding sails, set in the lower picture.
From Rees's Cyclopedia, 1819

Another new sail to make its appearance in the 17th century was the 'studding sail', which was set on extensions to the yards (studding sail booms) beyond the outer leech of the square sail. At first they were set each side of the courses and the topsails on the fore and main masts, and in such manner virtually doubled the effective area of each square sail. They were useless when the vessel was close-hauled or in a very strong wind, but they have always been beloved by artists who paint them whenever possible. Clipper ships used them extensively, but so also did collier brigs.

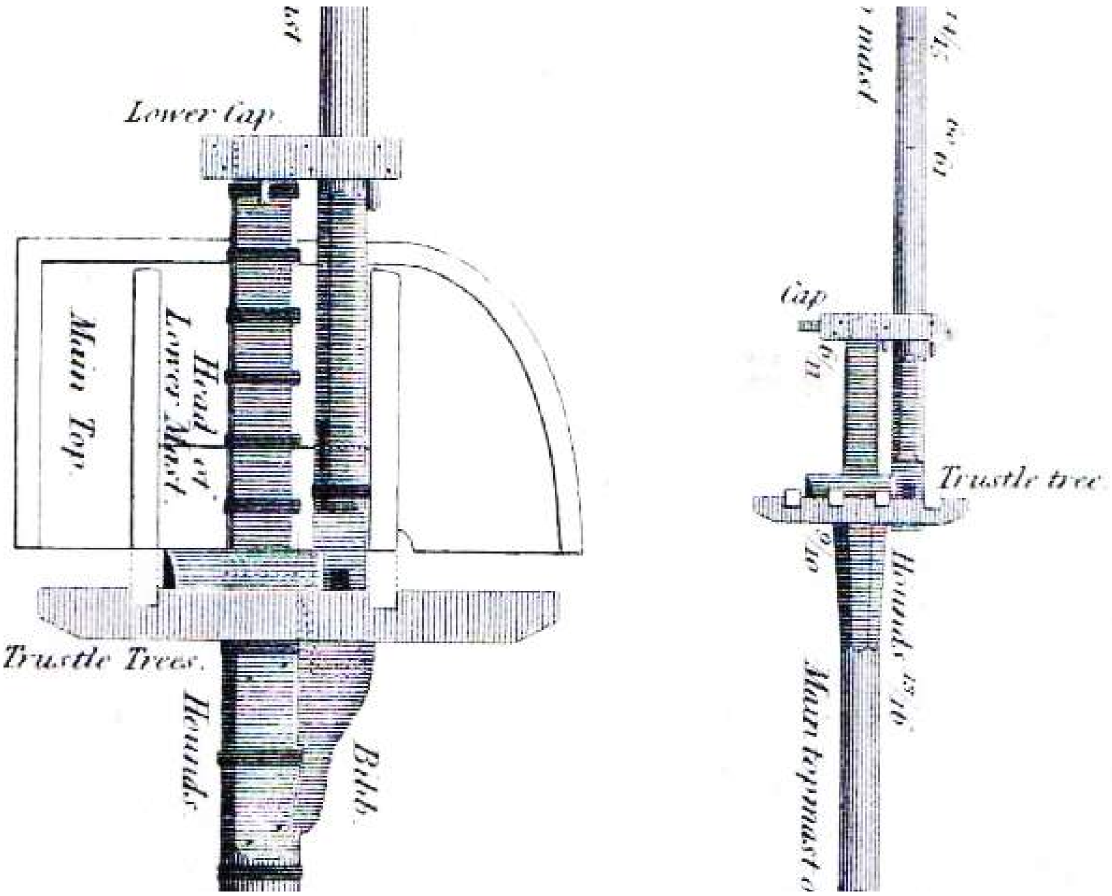


Sails from New Universal Dictionary of the Marine, by William Burney, 1815.

By the middle of the 18th century the part of the mizzen course forward of the mast was found to be really of little use, and so it was removed, but the lateen yard on which the sail used to be set was retained, particularly in the largest warships.

To set this smaller mizzen course, a gaff was used, and by 1800 vessels of all classes had finally abandoned the lateen yard in favour of the gaff. In any case, smaller single-masted craft had been using the gaff for some time, as well as the sprit.

So by the close of the 18th century the principal sails in a three-masted ocean-going sailing ship had become established: there was a minimum of three or four square sails on each mast, with jibs on the bowsprit and staysails between the masts; the masts were composed of three separate spars which overlapped each other; there were now footropes for the sailors to stand on and reef points for reducing the sail area.



The overlap between the lower mast and topmast in the left hand picture, and between the topmast and the topgallant to the right.
From The Elements and Practice of Rigging and Seamanship, by David Steel, 1794

However, the only mechanical gear to assist the crew were one or perhaps two capstans for hoisting up heavy gear or heaving in the anchor, although smaller vessels, particularly merchant-men, normally used a windlass for anchor work; and there was a rudimentary pump for use when the vessel leaked. Furthermore, this assortment of masts, sails, and rigging remained in essence unchanged for the remaining life of commercial sail.

The dates when new items of gear first appeared need recording, as they will assist in dating photographs, paintings and models. As headsails increased in size great strain was exerted on the bowsprit which resulted in the fitting of the bobstay and a martingale or 'dolphin striker' as the popular term calls it. A few scattered examples have been observed from 1775, but the first printed one appeared in David Steele's *Masting and Rigging*, first published in 1794. This is a good date to remember. Forked versions were to be found in the years 1810–30. Amongst various pieces of gear might be cited the trysail mast close abaft the lower mast of a brig to permit the hoops of the gaff sail to slide up and down, which converted the brig into a 'snow'. Then there was the 'bentinck' boom on which the fore course was set which saved continuous work on tacks and sheets, thereby reducing the crew numbers on collier brigs.

In the 1850s, a few attempts were made in America to divide the big topsails horizontally so that they could be handled more easily. In Forbes' version, the lower topsail yard hoisted up to the lower mast cap, but this arrangement was probably never used in Great Britain. In Howes' fitting, there was an iron truss on the mast cap to which the lower topsail yard was secured. A few were tried out here. Another way of furling or reefing the topsail was by rolling it around the yard, which was a method devised by Captain Cunningham. His patent topsail can easily be identified by what looks like a ladder running vertically up his sail. Many vessels carried them, although some masters were cautious and had a patent topsail on one mast and the conventional point-reefing topsails on the others. Cunningham's topsails were popular from the early 1850s until the mid 1860s when double topsails similar to Howes' rig became widely adopted. In like manner, topgallant sails were divided horizontally after 1870.

The use of galvanized wire for shrouds and standing rigging gave greater strength and a lighter appearance aloft, but still permitted a degree of flexibility. Wire was also used in running rigging. The increasing use of iron and steel plates for constructing masts and yards meant that jury rigs made from damaged spars could not be fashioned on board after a dismasting. Ocean-going sailing ships continued to ply the trade routes, while steamships serving ports in South Africa and the long haul to Australia and New Zealand deemed it advisable, even in 1890, to carry masts fitted with some square or fore and aft sails for fear of engine breakdown. In any case, men brought up in sailing ships liked any excuse to hoist sail.

Meanwhile, ketches, schooners, and brigantines continued sailing with their wooden hulls, timber masts, and hemp rigging. Little difference will be found in models and pictures between vessels of the 1840s, and those of fifty years later. The majority of the inhabitants of the United Kingdom were unaware that at the close of the 19th century, schooners still voyaged across the Atlantic and to all the ports in Europe.

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TYPES OF RIG

All images on next three pages © Brian Lavery

FORE AND AFT RIGGED, SINGLE MAST

The 'sloop' rig with a mainsail and a single sail forward of the mast, seen here on the highly popular Mirror dinghy .

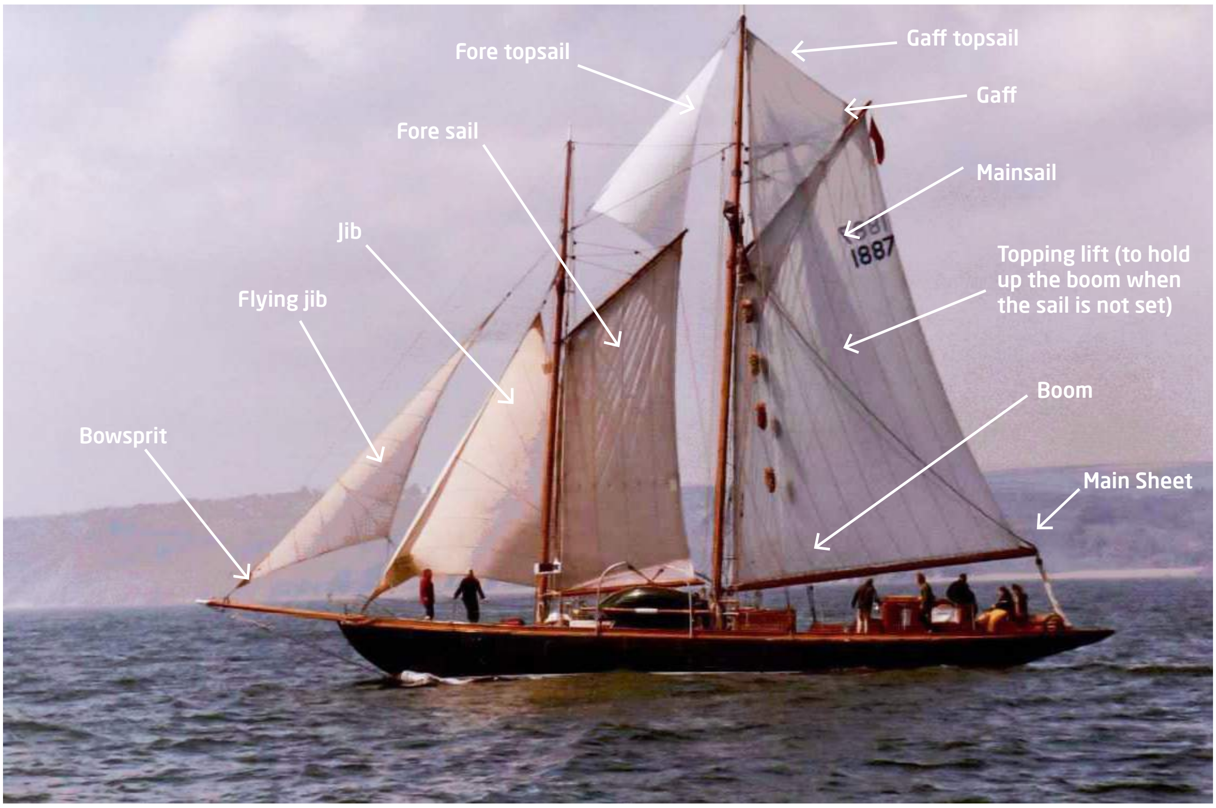
A Norfolk keel uses a single mast and sail.

The cutter rig has one or more sails forward of the mast, as seen in this Colchester oyster smack.

FORE AND AFT RIG, MULTIPLE MASTS

The yawl rig has a small mizzen mast well aft. The most common type in British waters is the Thames barge.

A ketch has a much larger mizzen mast, as seen on the Irene of 1907. Her main topsail has not yet been set.



On the two-masted schooner, the after mast is the larger one, as on the yacht Hoshi of 1909.

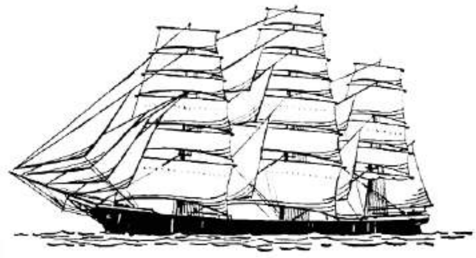
SQUARE RIG

Single-masted square rig is extremely rare on modern vessels, but is seen here on the Comrade, a Humber keel of 1923.

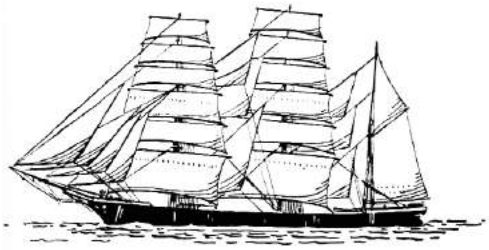
The brig, with two square-rigged masts, is far more common. This is the Royalist, used for training by the Sea Cadets.

The Norwegian Sorlandet is a full-rigged ship, with three masts, all square rigged.

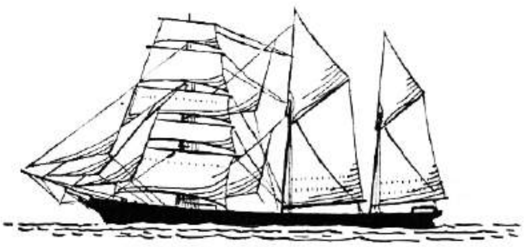
The Russian (ex-German) Kruzenshtern is a barque, square rigged on all masts except the after one.



Ship

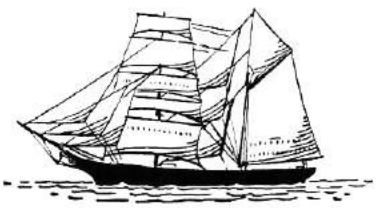


Barque

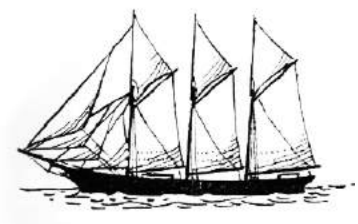


Barquentine

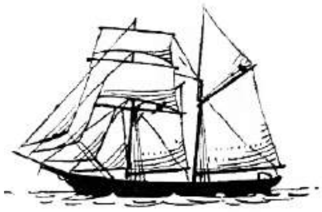
Brig



Brigantine

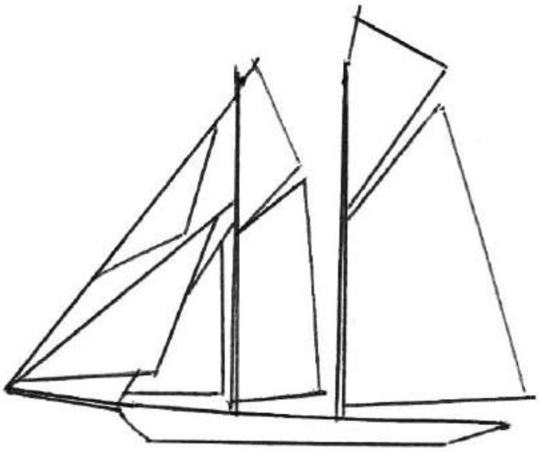


Three-masted schooner

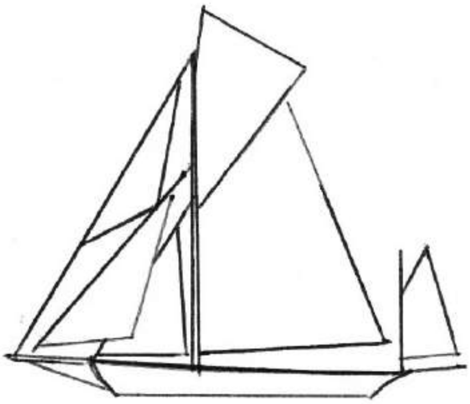


Two-masted topsail schooner

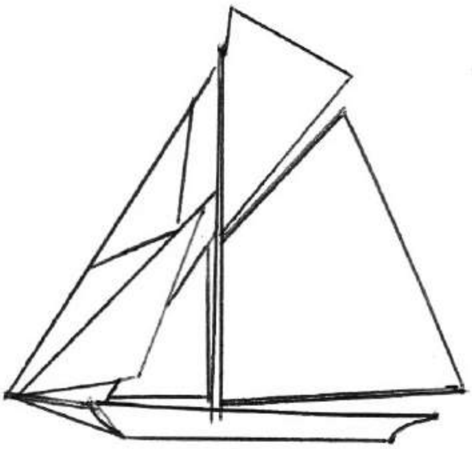
Above images on this page from All about Ships and the Sea, by E P Harnack, 1959.



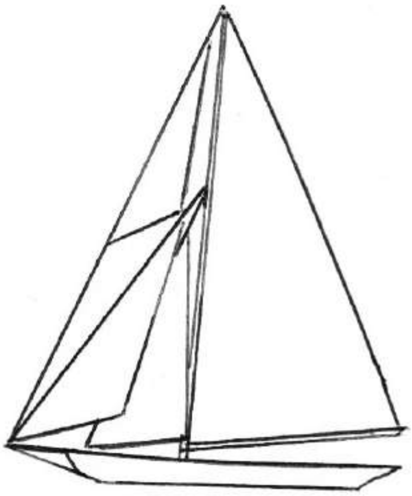
Two-masted schooner



Yawl



Gaff cutter



Bermuda cutter

Gaff sloop

Lug rig

Above images © Brian Lavery

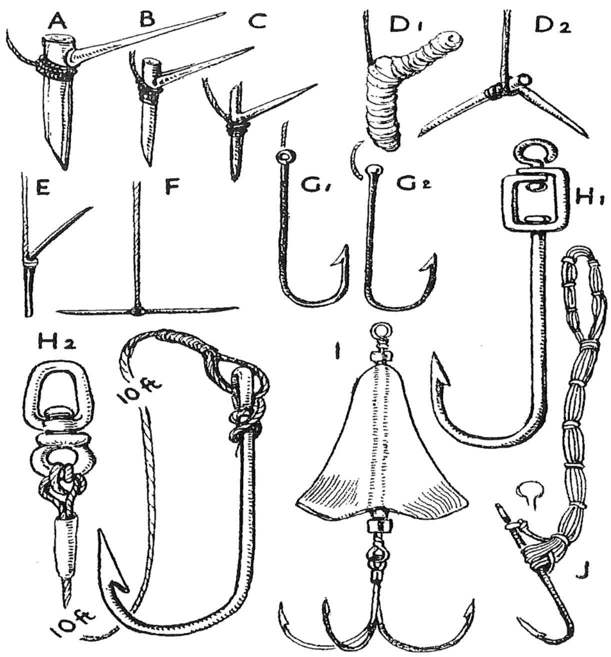
4 FISHING GEAR OF THE BRITISH ISLES

BY ARTHUR CREDLAND, FORMER KEEPER OF MARITIME HISTORY, HULL MUSEUMS

NB. All images in this chapter, unless otherwise indicated, are taken from F.M. Davis, An account of Fishing Gear of England and Wales, HMSO first published 1923, 2nd edition 1927, 3rd edition 1937, 4th edition, 1958.

EARLY DAYS: FISHING BY RIVER AND SHORE

Many collections have miscellaneous fishing-related items of uncertain age and origin. Various simple hooks (of metal, bone or horn), stone weights, or sinkers might be British (or at least European) of medieval or prehistoric date, or they may be stray ethnographic items. Common artefacts are large North American Indian and Eskimo fish spear points which seem to have been collected because they resemble prehistoric examples from northern Europe. The various hand books of the Museum of London and the British Museum will help distinguish some of this material. Often mixed in with the artefacts used for early domestic scale fishing are sundry hooks, rods, reels, flies and all the paraphernalia of angling which has developed apace since the days of lzaak Walton (1593–1683). Indeed the earliest treatise, *The Art of Fishing with the Angle,* was published in 1496. These early sources all have some illustrations which are of help in dating and the literature gets ever more prolific up to the present. An excellent guide to angling equipment is Turner (1989) and for signed and marked material trade directories and trade catalogues may often enable a specimen to be dated with some precision.



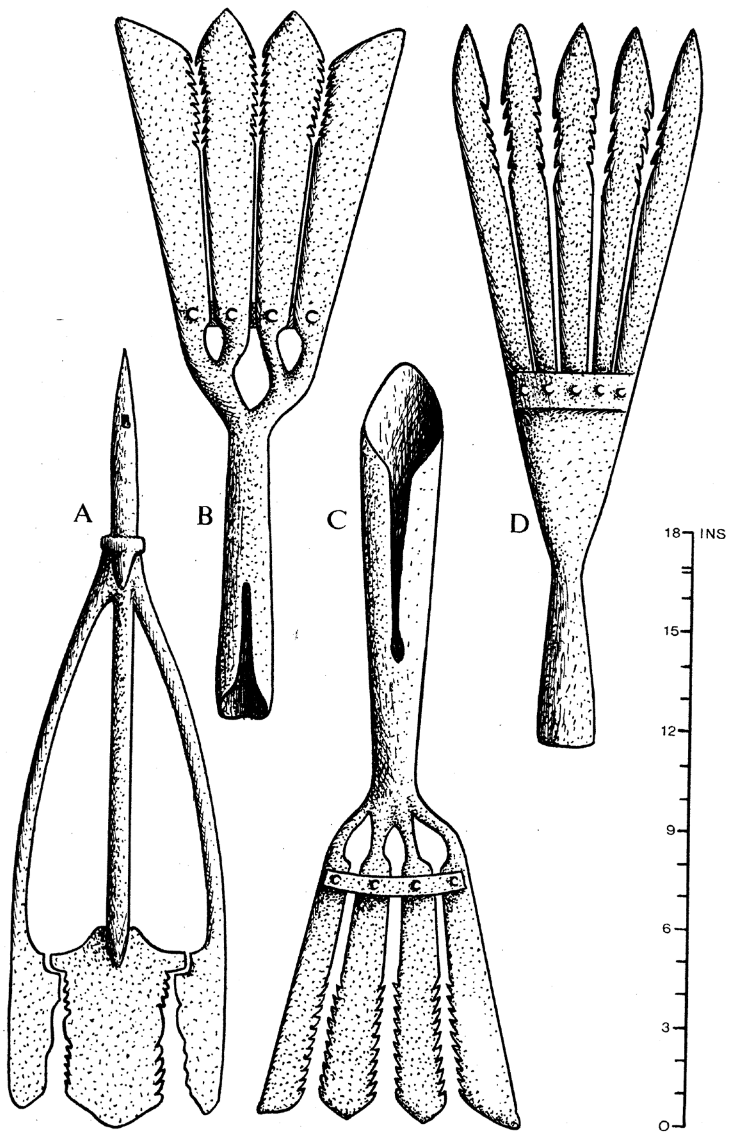
Types of fish-hooks.

A. Thorn-hook (Thames Estuary). B .and C. Thorn-hooks (Wales). D1 and D2. Showing action of Thorn-hook. E. Pin-hook. F. Double pointed gorge. G1 and G2. Typical barbed hooks. H1 and H2. Swivelled conger hooks. I. Mackerel spinner. J. Gangeing.

Fish hooks

One of the oldest methods of fishing known to man is the fish weir, a barrier constructed between the high and low tides either made entirely of wooden stakes, or of stakes and wattle, or stakes and nets. These are fixed structures used over many years, examples are the hedge baulks of Morecambe Bay, the Kiddles or Kettle nets of the south coast (Dungeness, Rye, Dymchurch) and the stake nets for salmon, mainly in Scotland. Clearly these structures will not usually be transplanted wholesale into a museum but portions might be displayed along with photographs and diagrams of the site in question.

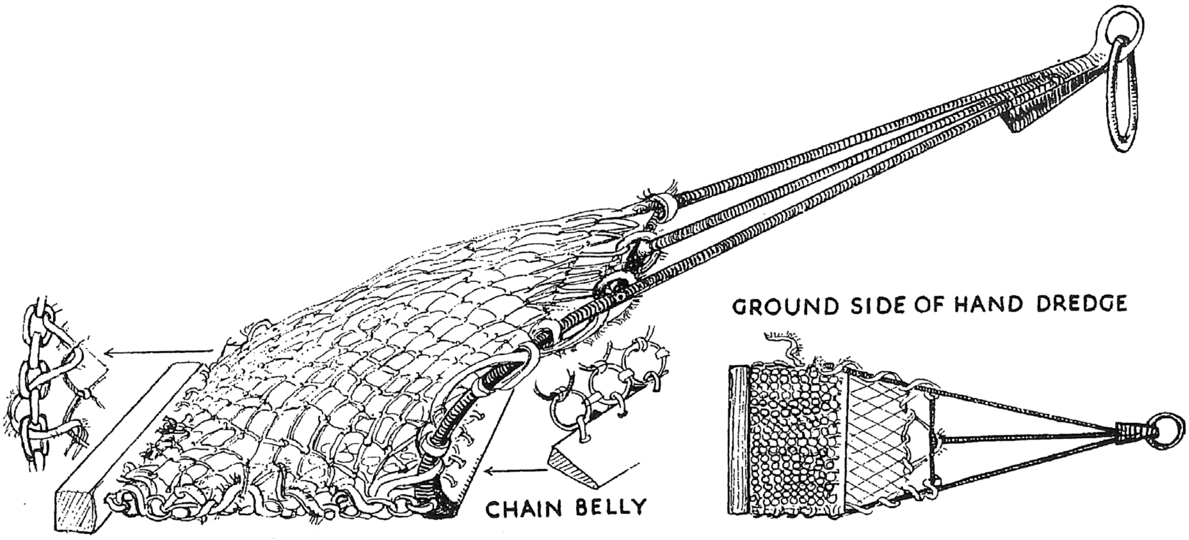
On the Broads, Fens, and Thames estuary, where eels are common, fishermen employ a variety of traps. These conical bags and associated lead-in nets are up to nineteen feet long, so collecting is feasible. A wickerwork eel pot was also used and the same sort of structure was employed for catching salmon, known as a 'putcher' on the Severn. Also used for taking eels and salmon was a wide variety of fish spears. They vary immensely in the number of tines, and their width and length.



Eel spears: A Ribble valley, Lancashire; B Cambridgeshire; C Trent valley, Nottinghamshire; D Broads, Norfolk (made at Great Yarmouth)

Eel Spears

Oyster dredgers are another ancient implement, their construction has many regional variations but the principal is the same: a sharp-edged 'scythe' which is scraped along the bed, lifting the oysters which collect in the net behind. The hand variety are some 2-3 ft (0.6-0.9m) across but there are larger mechanically-lifted types.



Oyster dredge

The simple push nets for shrimps and prawns are usually worked by one man (flimsy versions were once familiar to children at the seaside for hunting in rock pools for anything that moved). These usually have triangular or trawl-like nets but the 'pandle' found on the south coast is a broad shallow scoop.

The cockle rake is scarcely distinguishable from the garden rake, early examples of both are entirely of wood, and later ones have metal tines on a wooden or metal bar. The hand forks for digging out cockles have two or three tines which bent over and are easily mistaken for garden forks.

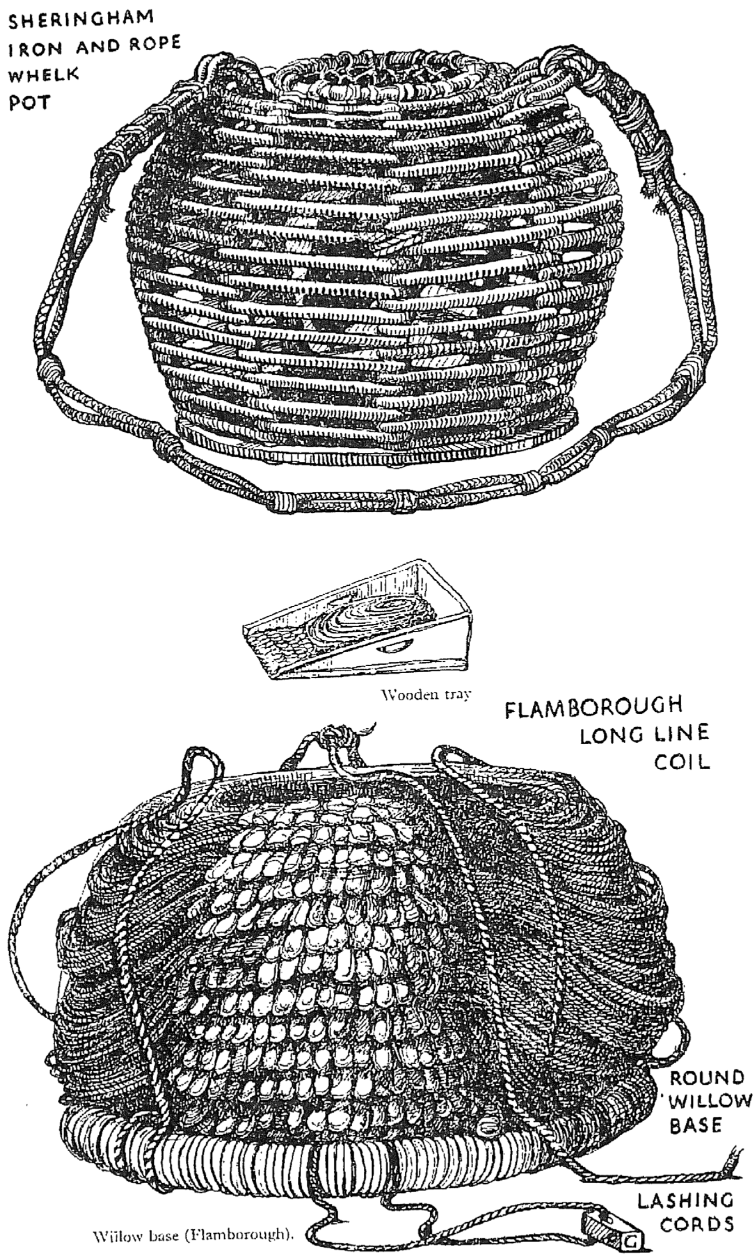
There is a rich vocabulary covering the implements described and this terminology ought to be pursued in local sources, dialect dictionaries, histories of particular localities and the memoirs and reminiscences of local fishermen. There has been a certain amount of confusion in the general literature regarding names, especially as these may change with time and as a result, perhaps, of the importation of types previously foreign to a particular location. Over the years materials may also change, this is particularly so since the 1950s when metal largely replace wood; heavy gauge wire is substituted for hazel, willow or cane; and 'nylon' and other synthetics for traditional twines, cords and rope.

A key source of information on all those kinds of instruments and nets, etc. is F.M. Davis' publication for MAFF first published in 1923 and subsequently revised. See his classification appended below.

INSHORE AND OFFSHORE FISHING

LINES AND POTS

Crab and lobster pots are familiar items from all round our coast. They show regional variations in both size and shape and on the south coast a French pattern can be found: a cylinder of wooden laths, closed at each end by netting or laths, with a single opening half way along. Traditional wicker construction has often given way to galvanised iron wire combined with 'nylon' netting. Conical pots for whelks are used both for making a commercial catch of these molluscs and to provide bait for hand lines.



Whelk pot and long line coil

Hand line fishing with a single hook or a handful of hooks is one of the most ancient methods of making a catch. The 'great lines' or 'long lines' of the inshore fishermen can however employ thousands of hooks each attached to the main line by a 'snood' which in the old days might be a horse-hair. Neatly coiled, each line is put on a wicker base (known as a ‘skep’ in East Yorkshire) or in a wooden tray. Each hook first has to be carefully baited with mussel, whelk, or limpet. Mussels and whelk gathering is referred to above but limpets were prised off the rocks using a device called in Yorkshire a flithering knife, the limpet being known as a flither. The ‘knife’ was in fact a simple T-shaped metal device held in one hand, the stalk of the T having a chisel point. The shellfish were then held on a metal spike (‘spit’), a pointed metal rod some thirty inches (0.46m) long with a loop to form a handle.

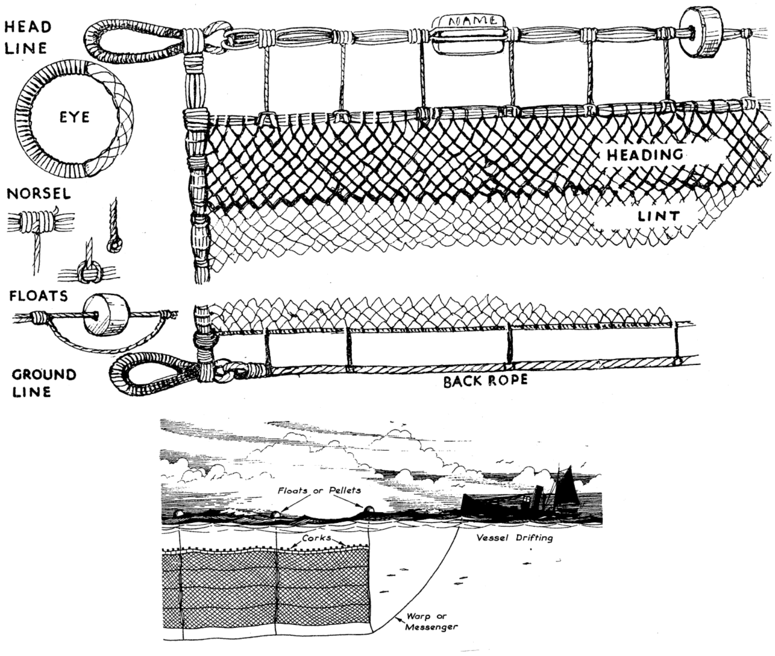
A mallet was used for smashing whelk shells, a common mallet with a rectangular section head, metal plates fixed to both faces. Unless collected in context and recorded at the time most of these ‘makeshift’ baiting tools would not be identifiable.

Hand lines were used from a variety of craft including the well-smacks which had a central hold enclosed by transverse bulkheads in which fish were kept alive. Holes were pierced near the water line allowing the seawater to circulate and be refreshed.

Initially from smacks operating out of Harwich, then Barking (from the 1790s) hand-lining for live fish keeping was maintained in Grimsby till *c* 1904. The fish were kept in containers known as ‘trunks’ suspended in the dock or set on the dockside and the fish killed when the sale was made. On board ship the fish were pierced with a ‘pricker’ to deflate the bladder and the fish was ultimately despatched with a wooden bludgeon hence the popular name for the ships associated with this trade – ‘codbanger’. Similar clubs are known as a ‘priest’ in Scotland. These implements were variable in form and somewhat makeshift so out of context and without documentation are almost impossible to verify.

DRIFT NETS, SEINE NETS; AND NETTING NEEDLES

Drift nets are gill nets, not fixed to the bottom but attached to a boat or a series of buoys. They are assembled in a long series known as fleets. The width and depth of each component, mesh size and arrangement of the headlines and floats are determined by the species to be caught e.g. pilchard, mackerel, salmon and sea trout. It is really only practicable to collect a sample of net and headline and its use explained with photographs and diagrams.



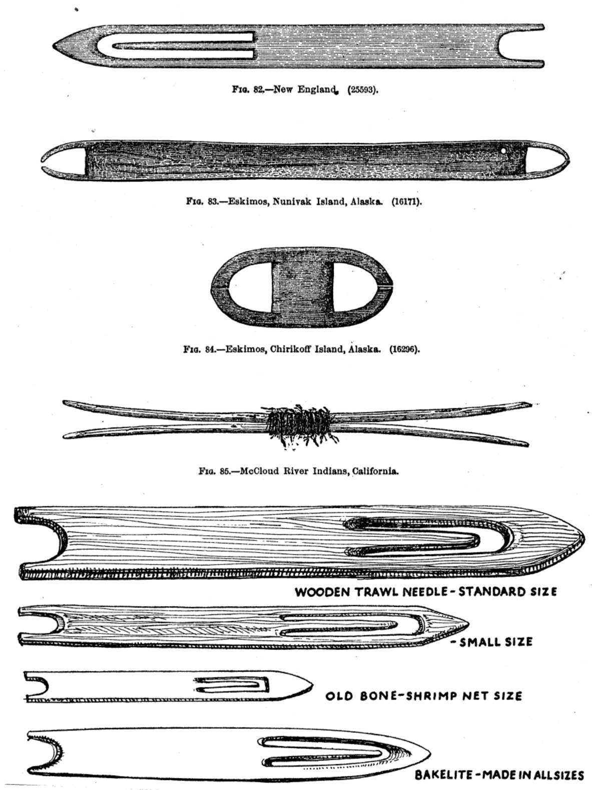
Drift netting

The herring industry has a huge literature. Great Yarmouth was the 'metropolis' of the herring fishery in England until the 1960s. The role of the Scottish ports extended beyond their confines and large numbers of Scottish fisher girls followed the herring along the coast and gutted and prepared the fish for preservation in brine or kippering.

A variety of seine nets are in use, characteristically one end or wing is buoyed while the boat brings the other round to meet it. The purse seine and ring net completely entraps the fish in a wall of netting. In contrast the Danish 'seine' or 'snurrevaad' resembles a trawl with very large wings.

Netting needles or braiders are easily recognisable but identifying the source and age of a particular example is problematic. They are most commonly wood, sometimes bone from early times or even horn. Inevitably the modem braider is plastic. The main confusion concerning origin comes from overseas examples, examples from Eskimo and Native American sources in particular, which were in use relatively recently and might easily be mistaken for prehistoric types.

The (usually) rectangular wooden net gauge for regulating the size of the mesh has a huge variety of names: spool on the Yorkshire coast, knell in Fleetwood also pin, shale, moot, cowl, keevil, kibble, and mesh.



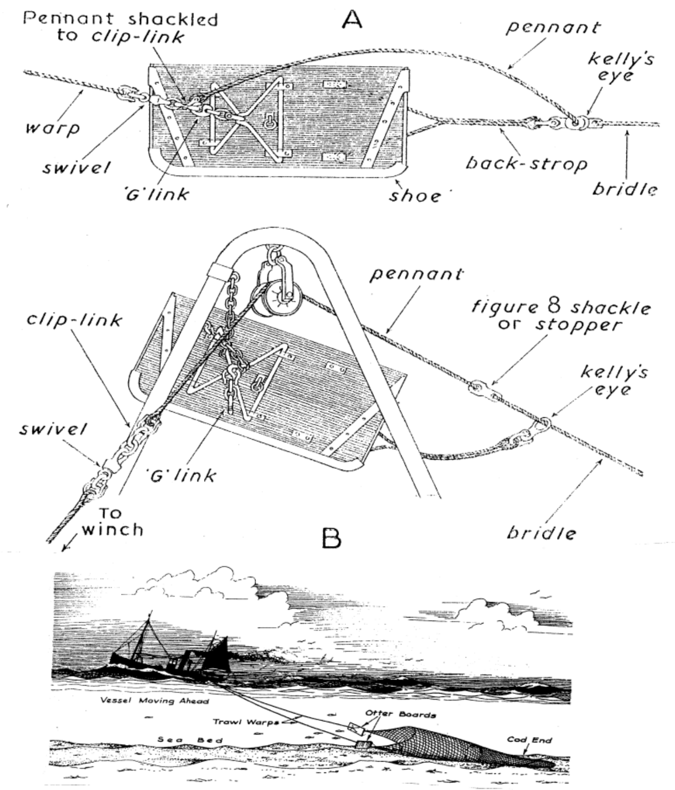
Net needles (source not identified)

Net braiding remained a community activity even in the deep-sea ports but since the 1950s net making has been almost entirely by machine and indeed machines were already in use in the 19th century. The fishermen still have to know the basic skills of braiding so that nets can be repaired while at sea, meaning needles of traditional design are still commonplace.

TRAWL NETS

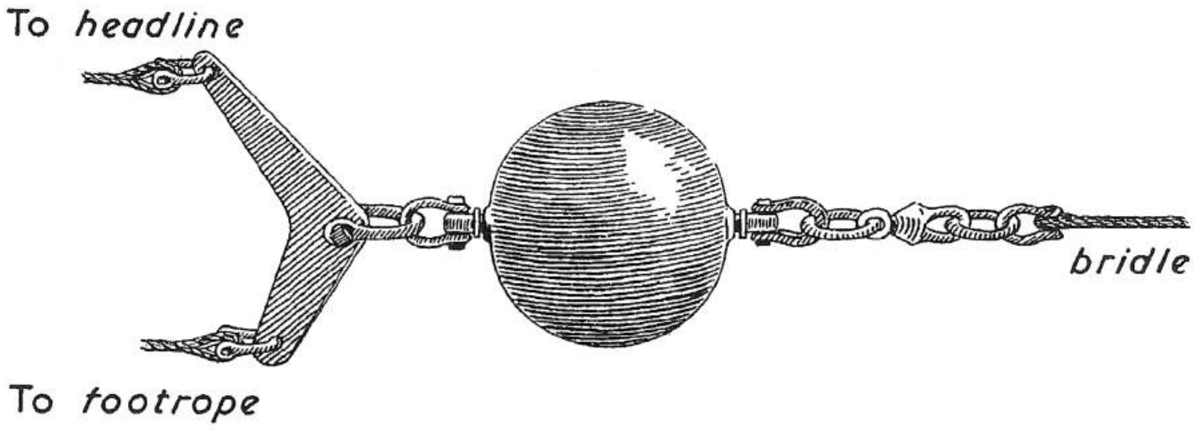
The trawl net is used inshore and offshore from a variety of small craft, steamers and motor vessels. The early form is the beam trawl, consisting of a simple bag-like net narrowing to the closed end, and the mouth stretched open with a wooden beam. At each end of the beam is a metal skid referred to as an ‘iron’ or ‘head’. Apparently inspired by the oyster dredger, the ‘wondyrchoun’, as it was called in the fourteenth century, is towed by a warp dragging the net along the seabed or just above. It was used to catch everything from shrimps to the biggest deep-water fish and varies accordingly in size with a beam from 3-4 feet (0.9-1.2m) up to 50ft (16m) long. Most nets are too large to be easily collected for a museum but the ‘irons’ often survive, a triangular or tear-drop-shaped hoop, the long side forming a skid and a socket for the end of the beam on the upper part.

There were experiments with otter boards in the 1870s and 1880s, and the Granton trawl patented by Mr Scott of Granton-on-Spey in 1894 eventually replaced the beam type. Elimination of the beam meant that the net size could be increased, though maximum efficiency could not be achieved until the introduction of steam (from *c* 1880) when the vessel and the towing of the net was no longer dependent on the vagaries of the wind. Even before the arrival of steam powered trawlers a variety of smacks and fishing craft employed a steam capstan which provided a welcome relief from manning the capstan bars and hauling in the net by hand. The best-known name in trawl winches for small craft was Elliott and Garrood of Beccles and a number are still preserved.



‘Otter’ trawl gear (source not identified for lower image above)

In the 1950s the Vigneron-Dahl trawl largely replaced the Granton trawl. In this design, the otter board is no longer adjacent to the mouth of the net but linked to it by long bridles of rope or wire. The bridle is linked by shackles, swivels, and crows feet to a ‘Dan Leno’, an iron-shod, wooden or all-metal post to which the headline and footrope are attached. All of these components vary in design according to the manufacturers favoured in particular ports.



Ross type Dan Leno

Since the 1960s and the introduction of the stern trawlers, nets have become enormous and the trawl doors (otter boards) are now made entirely of metal. The early otter board was made of stout wooden planking shod with iron while large triangular brackets enabled them to be fastened to the warps. Typically those used in the deep-sea fleets of the 1950s and 1960s were rectangular, some twelve feet (3.6m) by six feet (1.8m). Smaller examples tend to have a D shape.

Though the nets themselves are not generally preserved, except for small samples, an abundance of small fittings can be found. The head rope was held up by a series of floats, which in the old days were made of cork cylinders but later of aluminium spheres. On the ground rope, protecting the net from rough contact with the seabed, are the bobbins, originally wooden cylinders and then replaced by a variety of metal cylinders and spheres (compressed side-to-side), and also rubber bobbins.

Glass floats were widely used until the end of the 19th century in conjunction with both nets and lines. The great lines were anchored and marked with buoys and these and the larger dhan buoys, which were used to work an area thought worthy of sampling, sometimes survive. They are largely makeshift combinations of wooden poles, crudely cut flags, with barrel floats in early days. Modern deep-sea buoys have aluminium poles and hollow plastic floats, inshore markers are often more primitive in construction and the float is often a crudely shaped lump of polystyrene.

As well as the catching gear there is a whole miscellany of movable items used on board fishing craft. These include cookers for shellfish, galley stoves, fish kettles, binnacles, and boat compasses. A curiosity in the North Sea fishery was the survival of the traverse board, unchanged since the Middle Ages. The various pegs on cords were placed in the appropriate holes to mark each change of direction and the time they had sailed on each course. Dade (1933) records an unusual example aboard a Penzance lugger visiting Scarborough that was carved on the surface of the galley bellows!

Wicker fish baskets remained in use down to the 1960s and it was still customary to hoist one on the mast to indicate that fishing was in progress, even on the vessels of the deep-sea fleets of Hull and Grimsby. Back home in port the ‘bobbers’ (Hull) or ‘lumpers’ (Grimsby) used baskets for discharging cargoes and the fish were then emptied into the fish ‘kit’ (a container holding 10 stone of fish) and ready for auction. Kits are open topped and flare gently from the base and originally were constructed of staves and metal hoops like a barrel. From the late 1950s they were quickly replaced by aluminium kits.

Apart from the equipment already described the fisherman’s tool kit was limited. The gutting knife is a simple folding knife (clasp knife) – the long blade ground into an elongated triangle with a sharp point for ease of insertion into the body of the fish. Offshore fishermen would also use a hand hook to help bring nets over the side of the boat. The dress of the fishermen traditionally comprised heavy leather boots (replaced by rubber thigh boots), a woollen jumper and waterproofs. The jersey or gansey was knitted with patterns distinctive to a particular port or fishing station with features unique to the fisherman's family group. The stiff heavily oiled canvas waterproofs, 'oilskins', and 'so'westers' were eventually replaced by light synthetic materials but a neck scarf is still usually worn to prevent chafing. An excellent source of information on the 19th-century North Sea fishery is the 'Toilers of the Deep', the magazine of the Royal National Mission to Deep Sea Fishermen. This includes many fine steel engravings of the men and ships, eyewitness descriptions and all sorts of practical advice including patterns for woollen mittens, balaclava helmets, and stockings. The mission maintained a presence on the North Sea, offering aid and comfort to the large number of trawlermen fishing the North Sea. The early mission ships were working smacks which also caught fish to help defray costs, so this charity is an integral part of the fishing story.

RNMDSF Collecting boxes – image taken from a RNMDSF pamphlet

Olsen's fishing almanacs, first published in 1876, provide an invaluable source of information, listing the fishing fleets of each port year after year. The numerous trade advertisements, often illustrated, show the range of equipment available to the fisherman and record its changes over the years. Individual ports have their own unique publications such as the Fisherman's Handy Billy published by the Hull Fishing Vessel Owners and Underwriters Joint Amalgamated Arbitration and Navigation Committee, but in recent times made available to fishermen everywhere as the Trawlerman's Handbook. As a general guide to handling a fishing vessel, the various editions also demonstrate the evolution of fishing techniques and equipment. Fishing News, Commercial Fishing and other periodicals together provide a detailed record of new developments in fishing, fishermen's views on these changes and a picture of how fishing is affected by the political and general economic situation. Numerous brochures are produced by suppliers of equipment and gear of all kinds and help provide a record of items which are large, unwieldy, and not easily collected.

WHALE FISHERY

There is a concentration of whaling artefacts in a handful of places in the British Isles, the two largest collections are Hull and Dundee. Miscellaneous harpoons, flensing tools and scrimshaw work are, however, scattered more widely. There is no space for a detailed treatment here but the bibliography highlights a number of works which describe whaling-related artefacts as well as the historical background.

F.M. Davis' classification of fishing gear

Class I: Fixed Instruments

All forms of gear temporarily or permanently fixed to the bottom.

- DIVISION A: Complete Barriers – structures of net, or other material, which completely prevent the escape of fish from a certain natural area which they have voluntarily entered.
- DIVISION B: Guiding Barriers – structures of net, or other material, which are placed in tidal waters, and are of such a shape as to direct the voluntary movements of fish into a desired area.
- DIVISION C: Eel Set Nets – special small-meshed bags with a non-return valve.
- DIVISION D: Filter Nets – fixed bag nets, set in moving water, which filter out the catch.
- DIVISION E: Basket Filters – basket structures acting like filter nets. 'Salmon Putchers' are also included here.
- DIVISION F: Fixed Gill Nets and Tangle Nets – instruments in which the fish are caught by the actual meshes of the net.
- DIVISION G: Trammels – complicated tangle nets with two or three parallel walls of different sizes of mesh.

Class II: Drift Nets

- Walls of gill nets, usually fixed to boats or other bodies which are free to move with the wind or tide.

Class III: Movable Drag Nets

Nets which are dragged along by human agency, aided by wind or mechanical power, and collect the fish.

- DIVISION A: Seines – walls, or modified walls of net, which can be placed in position so as to enclose, or partially enclose, a shoal of fish, which can then be fished at leisure or drawn ashore or to a boat.
- DIVISION B: Dredges and Shank Nets – conical bags with a rigid lower boundary to the mouth.
- DIVISION C: Beam Trawls – conical bags with a rigid upper and non-rigid lower boundary to the mouth.
- DIVISION D: Otter Trawls – conical bags, the mouth of which is kept open by kite like structures, and with non-rigid upper and lower boundaries.
- DIVISION E: Pelagic or Floating Trawls – trawls towed at various depths by one or two vessels.

Class IV : Baited Traps

- DIVISION A: Pots – baited receptacles with a non-return valve.
- DIVISION B: Baited Hoop Nets – conical bags with a rigid circular mouth, which are baited and placed on the bottom and suddenly hauled to the surface.
- DIVISION C: Hand lines – small series of baited hooks requiring constant attention.

- DIVISION D: Long-lines – larger series of baited hooks requiring only periodic attention.

Class V: Man-Power Instruments

Various instruments, usually manipulated by a single man, which do not fall under any of the above heads, e.g. fish spears.

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PERIODICALS

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World Fishing

Whale Fishery

5

ANCHORS

BY CAPTAIN CHRIS YOUNG, RN

HISTORICAL SUMMARY

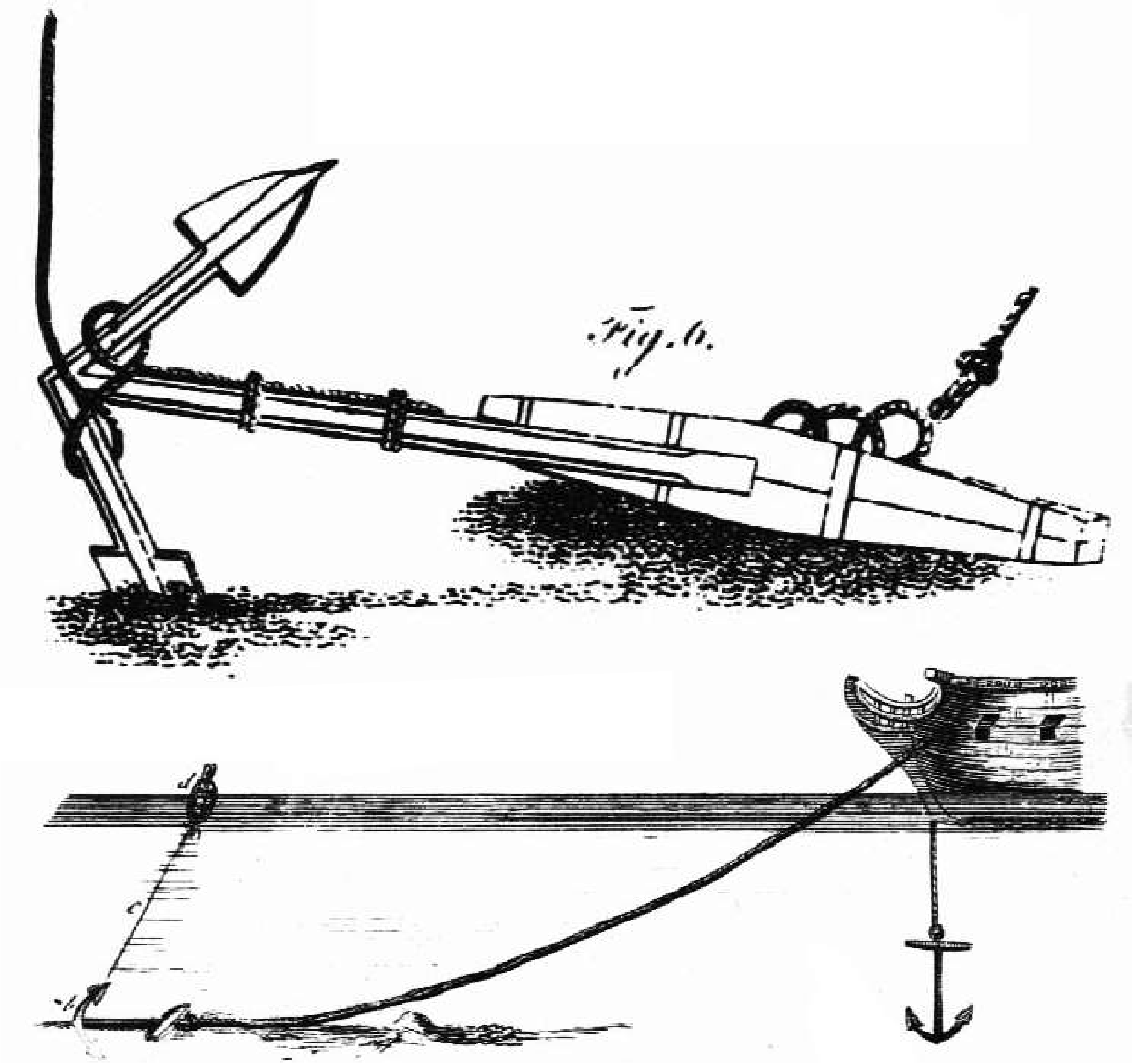
The term anchor embraces a wide range of artefacts, united only by their ability to hold a vessel more or less in one place against the forces exerted by winds and currents. Because of the symbolism inherent in a device on which a ship's safety depends, many of the words associated with anchoring have passed into figurative language, like 'brought up short', 'sheet anchor', 'good holding ground', 'anchor's a-weigh (or away)' and so on. Even 'bill-board' has a claim to originate from the sacrificial timber fastened to the ship's side to prevent damage from the anchor flukes (bills) when the anchor is catted (see below for this arcane procedure).

A primitive stone anchor of a type used in Roman times.
EQS0009 © National Maritime Museum, Greenwich, London

The earliest anchors were simply weights, usually of stone, which by sinking into the sand or mud on the bottom gave a certain amount of holding power. These can still be found in use today in primitive fishing boats (and some not so primitive). They can be of any shape, but must have a hole through which the anchor rope can be fastened, and typically they show the 'weathering' characteristic of an object which has been subjected to abuse by sand and rocks for a long time. Their holding power is not great, which meant the crew had to be ready to row or sail the vessel out of trouble if the anchor or anchors failed to hold. Not surprisingly, better anchors were soon developed. These are based on the idea of a hook which lies on the bottom, and as the pull comes on the anchor rope, the hook bites into the ground and hopefully holds fast. The word 'anchor' comes from the Latin word meaning 'bent'.

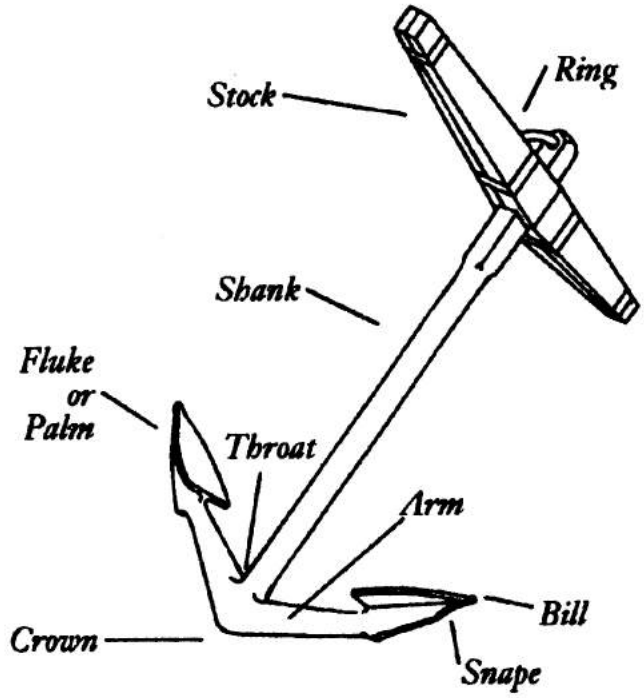
Hooked anchors were much more successful, but their effectiveness depends on a number of factors:

1) The angle at which the anchor rope or cable makes to the bottom, ideally it should pull horizontally so that the hook has maximum effect – this is achieved by making the anchor cable both long and heavy so that its natural catenary shape does the job. Typically a ship will let out a length of cable equal to three times the depth of water for just this reason.

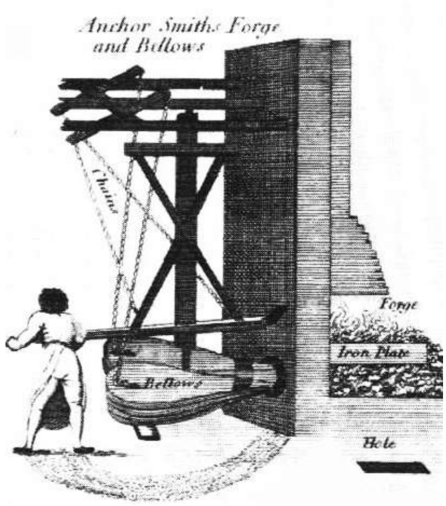


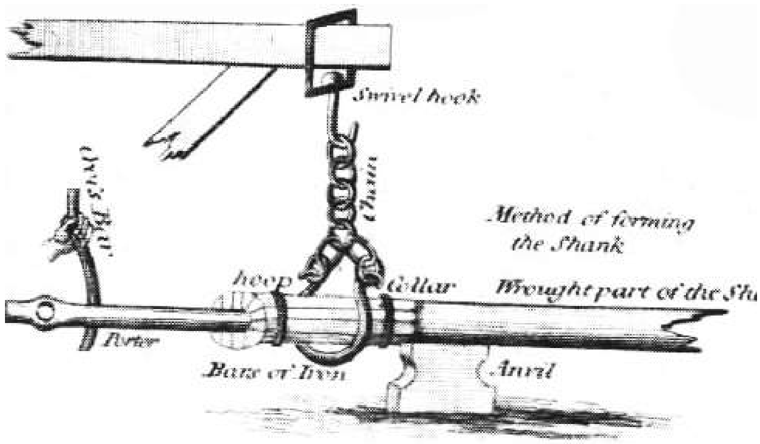
The basic principle of the anchor – one of the flukes buries itself in the sea bottom to hold the ship in position.
From Universal Dictionary of the Marine, by William Falconer 1769

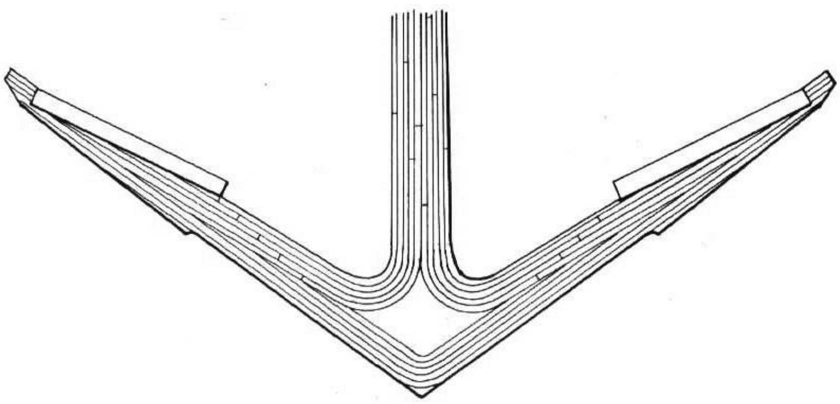
2) Making sure the hook digs in rather than sliding over the ground – there are several ways of achieving this: the anchor may have several blades or 'flukes' around the central stalk or 'shank' so that at least one should eventually bite; or the anchor may have a 'stock', which is a cross-piece attached to the top of the shank at right angles to the line of the flukes so that when it touches the bottom it turns the anchor over to make one of the flukes dig in; or the flukes may be on a swivel so that whichever way they land on the bottom they will quickly be caught and dig in. These anchors are often (oversimply) termed 'Admiralty pattern'.



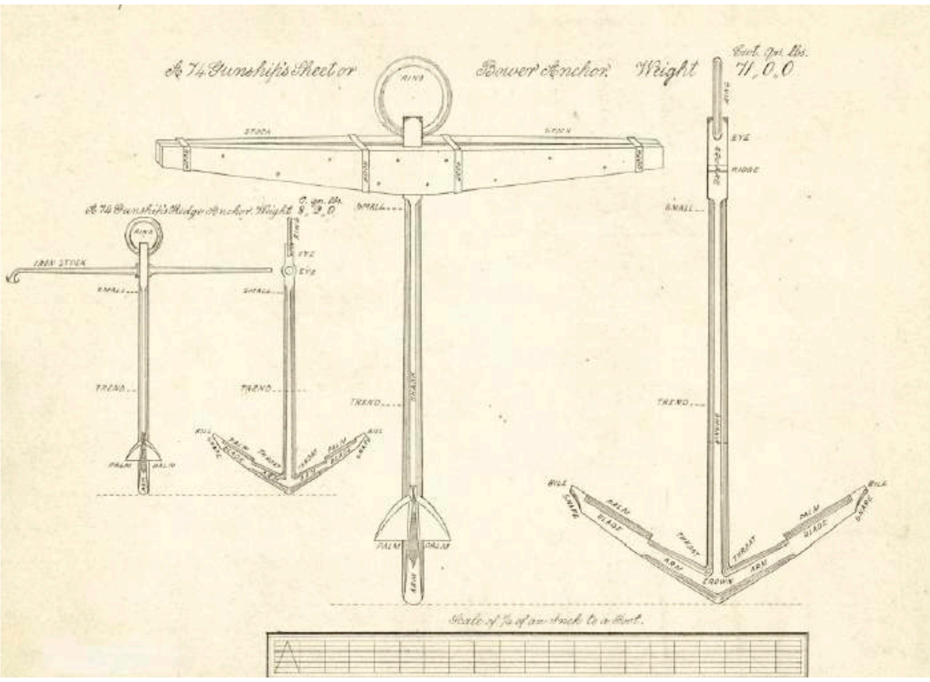
Parts of an anchor
from 'Anchors: an Illustrated History' by Betty Nelson-Curryer, London, 1999







Anchors were made by welding flat strips of metal together, which can sometimes be seen if they rust. The top pictures, from Steel's The Elements and Practice of Naval Architecture of 1805, show parts of the process. The bottom diagram shows methods of fitting the pieces together.

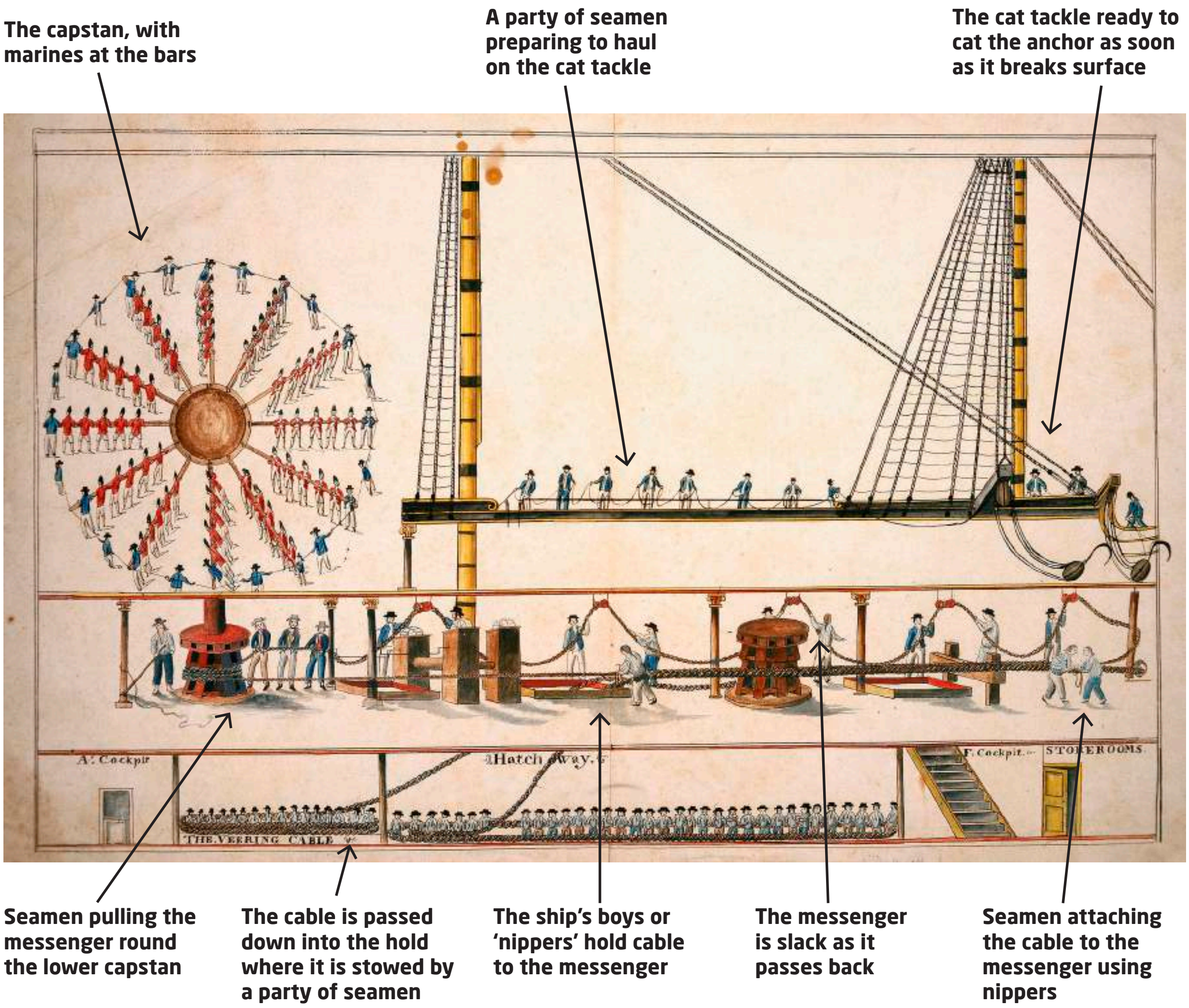


The anchors of a 74-gun ship. It usually had four sheet or bower anchors, all similar in size, plus a smaller 'kedge' anchor which could be put under a boat and laid out some distance from the ship, and a 'stream' anchor.
ZAZ6698 © National Maritime Museum, Greenwich, London

3) Having a big enough anchor – they need to be heavy beasts to avoid the force exerted by winds and currents on the ship pulling them out of the ground. In early days, ships had many anchors (St Paul's shipmates cast out six anchors and prayed for the dawn), but they were also big and heavy. Iron was used from an early stage, and lead was often used to increase weight. Later developments concentrated on the design which gave the greatest holding power for a given weight. Although naval ships had huge crews and could handle heavy anchors, it was a huge job to get up the main anchor, and merchant ships were always keen to find a lighter version that would do the job, at least until powered capstans and windlasses were fitted.

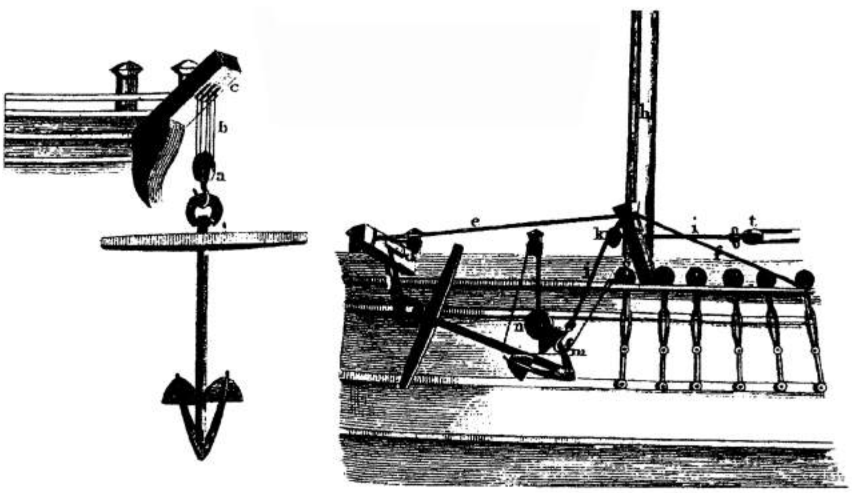
HANDLING THE ANCHOR

Prior to powered capstans and windlasses, getting the anchor up in a sizeable ship was a huge task, involving lots of people and an elaborate procedure. The cable (whether a rope or a chain) was often too heavy to go round the capstan, so the hauling was done on a separate smaller rope, called the messenger, which was attached to the cable with temporary lashings, called nippers. When the nippers got close to the capstan drum, the capstan was stopped while fresh nippers were applied near the hawse pipe. The old nippers were removed, and hauling could restart – a smart crew would hardly notice the change, so that raising the anchor could proceed almost continuously. The anchor became 'a-weigh', i.e., had been weighed, when it was definitely clear of the sea bottom, though in murky waters it was difficult to be sure until it started to show above the surface.



Raising anchor in a sailing warship. The cable itself was too thick to wind round the capstan so a messenger, an endless rope, was attached to it temporarily by smaller ropes known as 'nippers'. In this case the ship is held by two anchors so one group of men is letting out or 'veering' the cable of one of them to allow the other to be taken in.

D4802 © National Maritime Museum, Greenwich, London



'Catting' (left) and 'fishing' (right) an anchor – the cable is not shown for simplicity.

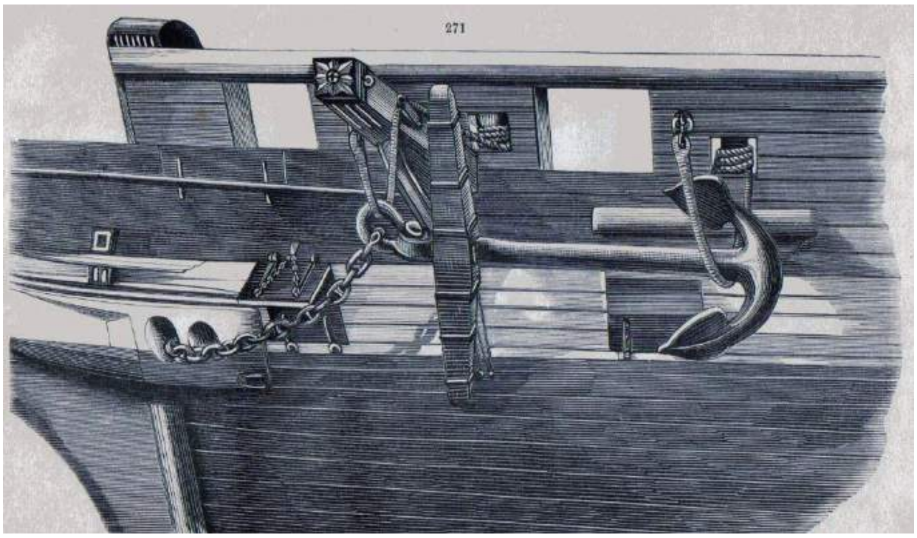
From Darcy Lever's The Young Sea Officer's Sheet Anchor: Or a Key to the Leading of Rigging and to Practical Seamanship, 1819

Once hoisted, the problem was how to stow the anchor tidily and safely until it was needed. Although they might be hoisted onto the deck and lashed down when the ship was out of sight of land for a long period, it was essential to have an anchor ready to be let go at short notice whenever the ship was in coastal or shoal waters. In the sailing ship days with stocked anchors, at least one anchor would be 'catted' at any time when it might be necessary to let go an anchor in a hurry. This meant it was hanging over the ship's side near the bow, with the cable attached. The top of the anchor, where the cable is attached, would be hauled up to the 'cat-head', which was a heavy beam projecting far enough over the side to hold the anchor clear from hitting the hull. The anchor would be allowed to hang down if anchoring was really imminent, but more usually the lower end was hauled up so that the shank was horizontal, with the flukes pulled tightly against the ship's gunwale. In this position it was described as 'fished'. When the ship was in deep water far from land, the anchor would be lifted inboard and lashed on the foredeck, with the cable detached and hauled back into the hawse pipe. A lighter rope was attached to the free end of the cable and left rove through the hawse pipe and back onto the forecastle so that the cable could be hauled back out when it was needed again. Just to confuse, this also was called a 'messenger'.

Stockless anchors were a very popular innovation because they could simply be pulled tightly up against the end of the hawse pipe, thus avoiding the laborious procedures for catting and fishing. These came into their own when improved forging techniques allowed them to be made with flukes which could swivel either way when the anchor touched the sea-bottom and dig in.

In smaller craft other designs became popular, such as the plough-like anchors, typified by the CQR (sounds like 'secure') used by yachtsmen and fishermen.

Anchors are also used for permanent moorings, and fishing gear moorings, sometimes with single flukes.



An anchor catted and fished but ready for release.
From Nares's Seamanship of 1862

ANCHOR NAMES

A large traditional sailing ship had six or more anchors, partly in case the cable had to be cut, for example to leave an anchor behind, when the weather or the enemy dictated a fast getaway, and partly for different uses. The heaviest anchors were called bower anchors, and a big ship would have several. In earlier days there was usually one very large anchor, called the sheet anchor, but this died out. A bower anchor was supposed to be as long as two-fifths of the ship's greatest breadth, or 'beam'. Smaller anchors, called stream anchors, were used for anchoring in a gentle tideway where the heavy bower was not needed. Kedge anchors were quite small, and they were used to haul the ship along when there was no other way of moving her. A ship's boat or boats would carry the anchor out in the desired direction and drop it. The cable would then be hauled in by the ship's capstan until the desired position was reached. If necessary, the kedge was lifted and carried out further by the boat as often as necessary to reach the right spot. It is difficult to imagine a more laborious and snail-like procedure, but it was often a lifesaver.

The number of different patterns is enormous, and beyond the scope of this article. They were often named after the inventor, but some names were more descriptive. The reader is referred to:

- Anchors – an illustrated history – by Betty Nelson Curryer (Chatham, 1999)
- Anchors – by Captain Neville Upham (Shire Books)

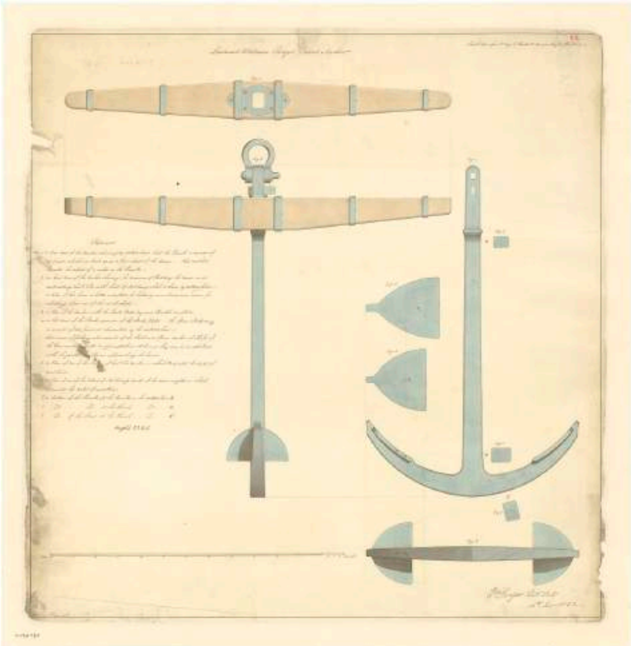
A modern model of a replica of an early 'killick' or small wooden anchor, with lead parts to make it sink.
SLR2057 © National Maritime Museum, Greenwich, London

Admiralty pattern anchor c 1750. Until after 1815, British naval anchors had the pointed crown, as seen here. They also had a wooden stock, which was believed to help operation in certain conditions.
EQS0014 © National Maritime Museum, Greenwich, London

A selection of anchor parts painted by William Payne in 1815
PAD8584 © National Maritime Museum, Greenwich, London

A single-fluke anchor, probably used for a permanent mooring where it could be laid carefully in place.
EQS0015 © National Maritime Museum, Greenwich, London

Another way of making a mooring anchor was to bend down one of the arms so that it was not a danger to shipping passing over it, as shown in this example in Chatham Historic Dockyard. Of course it would be the other way up when in use.
© Brian Lavery, with kind permission of Chatham Historic Dockyard Trust



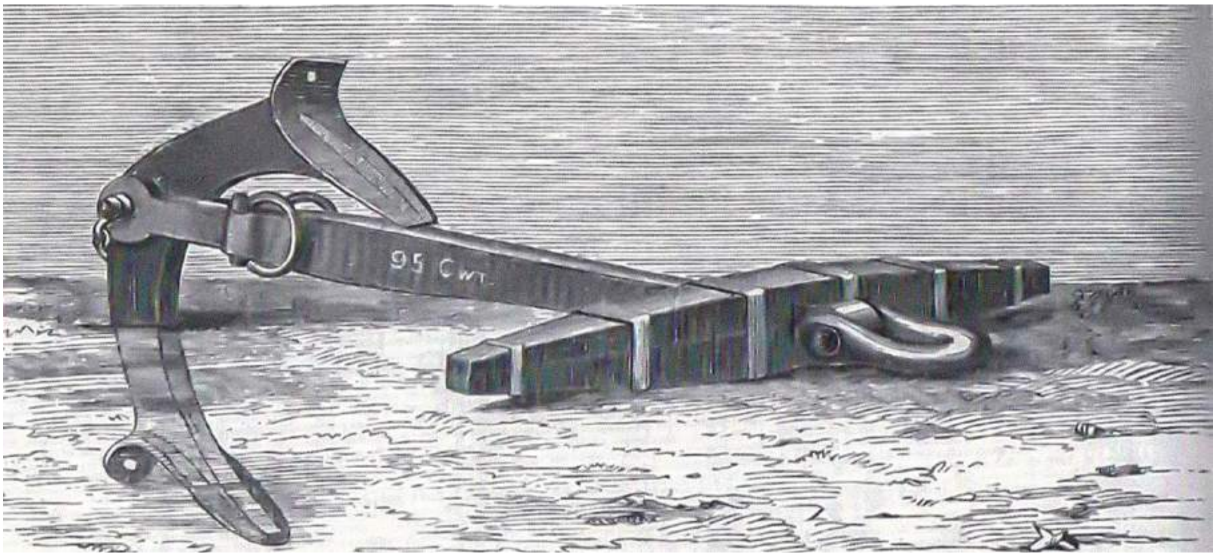
A type of round crown anchor drawn in 1832.

ZAZ6730 © National Maritime Museum, Greenwich, London

Nineteenth-century anchors usually had the round crown which was stronger, and an iron stock. This could be removed to make it easier to stow the anchor. This example Admiralty Pattern Anchor was used on the Royal Yacht Victoria and Albert of 1899.

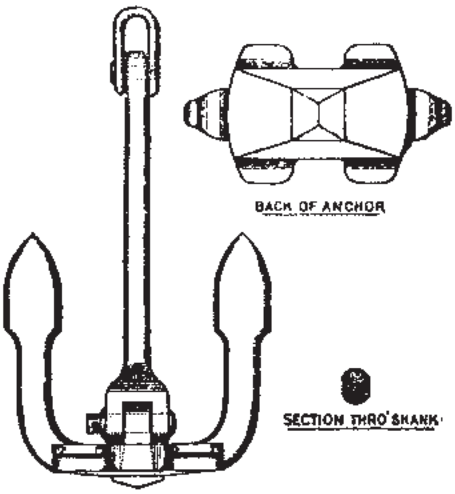
EQS0013 © National Maritime Museum, Greenwich, London

This small anchor has rings near the centre of the shank to help lifting in difficult conditions.
EQS0005/ 6 © National Maritime Museum, Greenwich, London

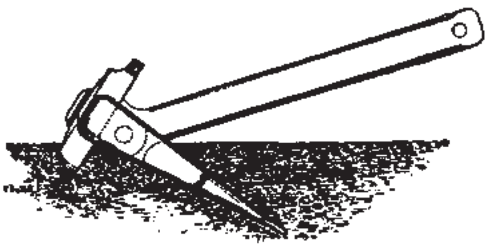


The Trotman anchor, a popular type around 1843 when it was used for Brunel's SS Great Britain.
© ss Great Britain Trust

There were numerous 19th-century inventions for anchors, some of which are shown here in model form.
SLR2870 & others © National Maritime Museum, Greenwich, London



A stockless anchor, the 'Reliant' type of 1890
from 'Anchors: an Illustrated History' by Betty Nelson-Curryer, London, 1999



The stockless anchor of HMS Cavalier, a common type in the 20th century
© Brian Lavery, with kind permission of Chatham Historic Dockyard Trust

The anchor of the nuclear submarine Dreadnought of 1960 was designed to fit onto the shape of the hull.
EQS0188 © National Maritime Museum, Greenwich, London

CONSERVATION

Anchors do not differ essentially from any other stone, timber or metal objects which have been exposed to a marine environment for a long time. Thus the main concerns will be, in the case of wooden elements, replacement of saline water by an inert liquid, and in the case of iron parts, effective anti-corrosion techniques. Most iron parts will be of wrought iron, which presents particular problems, since the repeated folding process used in creating a wrought iron billet creates a coarse lamination, and removing corrosion from the surface of a wrought iron object leaves perhaps several layers of corrosion unseen but active below the surface. Such objects need special techniques such as electrolytic extraction of chlorine ions, or storage in a low-humidity (below 20% RH) environment. Surface preparation of wrought iron needs care – grit blasting can do quite severe damage for instance, and specialist advice on coatings is essential.

ANCHOR CABLES

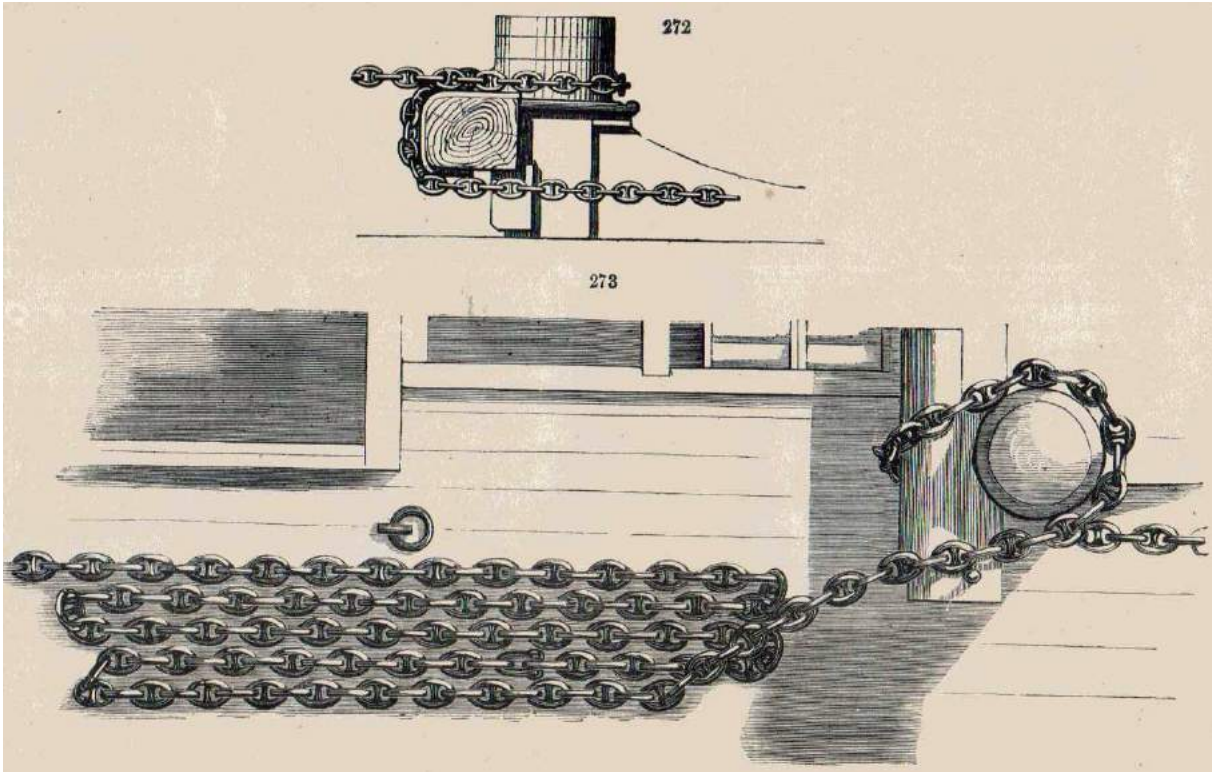
Although the use of chain cable is very ancient, anchor cables were predominantly hemp rope at least until the price and quality of iron suddenly became more favourable at the end of the 18th century. Chain cable was more effective because its greater weight per unit length helped to ensure that the anchor end of the cable lay flat along the bottom and gave the anchor a better chance of biting and holding. Chain was also stronger. One compromise was to use a length of chain attached to the anchor, and then a rope cable for the rest.

SIZES

Anchor cables were of great length – up to 200 fathoms (365m). In describing distance at sea, seamen use the unit of a *cable* to mean 100 fathoms (182m), but this does not mean all cables were this length, it was simply a tenth of a nautical mile (one minute of latitude or about 6080 feet/1850m). Cables were made in a number of lengths. The size of a rope cable was, confusingly, expressed as the girth or circumference, but for chain cables as the diameter of the bar from which each link is made. A common unit of length for chain cable was the *shackle* of 12½ fathoms (23m).

CHAIN CABLE

Very ancient bronze chains have been found, but predominantly they were made of iron and then later steel, usually galvanised (coated with zinc). There were chain cable manufacturers in the main ports, such as Acraman's in Bristol, but the main manufacture of heavy chain for land use became concentrated around Cradley Heath in the Black Country, and they got into the maritime trade in due course. They can be either studded or not. This refers to whether a stud is welded across the middle of each link to give extra strength. Large modern cable is almost all studded, but it becomes less common as you go back through the Victorian era.



The handling of chain cable, from Nares's Seamanship of 1863

An anchor at Chatham Historic Dockyard with its chain cable.

© Brian Lavery, with kind permission of Chatham Historic Dockyard Trust

SPECIAL LINKS

Since chains are made of links individually welded to link with their neighbours, the question arises – how do you join lengths of chain together or to something else, like a ship, or an anchor? Joining to the ship (usually down in the bottom of the chain locker) or to the anchor is no great problem – you just use a shackle (a U-shaped hoop with a pin across the end) of appropriate strength. Joining two lengths of cable to form a continuous chain which will pass, for instance, through a hawse-pipe or over a cable-drum, is more difficult. A joining shackle, or link, is required. There are all sorts of patent designs, but basically it comes in two halves, each of which is hooked through the end link of one of the pieces of cable. The two parts are then united in some cunning way and locked together with a pin or rivet. One more variant is the swivel shackle. Let's say a ship has two chain cables out for extra safety. They will be laid in different directions so as not to get tangled, but as wind and tide change, the ship will swing round, the cables will cross, and you have a real problem. Enter the swivel shackle – at one end it is attached to the two cables, above that is a swivel, and then a shackle attaches it to a single cable leading on board the ship, so that the ship can dance round to her heart's content without tangling the cables. A neat idea, but a miserably laborious arrangement to put in place!

A *foul* cable – this expression does not refer to the smell when pulling up your cable (although it often is) but to the cable being snagged on some obstruction – most often another cable, but it can be anything. This causes a real problem – especially in the days before divers and powered windlasses - and often the only solution was to cut the cable.

HANDLING CHAIN CABLE

Chain cable has a (malevolent) mind of its own and needs methodical handling. Its use on ships required a whole new set of fittings: a cable drum with *whelps* that mesh into the links and make it easier to pull on; cable stoppers and clamps to take the strain of the cable when it is holding the ship against a powerful current or a gale of wind; hoses to clean the cable as it comes in; and reinforcement to take the wear and tear imposed by a moving cable.

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6 NAVAL WEAPONS AND ARMAMENTS

BY CAPTAIN CHRIS YOUNG AND MATTHEW TANNER

IN CONJUNCTION WITH EXPLOSION! MUSEUM

The scope of this topic is huge, but in terms of what is likely to come the way of the average curator the most spectacular weaponry can be disregarded on the grounds that its size makes it unlikely to appear unexpectedly. At the other end of the spectrum hand weapons are mainly the same as those used on land, and therefore outside the scope of this handbook. Exceptions include the cutlass, which was primarily a sailor's weapon, and naval swords, which form a distinct class.

Two words of warning are essential at this stage. First, handling requires specialist knowledge in many cases: apart from the massive size of many objects, they may require careful support. For instance a torpedo is quite weak if slung horizontally. Secondly, one should never wholly discount the possibility that some explosive material may still be present. Substances used as explosives all share the property that they are likely to react with incredible speed and violence to heat or shock, and the older the explosive, the more uncertain its temper. Insignificant devices may be percussion fuses, whose effect is a lot nastier than you realise. Again, specialist help is needed, and indeed may be a legal requirement. You should know how to contact the nearest Ordnance Disposal team, but if you don't, the Police will. The Police can also advise on the comprehensive legal requirements for the storage and display of weapons.

FIREARMS

A sea service pistol of 1790
AAA2427 © National Maritime Museum, Greenwich, London

A standard 18th-century 'Brown Bess' flintlock musket. The naval version was similar to the army one, but more robust.
AAA2545 © National Maritime Museum, Greenwich, London

The Webley Mk1 revolver of 1887
AAA2409 © National Maritime Museum, Greenwich, London

Many firearms and hand weapons are very similar to those used on shore, although Navy patterns of familiar weapons such as the Webley revolver from 1887 are marked with the letter 'N'. The earliest pistols produced for sea use are 14 inch flintlock pistols in the 1730s, but by 1760 the barrel was usually 12 inches. The last flintlock pattern, with a 9 inch barrel, was introduced to the Navy in 1835, thereafter percussion pistols were issued. Muskets intended specifically for sea service appeared from about 1675, and are distinguished by heavy brass furniture (likely not to corrode much in the salty atmosphere at sea), and flat butt plates, designed to sit securely into musket racks against the motion of the ship. Flintlock muskets were superseded by percussion muskets in 1839, and in the following year, the Brunswick rifle was issued. Short versions of well-known rifles were operated by the Navy, until the 20th century, when standardisation in small arms became increasingly necessary. After the First World War, the Navy adopted land service weapons, except for the Lanchester submachine gun, which was copied from the German MP28/II and produced from 1941 exclusively for the Navy.

Presentation swords were often very elaborately decorated, but were rarely if ever used as weapons. This one was given to Captain W H Daniel in 1797.
WPN1554 National Maritime Museum, Greenwich, London. On loan from a private lender

The naval cutlass was a much simpler weapon, issued to sailors for boarding parties, etc. This example dates from around 1800. WPN1287 © National Maritime Museum, Greenwich, London, Royal United Service Institution Collection

Edged weapons were much the same as those used on shore, but chosen and adapted for use by boarding parties and their defenders – these included pikes, halberds, and slashing weapons (axe and cutlass). By the end of the 18th century naval officers generally used three types: the small sword, the 5-ball hilt spadroon, and the curved blade fighting sword. From 1805 swords were regulated. Naval officers retained their swords after they ceased to be of use in hand to hand combat, so these evolved into a dress weapon, losing their curvature and becoming slimmer. Royal Navy uniform swords have a characteristic pommel (often a lion's head) and blade decoration, often with the owner's name engraved on the bracket, which locks the sword into the scabbard. In the 18th and early 19th centuries, successful naval officers were frequently presented with swords by patriotic bodies, and these are often very elaborate and fine. *Lloyd's Patriotic Fund* swords were established in 1803.

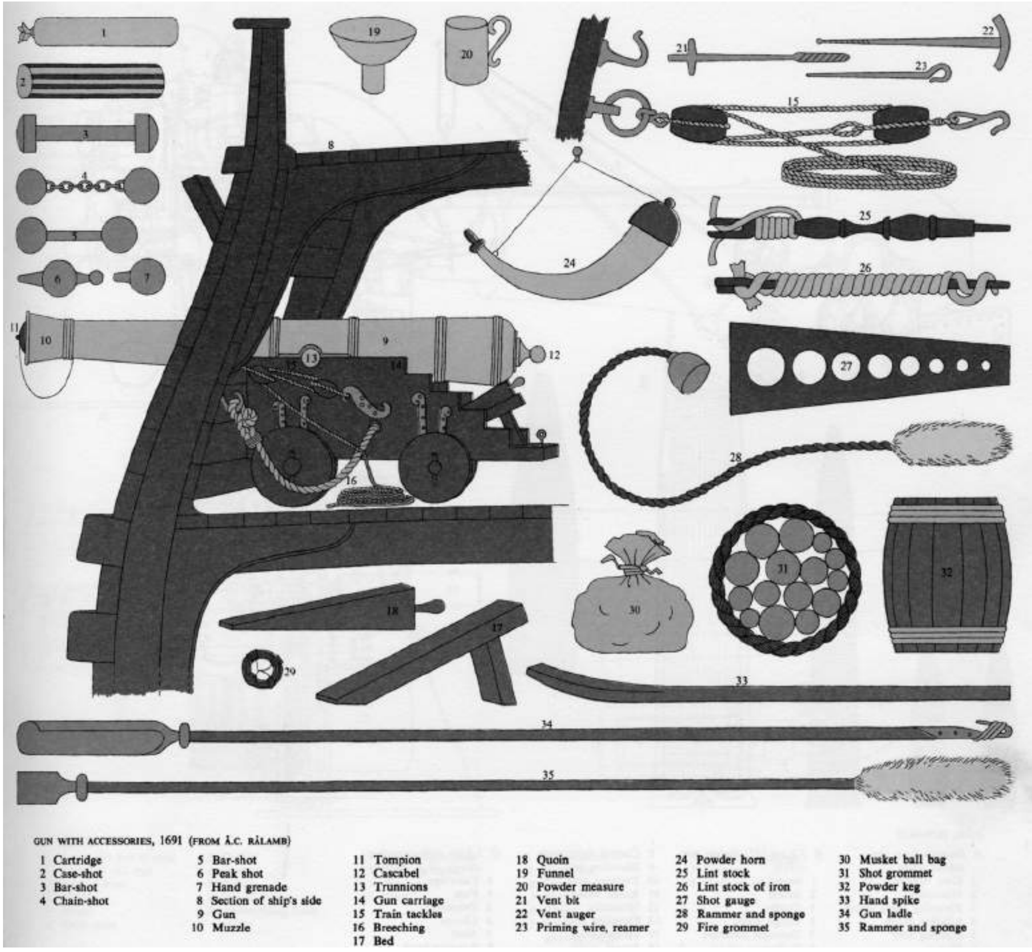
The ship's crew used weapons distributed from store before a battle. The first regulation cutlass was issued in 1804, with a long straight blade and a black iron hilt with a circular shell and a circular guard. The cast iron grip became leather in 1900, and the cutlass was not withdrawn until 1936.

NAVAL GUNS

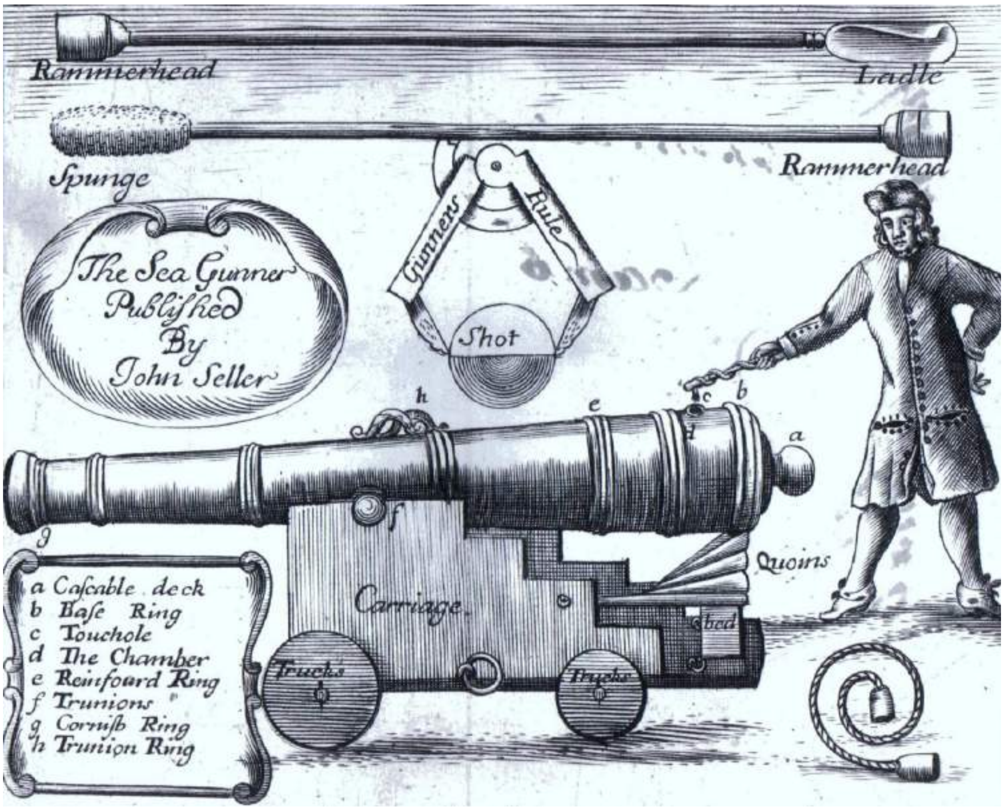
Cannon were developed from the beginning of the 14th century in various forms. They were usually muzzle loaded, although lightweight guns could use interchangeable iron breeches into which the gunpowder and shot were loaded. Due to the difficulty of sealing the breech effectively larger guns remained muzzle-loaded until the middle of the 19th century, when sophisticated breech-loading guns came into use. Projectiles could be almost any hard substance, but stone and iron balls predominated. The gunpowder propellant was rammed into the barrel from the muzzle, followed by the projectile, and the gun was fired by lighting the propellant through a touch hole in the barrel. The gun was mounted on a low-wheeled carriage, which allowed it to be manhandled around inside the ship. This carriage also allowed the gun to recoil when the shot was fired, but the recoil was limited by the thick rope purchases, which held the gun to the side of the ship. The gun crew used distinctive tools to ram in the propellant charge and the projectile, and to clean out the barrel after each shot. Cannons were made of bronze ('brass') alloys and wrought iron, until cast iron came to predominate. The major collection in the United Kingdom is in the Royal Armouries at Leeds and the Tower of London. There is a bewildering variety of names, some of which are given below (c.f. *The Oxford Companion to Ships and the Sea,* P.K. Kemp, 1976):

FOR THE 15TH AND 16TH CENTURIES

- Whole cannon – calibre (inside diameter of barrel) about 18cm, shot about 20 kilos
- Half cannon – calibre about 15cm, shot weight about 15 kilos
- Culverin – longer barrel relative to calibre, gives greater range
- Culverin – calibre c.13cm, shot 7.8 kilos, barrel 2.5-4 metres
- Demi culverin – calibre c. 10cm, shot 4 kilos, barrel up to 3.5 metres
- Saker – calibre 75mm, shot 2.5 kilos, barrel up to 3 metres
- Minion – calibre also 75mm, shot c.2 kilos, barrel up to 3 metres
- Falcon/Falconet – shot 1-1.5 kilos (falcon), 0.5-1.0 kilo (falconet)
- Perier or Cannon perier – short barrel firing medium sized stone shot, e.g. 20cm calibre, 11 kilo shot, 1.5 metre barrel, giving a range of some 1500 metres, as against 2200 metres for the culverin.



A gun with its accessories, c 1691

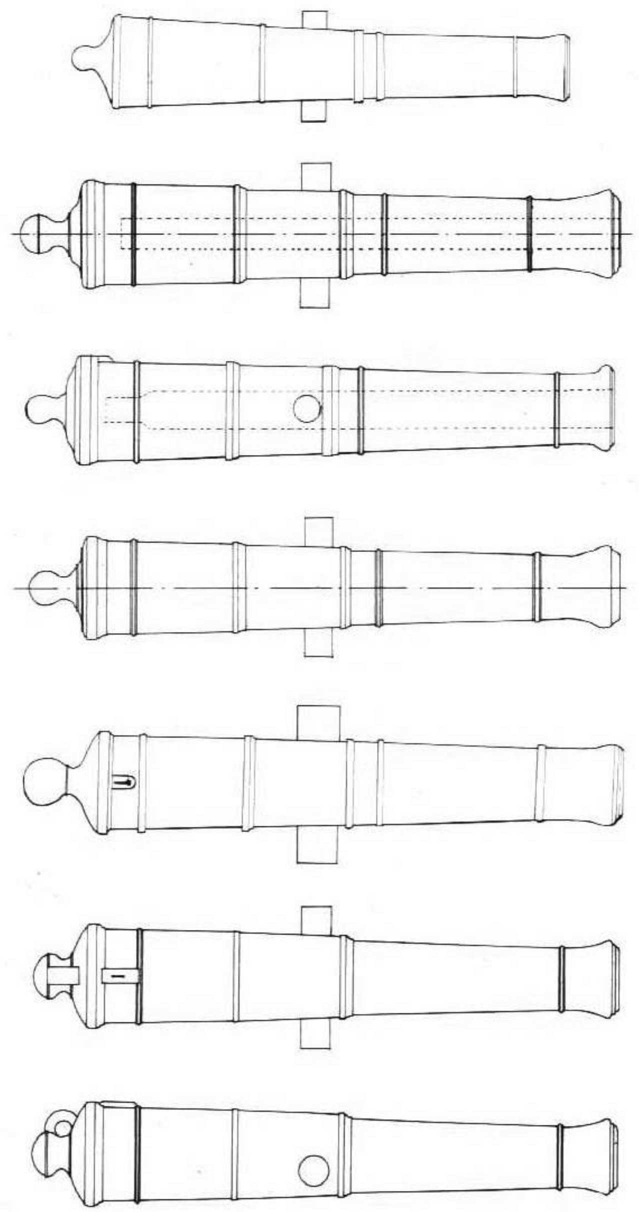


The title page of John Seller's The Sea Gunner of 1691 shows a cannon of the time and a number of the implements in use. It was important to check the size of shot to prevent jamming, hence the 'gunner's rule'.

18TH AND 19TH CENTURIES

- Gun – most smooth bore muzzle-loading cannon are named for the weight of shot they could fire e.g. ‘24-pounder gun’. However, the size of shot and the local units of measurement within which the guns were made vary very widely;
- Drake – a lightweight smooth bore gun with a conical chamber;
- Mortar – very short barrel indeed, firing many small objects (metal or stone) or a larger shot lobbed up at high elevation to fall vertically onto the target;
- Carronade – very short light gun of medium calibre using a small propellant charge to fire a large projectile against soft short range targets.

A junior relative of the cannon is the signal gun, often in bronze, which is still in use for starting yacht races, and looks very like a miniature cannon, and may have a similar carriage.



A gun recovered from the Edgar, lost in 1711

A typical Armstrong pattern 32-pounder, of a type in use from 1725–90

A light 32-pounder as proposed in 1753 – there is no evidence that they were manufactured in any quantity

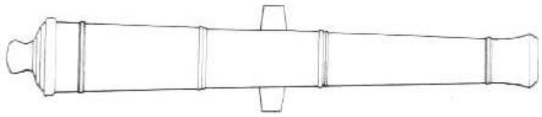
A 9ft long 32-pounder c 1770

A 9ft 6in 32 pounder from the Royal George, lost in 1782

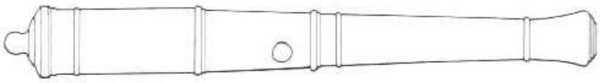
A Blomefield pattern gun with a ring on the breech, a type which became standard from about 1790

Stages in the development of the 32-pounder, formerly the demi-cannon, the standard lower deck gun of large warships for most of the 18th century.

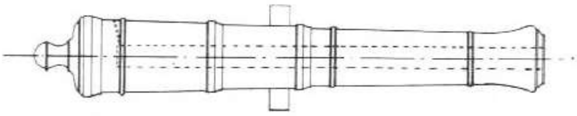
© Brian Lavery



An iron demi-culverin of 1680 from the wreck of the Dartmouth

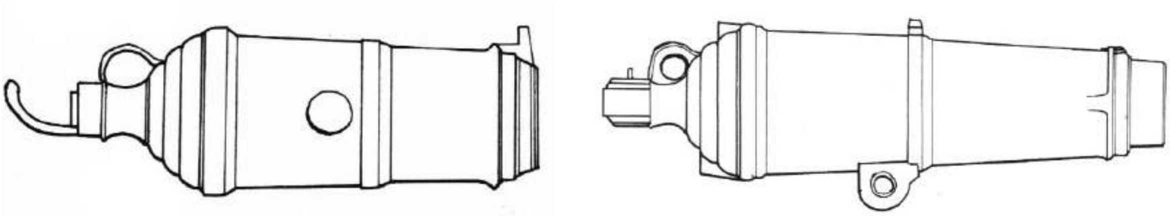


A 9-pounder of 1716

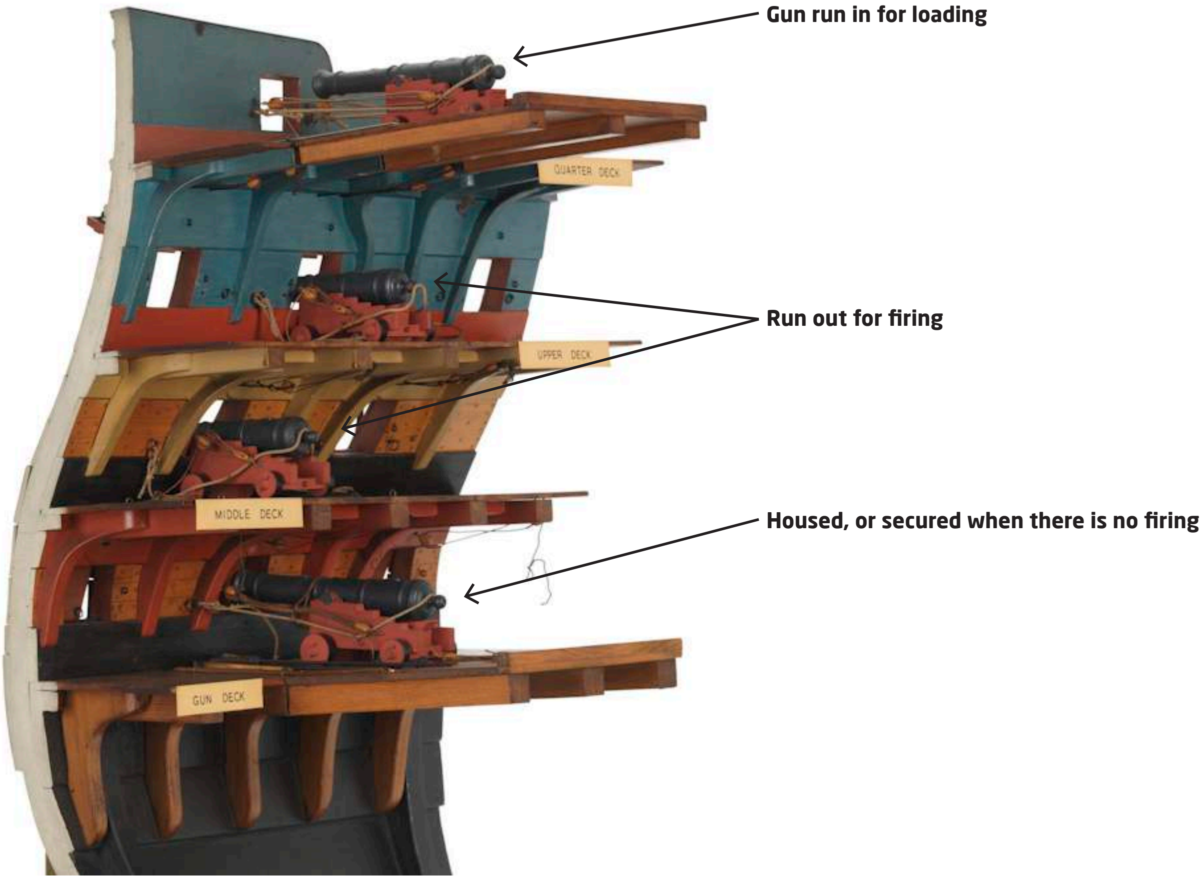


An Armstrong pattern 18-pounder, 7ft 6in long, of a type used between 1725 and 1790

The demi-culverin, a common type in the early days of sea artillery, became the 18-pounder.
© Brian Lavery

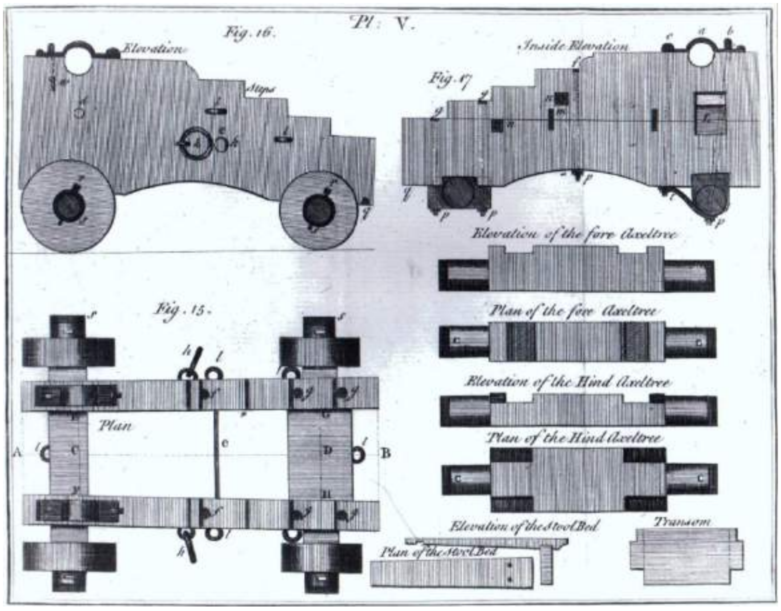


The carronade was a short gun with up to four times the charge of a normal cannon, developed in the Carron Iron Works in Stirlingshire. It proved decisive in short-range battle and was mounted on the forecastles and quarterdecks of most ships. The early version, c 1780, is shown on the left. The later version, from about 1790, was a more radical design.



Guns in different positions on a model of the Royal George of 1756.
SLR0495 © National Maritime Museum, Greenwich, London

Guns dug up after being used as bollards in Chatham Historic Dockyard.
© Brian Lavery, with kind permission of Chatham Historic Dockyard Trust



The parts of a gun carriage, mid 18th century
© National Maritime Museum, Greenwich, London

The rounded part or cascable of an Armstrong pattern gun
© Brian Lavery

The Blomefield pattern gun, standard during the wars of 1793-1815, had a simplified shape and a distinctive ring above the cascable.
© Brian Lavery

The crest on a late-18th-century gun. The '3' indicates the reign of George III (1760–1820).
© Brian Lavery

Number 3

Locks similar to those used on muskets were often fitted to naval guns from about 1780.
© Brian Lavery

A 110-pounder gun, HMS Warrior of 1860. It was made in several parts and was breech-loading. However, it was too far ahead of its time and did not work well.
© Warrior Preservation Trust

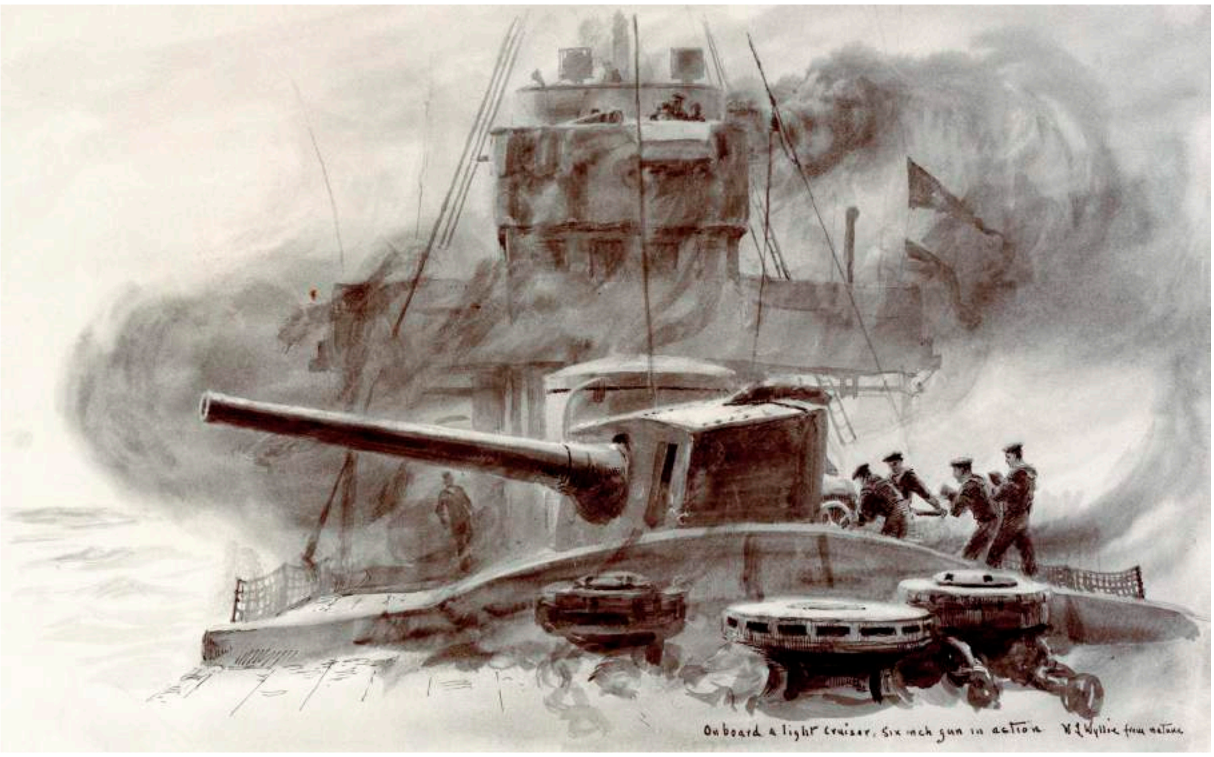
Guns became much bigger and longer, of iron at first, and then steel. They were developed to fire explosive projectiles, and the bore was fitted with spiral 'rifling' to impart a spin to the projectile in order to increase its accuracy and range. Some barrels had miles of wire wound round the inner tube, and then an outer tube was heat shrunk on top of the wire – others were made by heat shrinking successive steel tubes on to the inner barrel. Their mountings became very solid and strong, and the whole became protected by armour in a fixed barbette, and later this evolved into the hydraulically-powered revolving gun turret. Small guns made a comeback as a defence against aircraft, often with multiple barrels and a high rate of fire. The largest guns had explosive shells separate from the propellant charges (the latter in a silk bag). Guns below 150mm calibre usually had a combined shell and cartridge, and the brass cartridge cases are often found as souvenirs, or sometimes just the base of the cartridge was turned into a heavyweight ashtray. These guns were called 'quick firing' (QF), as distinct from the larger guns, which were designated 'breech-loading' (BL). QF cartridge cases often had a percussion striker in the base, and it is wise to check this is inert. The larger BL guns often had plugs decorated with a ship's badge called tampions which were placed in the end of the barrel to stop the inside rusting when not in use. These are very desirable collector's items. In the case of breech-loading and 20th century weapons, the primary source of help is the Naval Armaments Museum, Explosion!, at Priddy's Hard, Gosport, Hampshire.

A 4.7 inch naval quick-firing gun installed on the remote island of St Kilda just before the end of the First World War to deter German U-boats.

© Brian Lavery

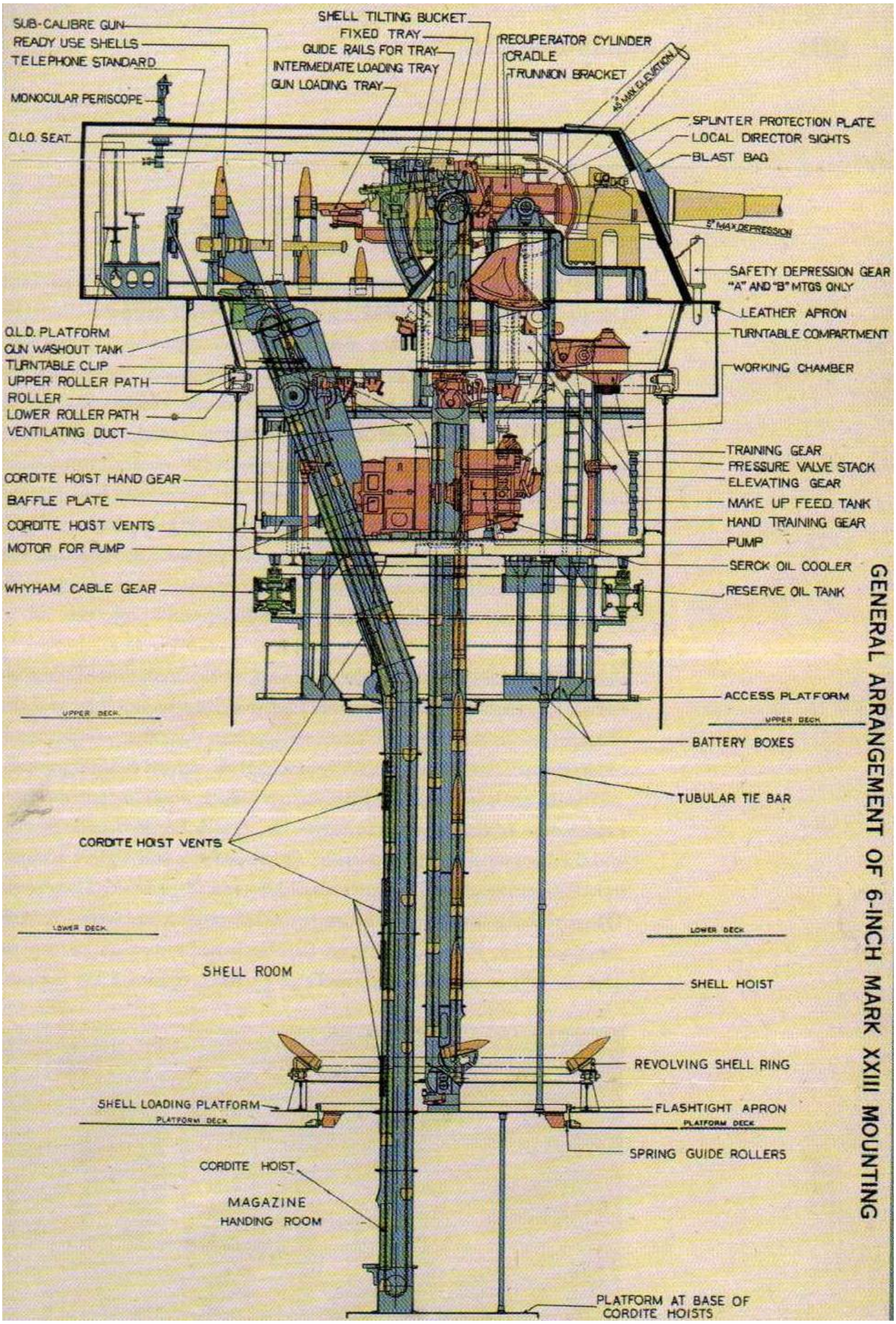
A model of a 12-pounder quick-firing gun of 1896. Guns like this were intended to fight off torpedo attack.

SLR2990 © National Maritime Museum, Greenwich, London



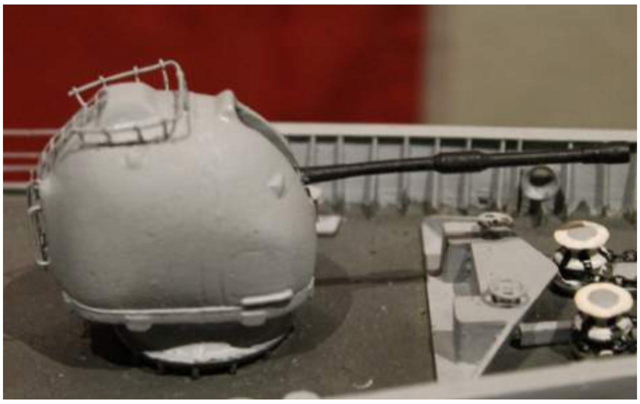
A 6 inch gun in a shield light cruiser during the First World War.
'On board a light cruiser, six inch gun in action', drawn by W L Wyllie, 1915-18
PAF1840 © National Maritime Museum, Greenwich, London

A model of a 4.7 inch quick-firing gun from a destroyer of 1916–17. These guns were the main gun armament of the ship, apart from its torpedoes.
SLR2932 © National Maritime Museum, Greenwich, London



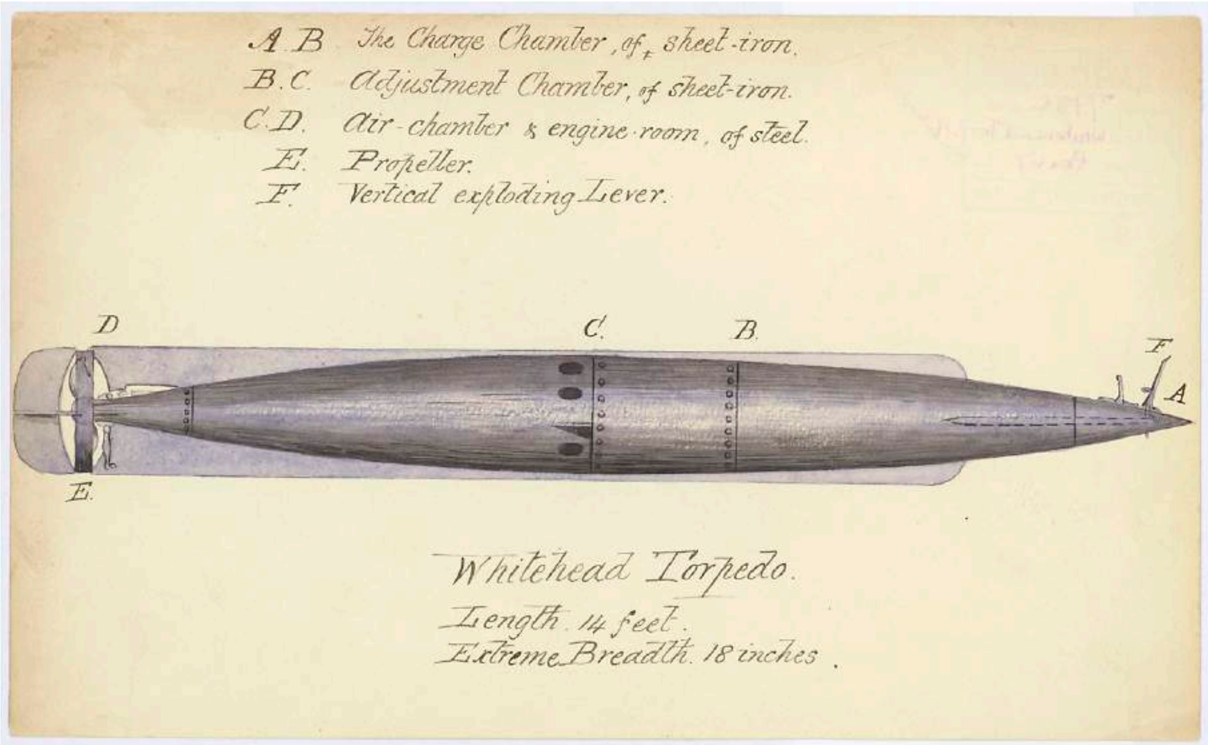
By the 20th century, the equipment of a major gun turret was very complex. This shows the 6 inch turret, as can still be seen on HMS Belfast in London.

from The Gunnery Pocket Book, 1945



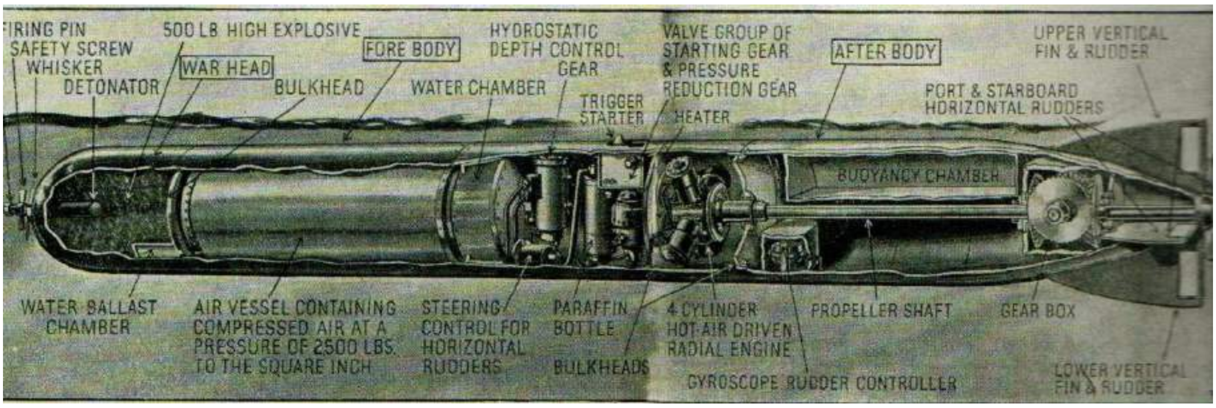
The 4.5 inch gun of a late-20th-century frigate or destroyer.
© Brian Lavery, with kind permission of Chatham Historic Dockyard Trust

TORPEDOES

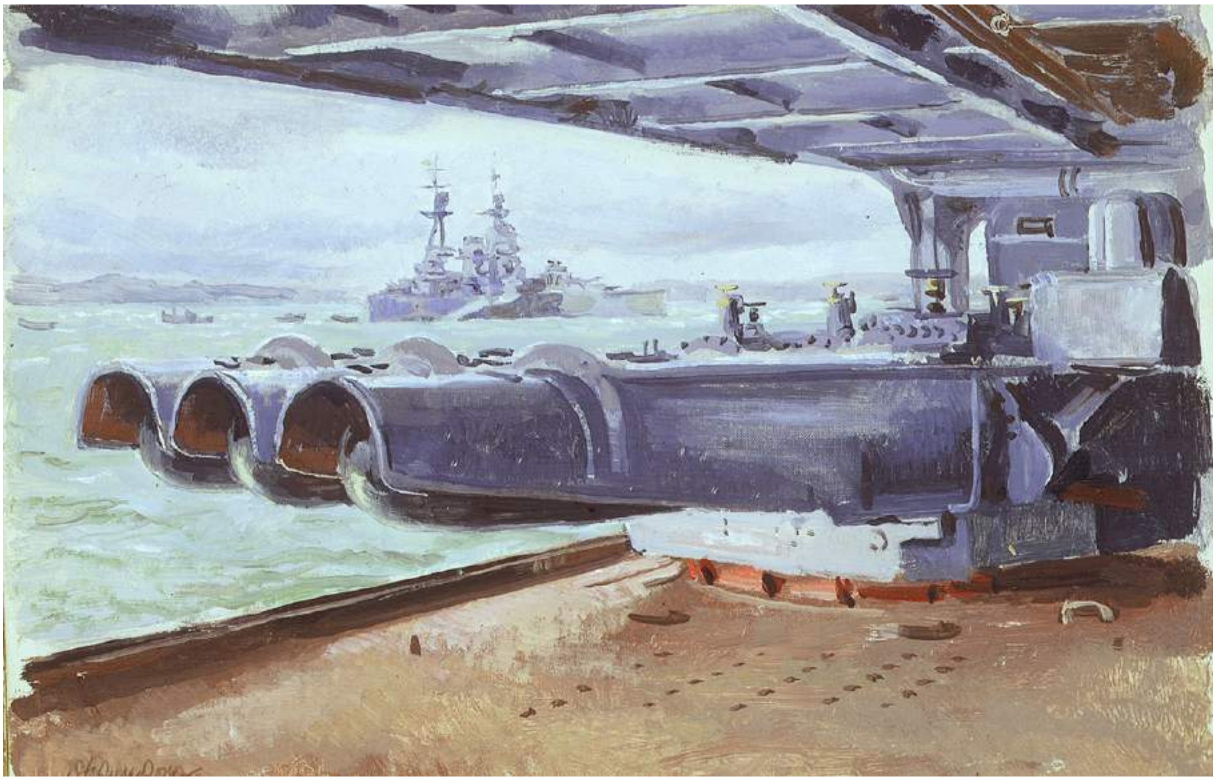


An early example of the type designed by Robert Whitehead in 1866, with the cigar shape that was common at the time.
ZAZ7020 © National Maritime Museum, Greenwich, London

A model of the straighter type of torpedo used c 1910 - the Royal Gun Factory Mark V torpedo
SLR2961 © National Maritime Museum, Greenwich, London, Phipps Hornby Collection



The interior of a torpedo, c 1938
from 'Britain's Glorious Navy', by Admiral Reginald Bacon, Odham's, 1942



Torpedo tubes on a World War II cruiser, 'HMS Rodney viewed from behind a cruiser's torpedo tubes', oil on canvas, by Stephen Bone.
BHC3587 © National Maritime Museum, Greenwich, London

Although a number of weapons intended to deliver an explosive charge against the underwater hull of a ship are recorded from early times, the modern torpedo dates from the 1860s. It quickly developed into a highly complex weapon (of varying effectiveness) which played a major part in the wars of the 20th century. They range from air dropped torpedoes, perhaps 2 metres long, to ship and submarine weapons over 6 metres long and 1.5 tonnes in weight. The head contains a large explosive charge, but some are test or practice weapons with an inert head. Many modern torpedoes have a homing mechanism which may be based on sensors in the head, and there is some kind of fuse arrangement for exploding the warhead. The after end usually contains the propulsion system, which can be of several types, and a buoyancy chamber. In between is the fuel system and the control equipment for maintaining the torpedo's course and depth. For its power, the torpedo is quite a flimsy weapon, and great care should be taken if lifting it in the horizontal position, particularly if it is in less than mint condition.

MINES

A model of a contact mine with its sinker underneath. When released the mine will float to just below the surface of the water. The horns which will cause it to explode look like spikes.

SLR2964 © National Maritime Museum, Greenwich, London

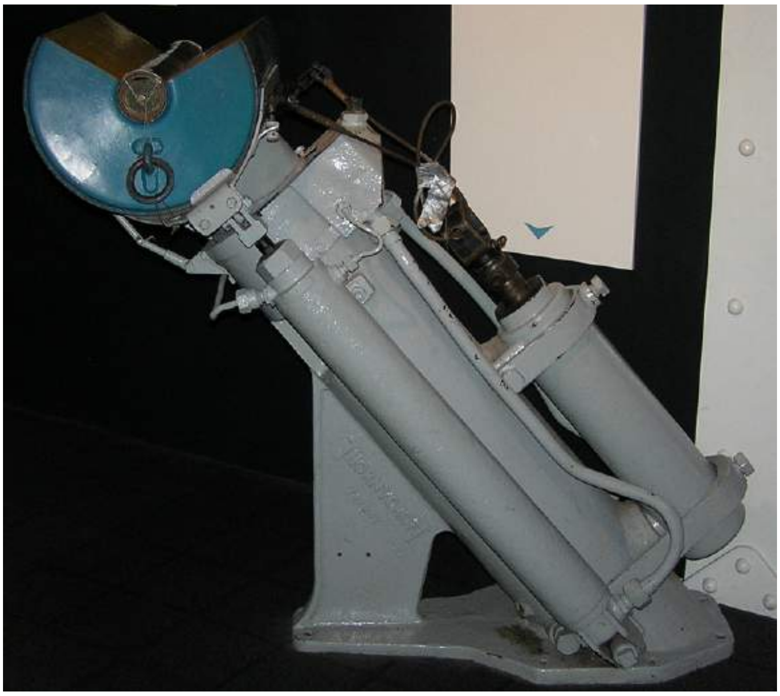
A contact mine

© Brian Lavery, with kind permission of Chatham Historic Dockyard Trust

Minesweeping has been a major commitment of the Royal Navy since the First World War. In this 1943 picture by Leslie Cole the seamen are handling an Oropesa sweep, which keeps up the outer end of the wire used for sweeping.
PAI0548 © National Maritime Museum, Greenwich, London

Mines come in many sizes and varieties. The-red painted globular horned mine (familiar in many seaside places as a converted RNLI collection box) is a First World War example, but other mines were exploded by impact, magnetic influence or acoustic signal, with increasing sophistication up to the present. They were frequently buoyed at a predetermined depth below the surface, in which case they were attached by a mooring wire to a sinker weight which formed part of the mine when it was laid (over the stern of a ship or from a submarine torpedo tube or from an aircraft). The whole assembly sank to the bottom, the mine then rose until a pressure switch indicated that it had reached the desired depth, at which point the mooring line was locked. Any mines acquired from official sources will have a 'Free from Explosives' certificate.

ANTI-SUBMARINE WEAPONS

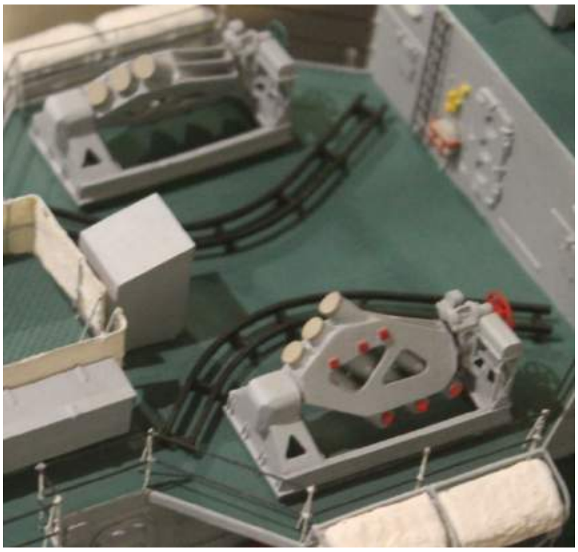


A Mark IV depth charge thrower from the Second World War, with a sectioned charge on top of it. Charges could simply be dropped over the stern, but the thrower allowed a greater spread.

KTP0015 © National Maritime Museum, Greenwich, London

The effect of dropping depth charges. 'Destroyers dropping depth charges', oil on canvas, 1942-44, Norman Wilkinson. BHC1591

© Norman Wilkinson Estate from collection at National Maritime Museum, Greenwich, London



The 'ahead throwing weapon', Squid, on the destroyer Cavalier, as in real life and on a model.
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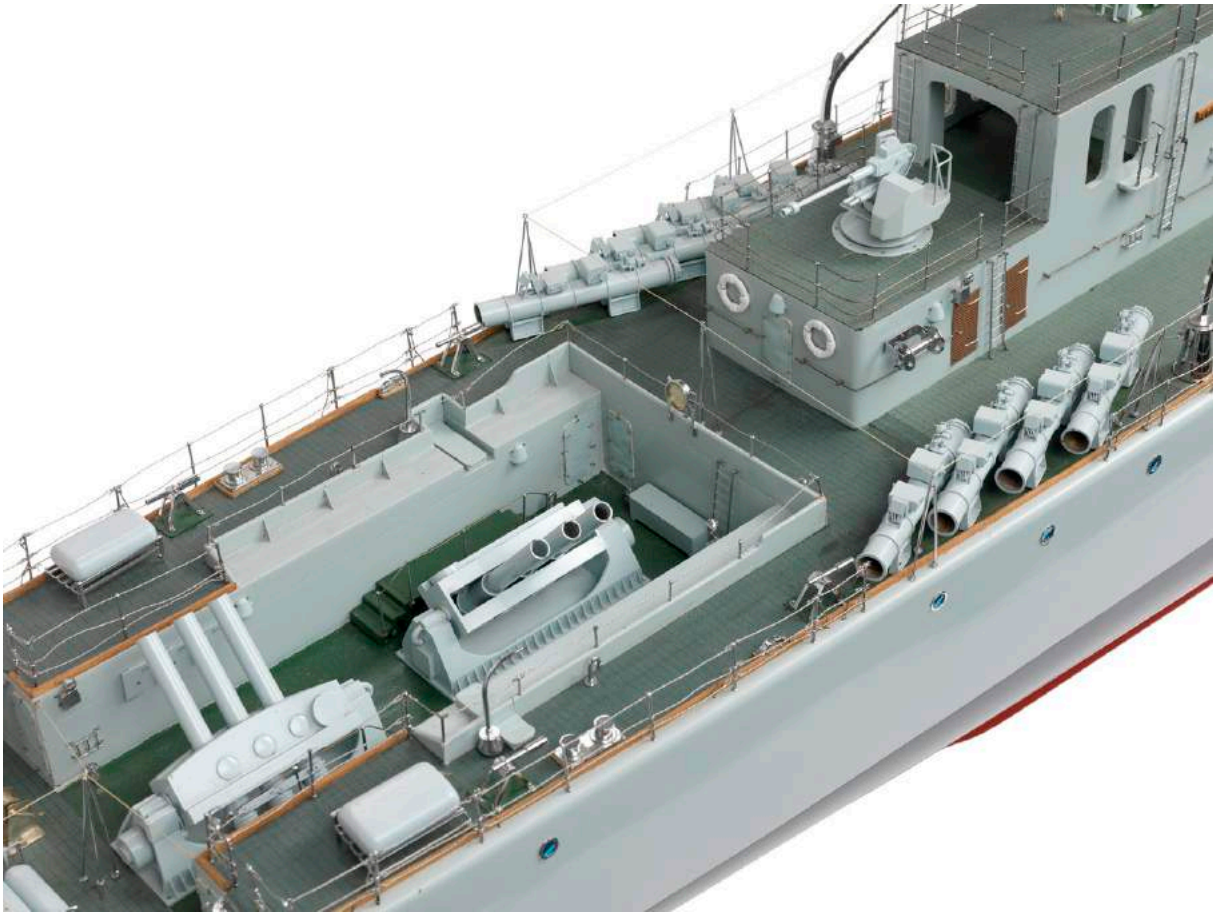


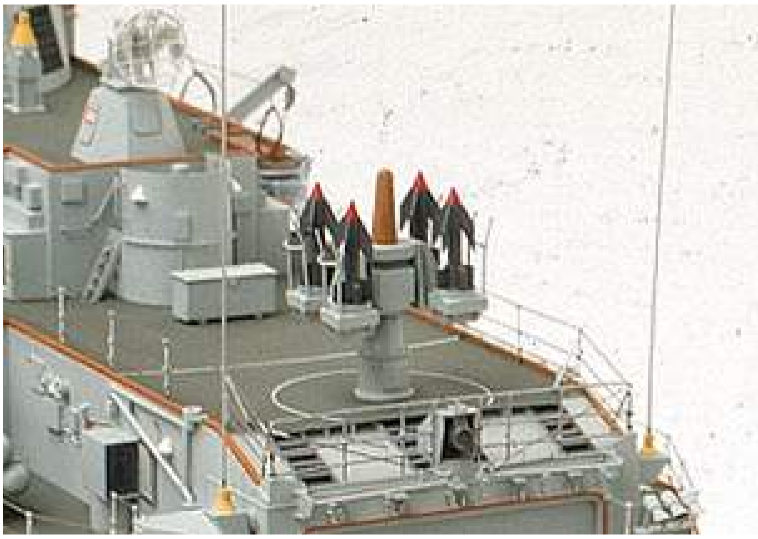
Ahead throwing weapons, a pair of three-barrel Limbo mortars on the frigate Londonderry of 1960. They could throw a pattern of six depth charges ahead of the ship.
SLR1707 © National Maritime Museum, Greenwich, London

For most of the First and Second World Wars, the depth charge was the standard anti submarine weapon. Basically it consists of a barrel shaped bomb, rolled off the stern of a ship, with a depth switch set to explode at the desired depth. By the end of the Second World War these were being supplemented by spray patterns of smaller multiple weapons, which could be thrown ahead of the ship hunting a submarine, using a mortar type launcher. In the later 20th century development of the acoustic homing torpedo made it the main weapon against submarines.

MISSILES

A model of the frigate Cleopatra in 1977, fitted with launchers for four Exocet anti-ship missiles and a quadruple launcher for Seacat short-range anti-aircraft missiles.
SLR1724 © National Maritime Museum, Greenwich, London

Exocet launchers just forward of the bridge on the frigate Jupiter in 1984, with six launchers for the Seawolf anti-aircraft missile just ahead.
© Brian Lavery



The after Seacat launcher in the frigate Alacrity of 1974

SLR1749 © National Maritime Museum, Greenwich, London. Reproduced with kind permission of John R. Haynes, Fine Ship Models

The Seacat launcher on Cavalier

© Brian Lavery, with kind permission of Chatham Historic Dockyard Trust

The Sea Dart long-range anti-aircraft missiles on HMS Sheffield of 1971

SLR0079 © National Maritime Museum, Greenwich, London

From the 1950s guns were largely superseded by missiles in the world's navies, and some of these will find their way into museum collections. The range is so wide that expert advice is needed, but the usual caveat about ensuring that explosive devices and material are not present applies. Naval missiles range from 1 metre in length to the massive Trident ballistic missiles. The mix of materials used in these complex weapons means they present difficult conservation problems.

ROCKETS AND PYROTECHNICS

The idea of a rocket attack is not new. These boats, designed by William Congreve, were used to attack positions on French-held coastlines, as in this picture of 1814.
Detail of PAH7443 © National Maritime Museum, Greenwich, London

Rockets and incendiary devices known as 'Greek Fire' were used from the early middle ages to set fire to an enemy's sails and rigging and to spread general fear. Occasionally 16th-century ceramic incendiary grenades are found in maritime archaeological contexts.

Rockets came into general use as distress signals, with a flare carried to perhaps 500 metres height by the rocket. The flare then drops slowly on a parachute. Hand-held flares are also common. All pyrotechnics are clearly marked to indicate their nature, and should be treated with the greatest caution.

A Schermuly pistol
AAA3125 © National Maritime Museum, Greenwich, London

Rockets and mortars from 19th-century life-saving equipment are frequently found. A common survivor is the Schermuly line-throwing rocket gun (and sometimes a rifle) used to fire a line from rescuers on shore to a ship in distress.

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7 MARINE ENGINES

BY DENIS GRIFFITHS, LECTURER IN MARINE ENGINEERING, FORMERLY JOHN MOORES UNIVERSITY, AND MATTHEW TANNER

Marine engines may be for propulsion or for driving auxiliaries such as generators and pumps (winches and windlasses may also fall into this category but they are covered in the section on ship's fittings).

Engines may be steam or diesel and each category will be considered separately. Steam engines require a boiler plant and that will be covered after steam engines.

In many respects engines for propulsion purposes and for driving auxiliaries are similar, but the propulsion plant is usually larger. Naturally the size of the engine will differ with the size of the ship and the power requirement for driving the ship or powering the auxiliary machinery.

'The Charlotte Dundas' by JC Bourne and CF Cheffins.

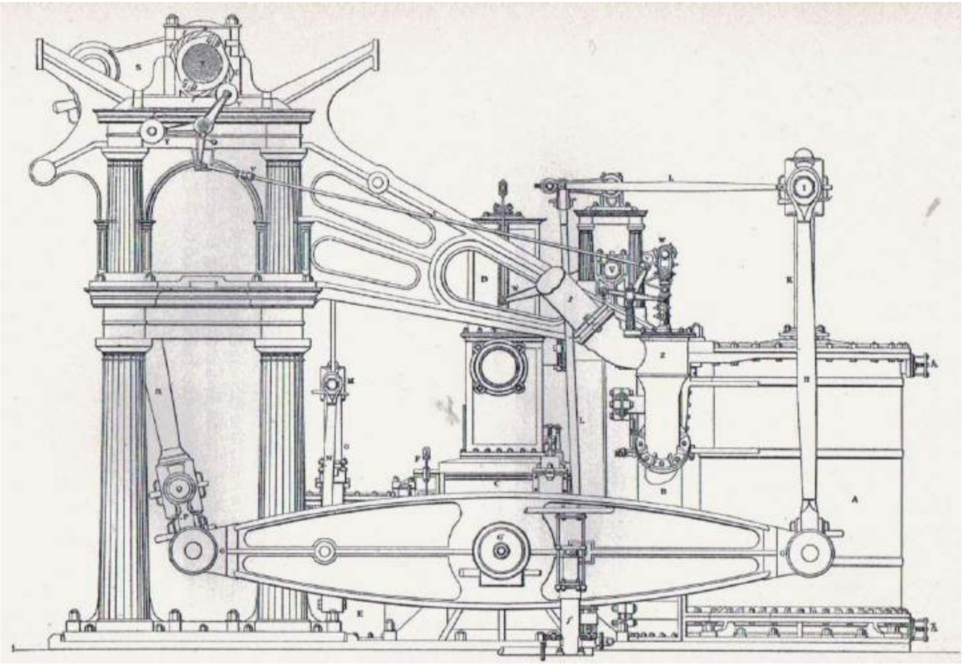
The Charlotte Dundas was trialled with a steam engine on the Forth and Clyde Canal in 1801, but rejected because of fears that it would erode the banks. Eleven years later, Henry Bell's Comet operated successfully on the River Clyde.

PAD6630 © National Maritime Museum, Greenwich, London

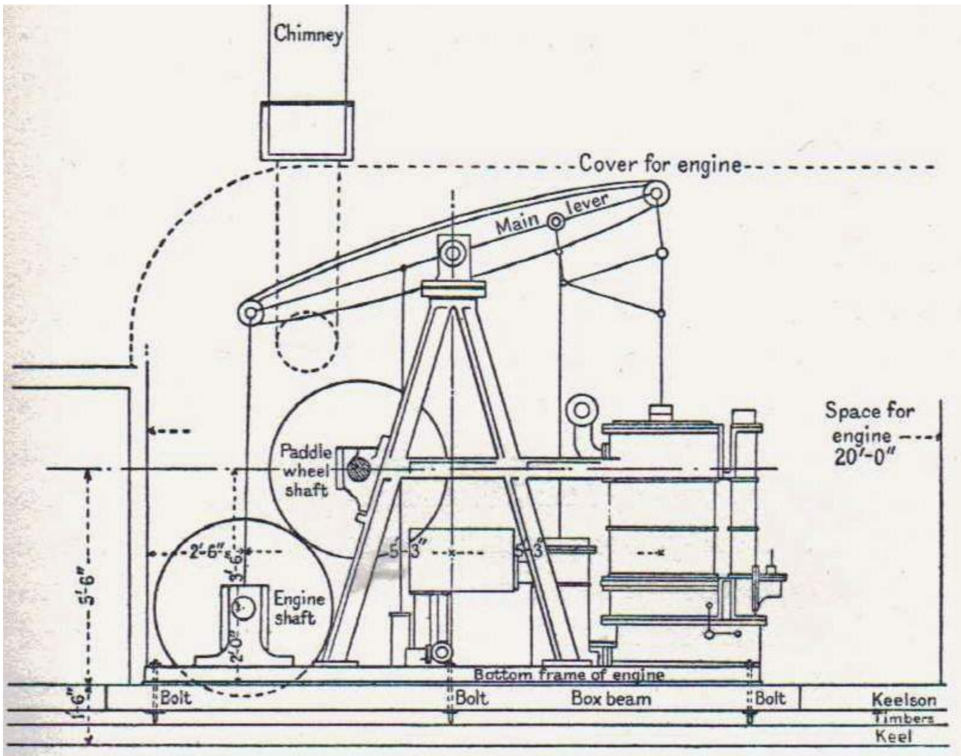
STEAM ENGINES

Steam engines may be of the reciprocating type or the rotary type. Reciprocating steam engines for ship propulsion were introduced in the late 18th century and the first engines were based on land pumping engines; early steamships were driven by paddle wheels and the engines were adapted to suit this form of propulsion. Rotary engines are turbines and they were introduced for driving marine dynamos in the late 1880s and for ship propulsion early in the 20th century.

STEAM PROPULSION ENGINES (PADDLE)



A side lever engine
from A Short History of Naval and Marine Engineering, Cambridge, 1937

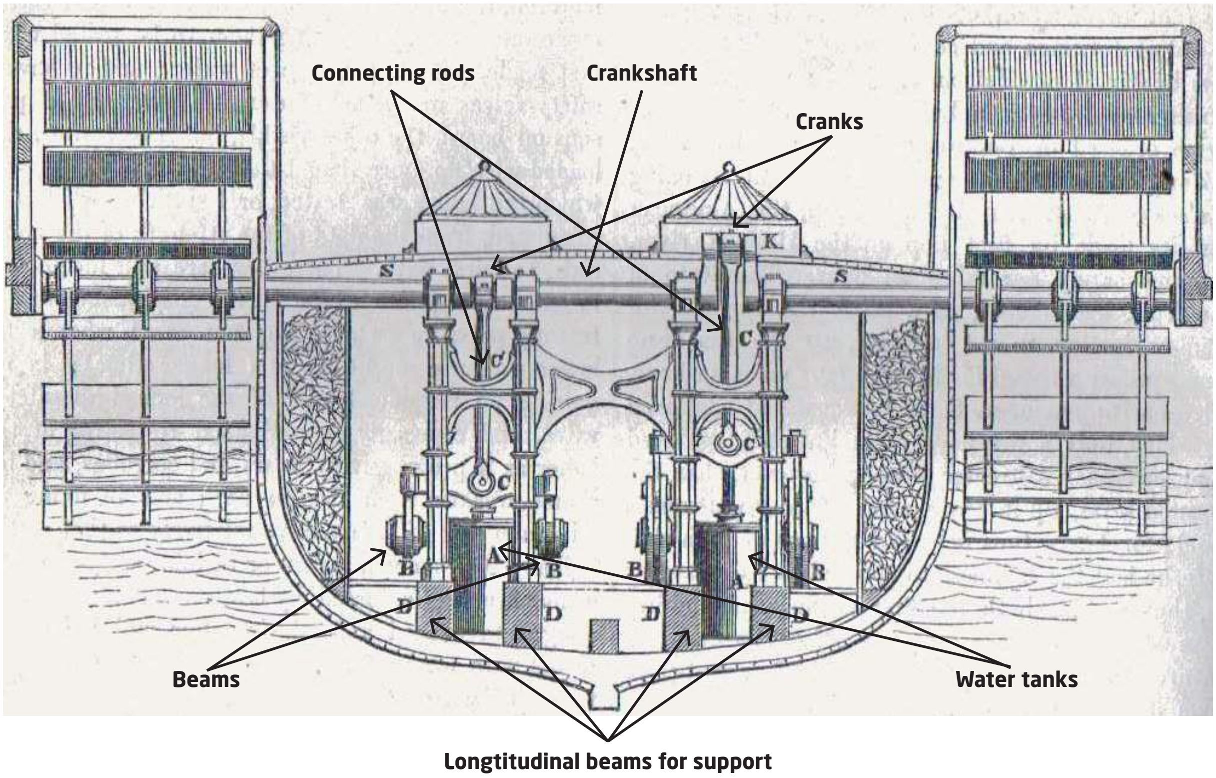


The beam engine of the Congo, the first naval steamer, in 1815.
from A Short History of Naval and Marine Engineering, Cambridge, 1937

The side lever engine was a modification of the Watt beam engine and that was introduced to ship propulsion in the 1820s; the design is characterised by the beams located low down alongside the cylinder. Variations of the design were introduced over the years to reduce the length of the engine and the grasshopper form is typical; this can be seen in the preserved engine of the paddle tug Reliant (1907) at the National Maritime Museum.

The American Walking Beam engine is another variation on the Watt beam engine but in this case the single beam is located above the cylinder and paddle shaft. This was introduced about 1820 and remained popular with American ferries into the 20th century.

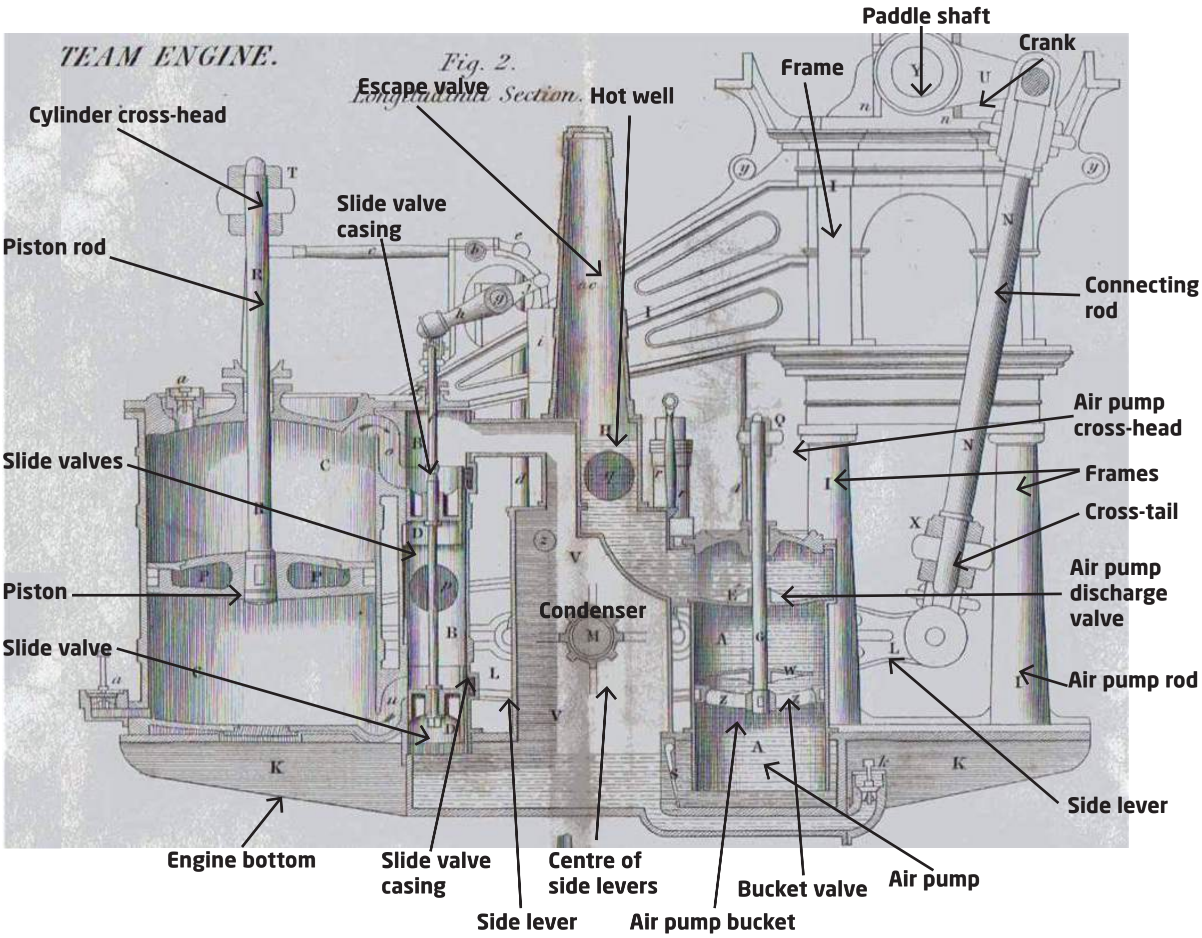
Beam engines were single cylinder designs, the steam being directed to the cylinder by means of a valve arrangement and exhaust passing to a condenser in order to gain from expansion of the steam down to low pressures; early condensers were of the sea water spray or jet type in which steam was condensed by the introduction of a sea water spray into the condenser chamber. This arrangement meant that the boilers had to use seawater feed. Early tubular condensers, which separated the steam and cooling seawater, were not successful due to blocking of the tubes by the grease which lubricated the cylinders. A change to passing the cooling seawater through the tubes avoided such blockage and the tubular condenser (introduced successfully in the 1840s) enabled fresh water feed to be used for boilers. The condenser was located at the base of the beam engine in the foundation plate.



A side lever paddle engine
From Cyclopeadia of Useful Arts, 1860

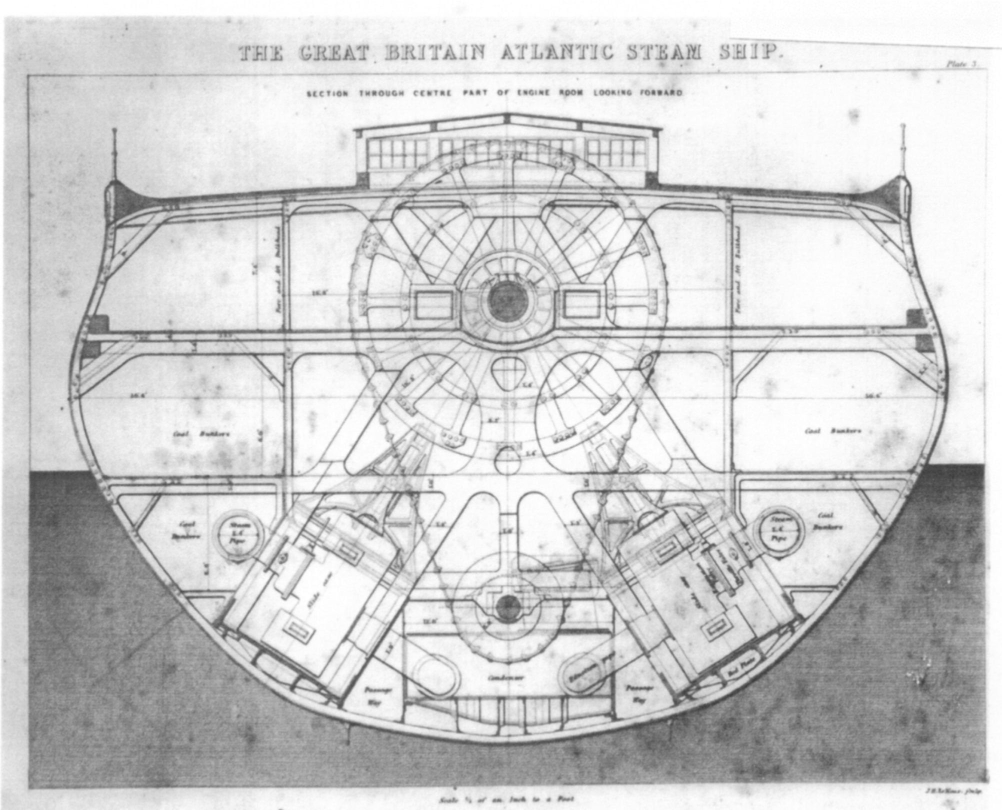
A number of alternative paddle engines were developed, the most successful of these being the oscillating type and the inclined type. Henry Maudslay took out a patent for an oscillating engine in 1827. The oscillating engine cylinder is pivoted, thus allowing the piston rod to be directly connected to the paddle crank; steam and exhaust are directed to and from the cylinder via the pivots. The diagonal paddle engines have inclined cylinders and that arrangement results in a shorter engine than the side lever type. The last British-built passenger paddle steamers, including the Waverley, were built in the late 1940s and these were fitted with triple expansion diagonal engines.

The engine of the paddle tug Clyde, which worked on the river from 1861 to 1912, installed on the river bank at Renfrew.
© Brian Lavery



Details from a side lever paddle steamer engine
from Young's Nautical Dictionary of 1846

SCREW ENGINES



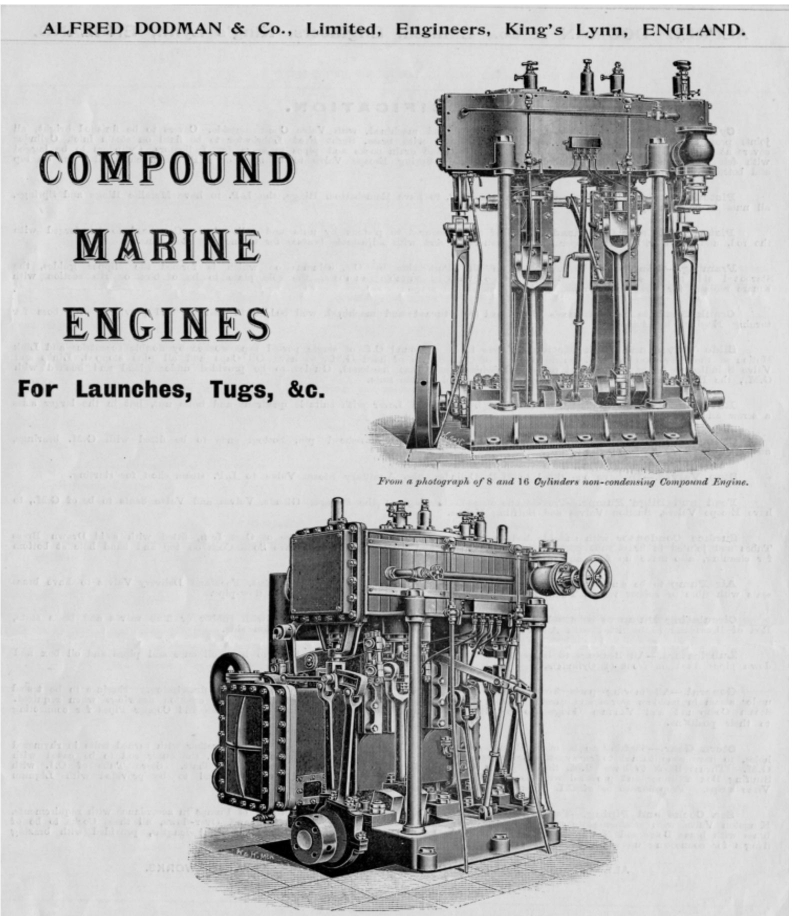
The original engines fitted to the Great Britain of 1843. A chain drive is used to increase the propeller speed; this was later replaced with gearing.
From John Weale, The Great Britain Steamship of 3500 Tons, 25 folios of engravings, London, 1847

Screw propulsion required higher engine speed than paddle propulsion and the early screw engines were modified paddle engines with speed increased by means of gearing, rope drive or chain drive. Cylinders were placed at the bottom of the ship with piston rods acting upwards, just like the paddle engine. Direct acting engines, with the piston rod directly connected to the crank or propeller shaft appeared in the 1850s and the horizontal form was initially used with success. This arrangement was popular for warships as the engine could be placed entirely below the waterline. Engines with the cylinder located above the crankshaft were known as inverted engines as the cylinder was inverted compared with the common paddle engine. The direct acting engine operated at about 50-60 rpm and a lever connected to the piston rod or the crankshaft would be used for driving the air pump, which removed water and air from the condenser in order to maintain the vacuum.

Valves for directing steam to the cylinder and allowing exhaust steam to leave the cylinder were driven by a linkage from the lever in beam or side lever engines or from eccentrics on the crankshaft in oscillating, diagonal or direct acting engines.

COMPOUNDING

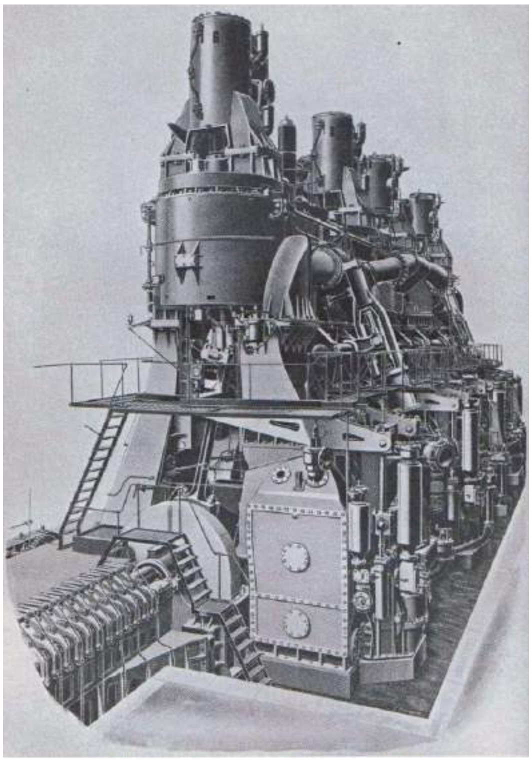
The concept of expanding steam in a number of stages in order to reduce the temperature drop, and hence steam loss in a cylinder, had been known from the late 18th century and the first two-stage expansion, or compound engine, was introduced by Woolf in 1803. Compounding was introduced to marine engines in the 1830s but was not successful and the real advantage of compounding was shown by Randolf and Elder in the 1950s; compounding is only an advantage when the steam pressure is high enough to justify two stage expansion of steam and that was only possible with higher strength materials and better boiler design. Many different compound engines were devised (generally to avoid infringing patents on existing designs) and the tandem arrangement was popular as it did not result in an increased engine length. Despite the increased length, the in line arrangement of two cylinders and two cranks was the most common compound engine because of its simplicity.



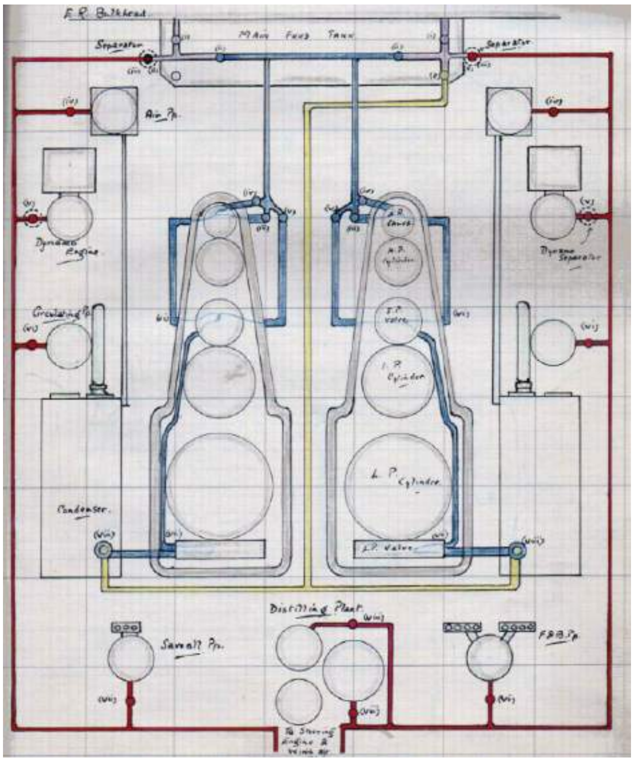
Types of compound engine

TRIPLE EXPANSION ENGINES

As boiler design improved and consistent high quality steel became available, steam pressures were increased and that allowed for triple compound, or triple expansion engines to be developed. The first large triple expansion engine ship was the *Propontis* of 1874 and this had an engine devised by Dr A.C. Kirk who was the engine designer for John Elder & Co. Because of boiler problems the engine was not initially successful and acceptance of the triple expansion engine was not forthcoming until 1881 when the *Aberdeen* entered service with a Kirk designed three cylinder triple expansion engine.



The five-cylinder triple expansion engine of the liner Campania of 1893
from A Short History of Naval and Marine Engineering, Cambridge, 1937

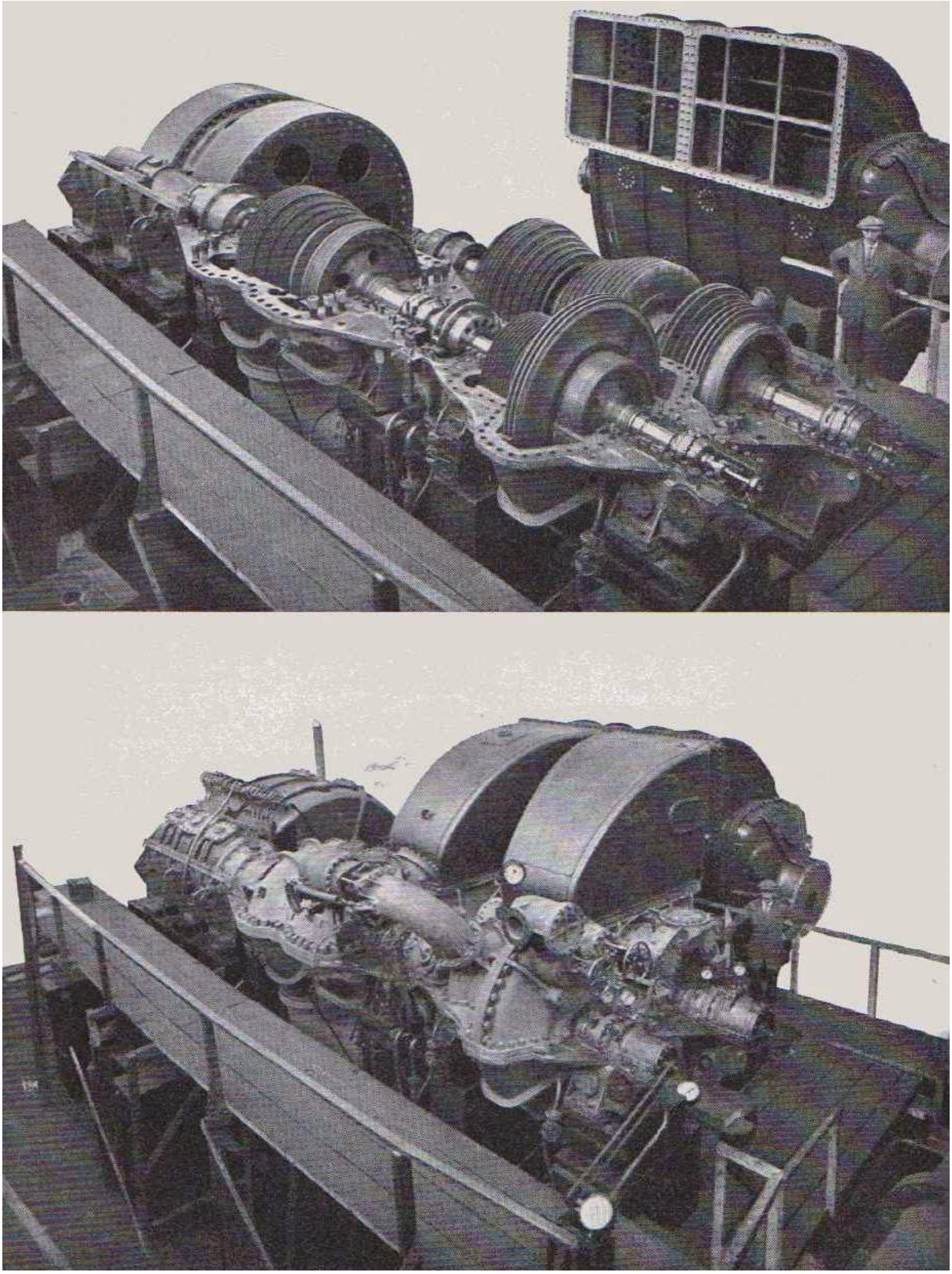


The engine room layout of HMS Carstairs, a minesweeper of 1919
from RAP Mountfield's personal midshipman's journal, c 1930 © Brian Lavery

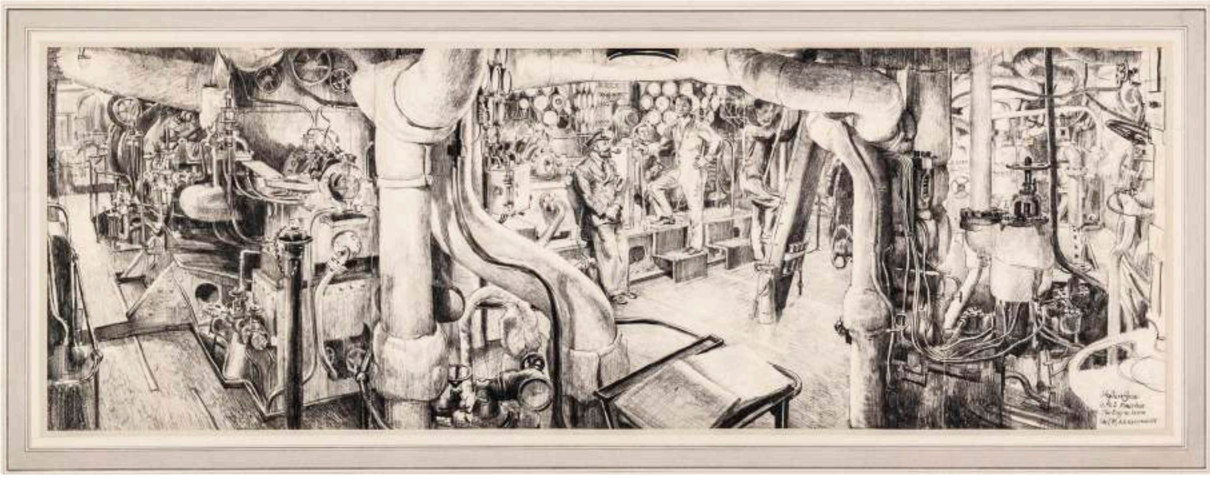
Over the years the triple expansion engine was modified with tandem cylinders and multi-cylinder low pressure stages being used. Some large engines operated as quadruple expansion engines but steam pressures did not really justify more than triple expansion. The three cylinder triple expansion engine remained in production until as late as the 1950s in a form which differed little from the design fitted in the *Aberdeen*. Because the reciprocating engine cannot expand low-pressure steam as efficiently as a turbine some large engines were fitted with exhaust turbines (White Star Olympic class ships, such as *Titanic* and her sisters) effectively making the plant quadruple expansion. The fitting of Bauer Wach turbines to small propulsion triple expansion engines started in the 1920s and continued until the 1950s and other means of improving engine efficiency were also used including steam reheat.

STEAM TURBINES

Steam turbines driving electrical generators were first used at sea in the 1880s and propulsion turbines, in Parson's *Turbinia*, during the late 1890s. Direct drive turbines could develop high power from a smaller engine compared with the reciprocating engine, but they were less efficient. With the development of effective and reliable gearing it was possible to drive a propeller at a relatively low speed to give good propulsive efficiency whilst allowing the turbine to rotate at high speed for high engine efficiency. Parsons *Vespasian* showed, in 1909, that a geared turbine installation was practical and efficient. Gearing also allowed for shorter turbines as staging could be carried out in separate turbines, all geared to the same output shaft. Turbines are not directly reversible and a separate astern turbine has to be fitted to the system. Single, double, and even triple reduction gearing has been used to reduce turbine speeds from high levels to acceptable propeller speeds.



The turbine engines of HMS Diomede of 1917, shown open and closed.
from A Short History of Naval and Marine Engineering, Cambridge, 1937



The engine room of the cruiser Mauritius drawn by Stephen Bone c 1944, showing the complexity of pipes and dials.
PAJ3023 © National Maritime Museum, Greenwich, London

BOILERS

Early boilers were of the drum type and were little more than a copper kettle sitting on a furnace. The box flue type boiler was introduced in the 1830s and hot gases from the furnace passed through flues within the boiler giving up heat to the water. This type of boiler operated at about 5 psi and required constant cleaning due to the build up of soot on the flue surfaces. Due to the flat flue surfaces the boiler was limited to about 5 psi steam pressures. The flue and other early boilers used a sea water feed and that meant constant blowing down in order to prevent the build-up of salt scale on the surfaces.

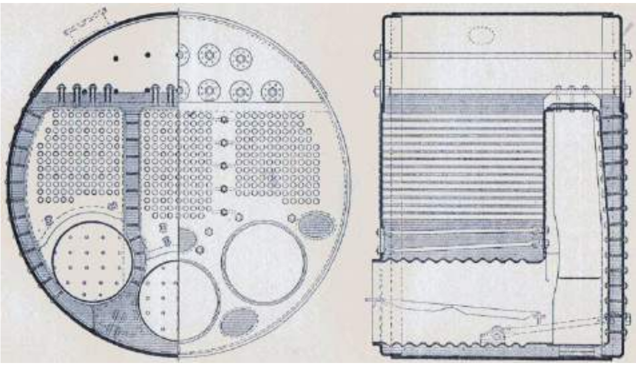
A fireman at work in the very hot conditions of the boiler room of a merchant ship in 1942, by Henry Carr. In the Royal Navy he would be known as a stoker.
BHC1558 © National Maritime Museum, Greenwich, London. Presented by the War Artists Advisory Committee 1946

Flue boilers gave way to tubular box boilers in the 1840s but these still operated at low pressures up to about 25 psi. Many novel designs were introduced in order to improve efficiency. Superheating or drying of the steam was practiced from the 1850s but it was not until the 1880s that effective superheating was used with triple expansion engines.

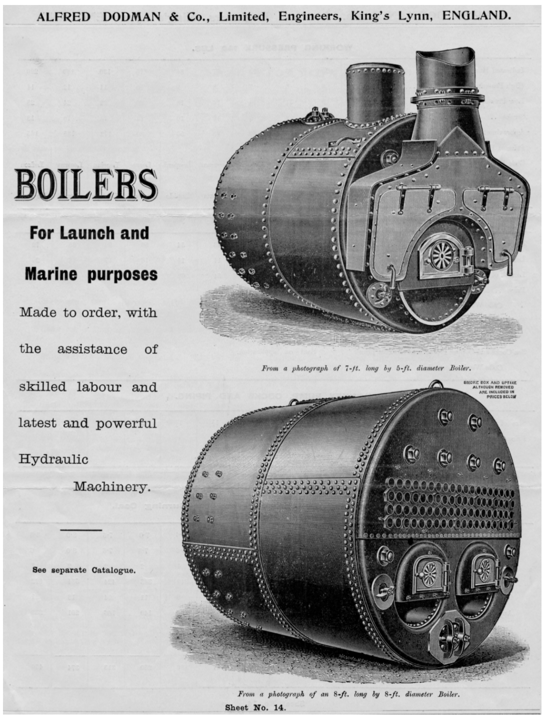
The box boiler developed into the elliptical shell tubular boiler in the 1860s and the cylindrical boiler later that decade. The Scotch boiler is the well known form of the cylindrical tubular boiler and the first of the type was introduced by Randolf and Elder in the steamer *McGregor Laird* in 1862. Improvements by way of improved design, manufacture and consistent quality steel turned the Scotch boiler into the standard unit for most steamships (apart from express liners) until the 1950s. Scotch boilers were still being fitted in ships in the 1960s.

Boilers were coal fired until the introduction of oil burning early in the 20th century but coal burning triple expansion engine ships with Scotch boilers were at sea into the 1950s. Most British tramp steamers were of this type.

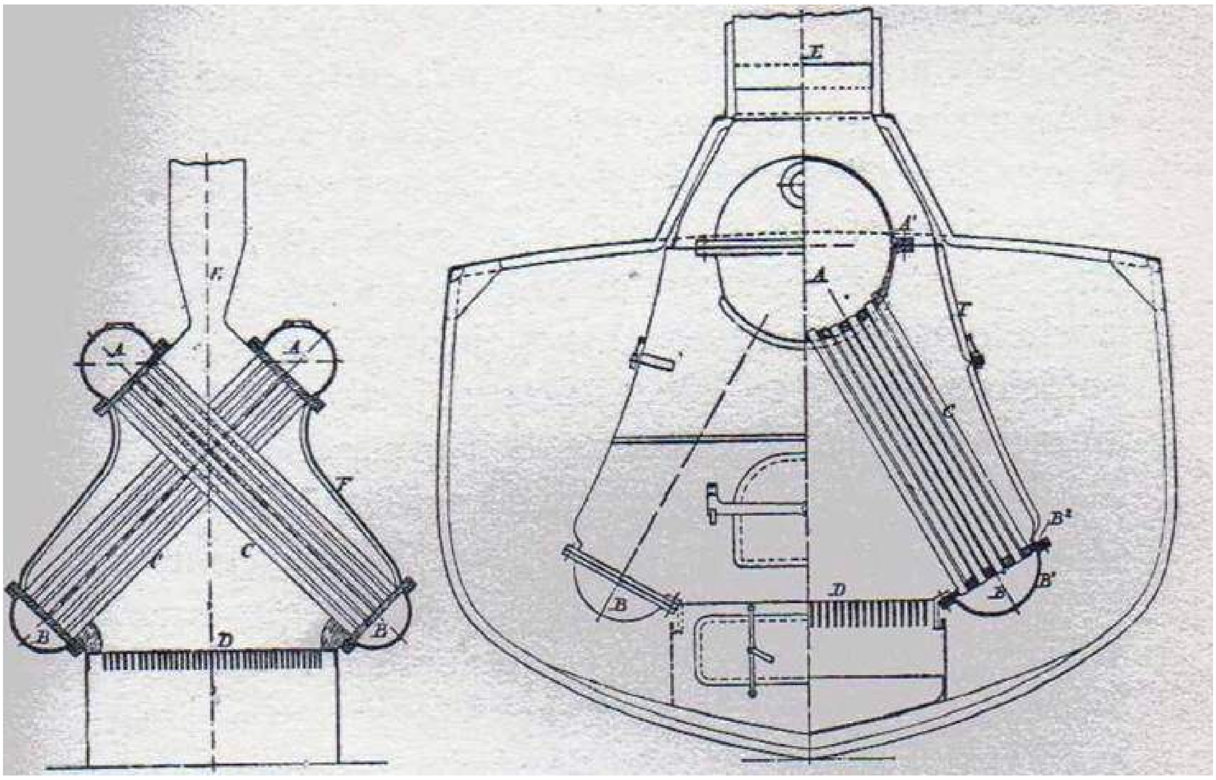
Water tube boilers were tried in the 1870s but most early attempts were unsuccessful due to the inconsistent quality of the iron or steel used. Naval engineering took a lead in the development of the water tube boiler with the Bellville, Yarrow, Thorneycroft and Normand designs being found in most British and European naval vessels. The Babcock and Wilcox design of water tube boiler was popular in America but also proved successful in British warships.



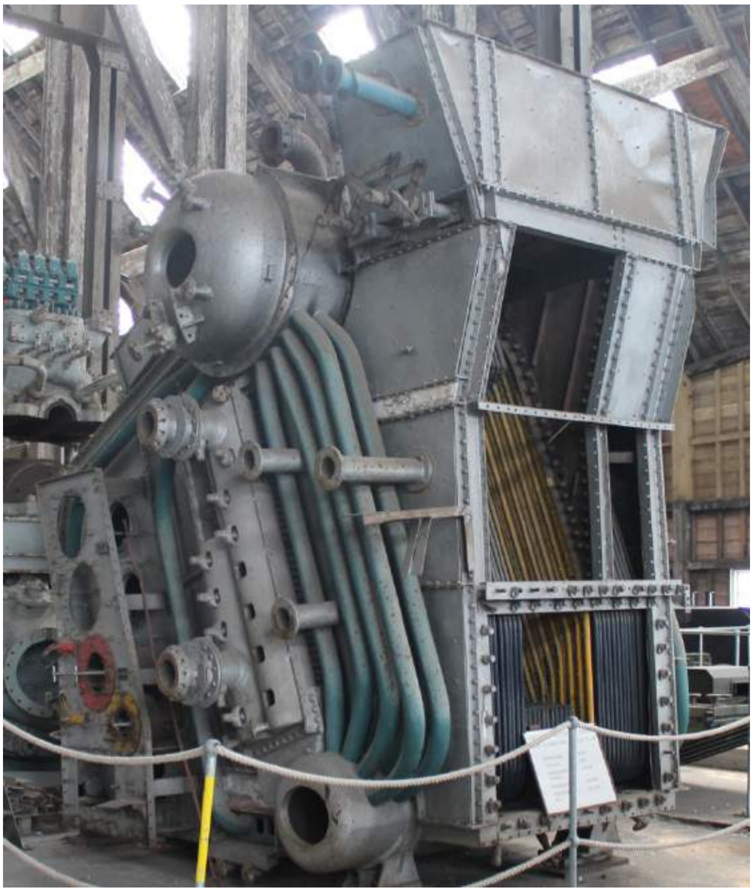
A cylindrical boiler



Types of steam boiler



A Yarrow boiler of 1889
from A Short History of Naval and Marine Engineering, Cambridge, 1937

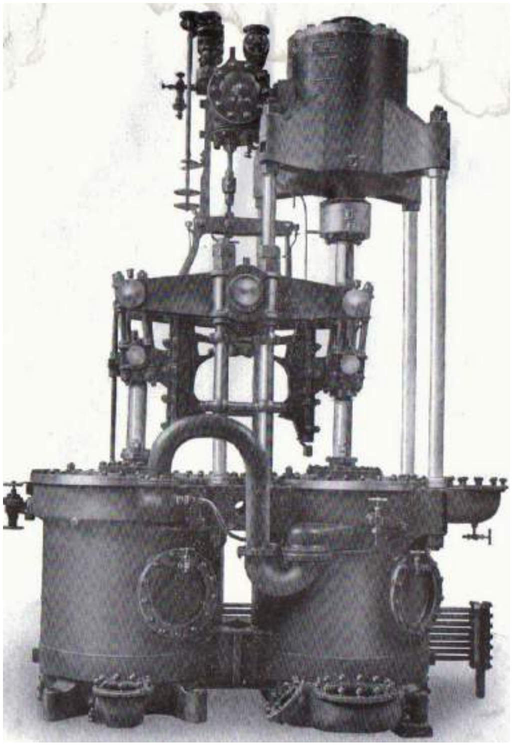


A Babcock and Wilcox boiler
© Brian Lavery, with kind permission of Chatham Historic Dockyard Trust

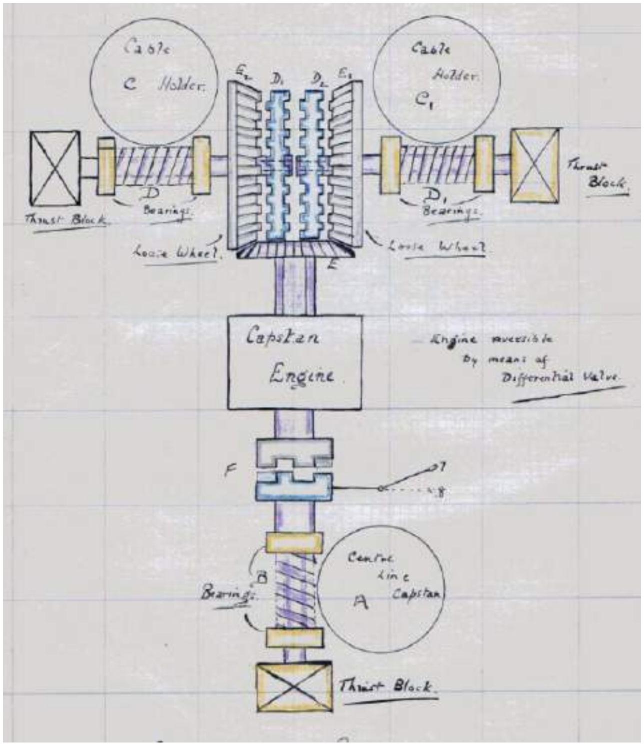
Forced draught was used as a means of increasing the steam generation rate of the boiler as it allowed more fuel to be burned because more air was supplied. Naval authorities favoured the closed stokehold form of forced draught where the entire boiler room was pressurised and airlocks had to be provided to allow for access. Merchant practice favoured the open stokehold system where the furnace was pressurised; this required a system, which shut off the air supply when the furnace door was opened for firing.

STEAM AUXILIARIES

Small steam engines were used for driving pumps from the 1860s and these were usually of the single cylinder simple expansion type. In later years compound engines would be used for driving larger pumps but in most cases a single cylinder engine was all that was required even into the 20th century. With the introduction of electricity to ships in the 1870s steam engines were used to drive the dynamos. Steam turbines quickly found favour for driving large dynamos but for smaller ships, tramps and general cargo ships (even as late as the 1950s) compound or triple expansion reciprocating engines were used for driving dynamos.



The Weir Dual air pump, Express type, c 1913

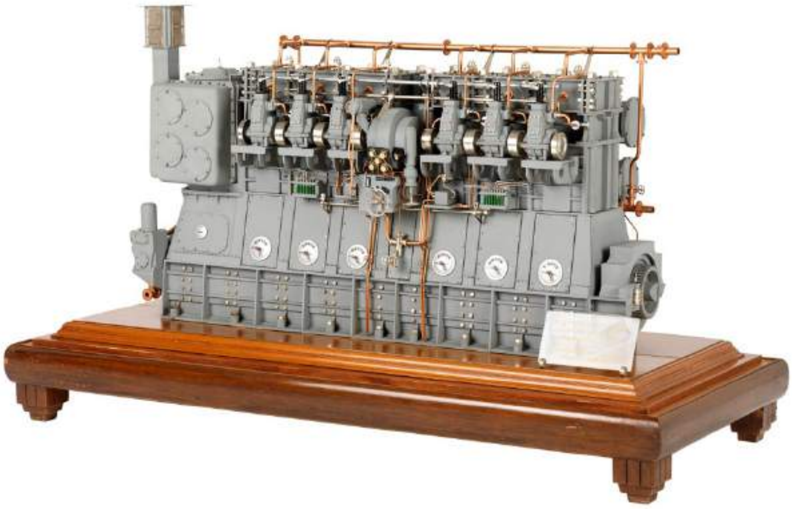


The mechanism of a steam capstan
from RAP Mountfield's personal midshipman's journal, c 1928-30
© Brian Lavery

DIESEL ENGINES

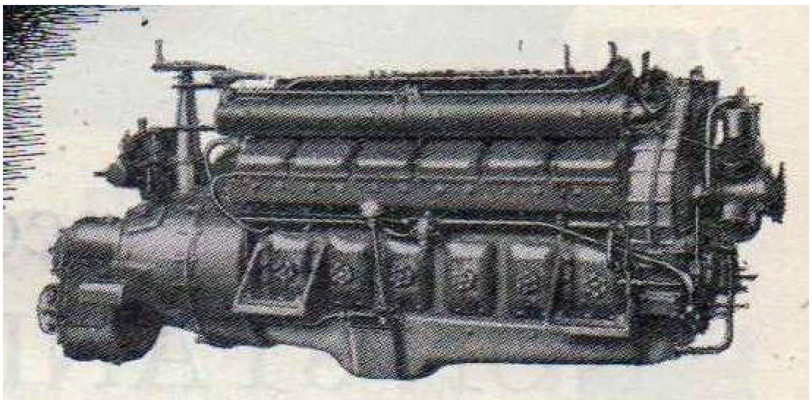
The first diesel engine was used for ship propulsion in 1904 but it was not until 1910 that the first seagoing ship was propelled by a diesel engine.

There are two basic operating cycles for the diesel engine, the four stroke cycle and the two stroke cycle and there are two different designs of engine: the crosshead type (like the steam reciprocating engine), and the trunk piston type (like the automobile engine). The trunk piston engine has a lower headroom requirement than the crosshead type and so it is suitable for confined spaces like submarines and modern cruise ships. The trunk piston engine operates at a higher speed than the crosshead engine and so it requires gearing to connect it to a propeller running at low speed or is used to drive an electrical generator and that electricity is used to propel the ship (or provide for general electrical supply to the ship). Crosshead engines are normally directly connected to the propeller and such engines must be reversible so that the ship can run ahead and astern.



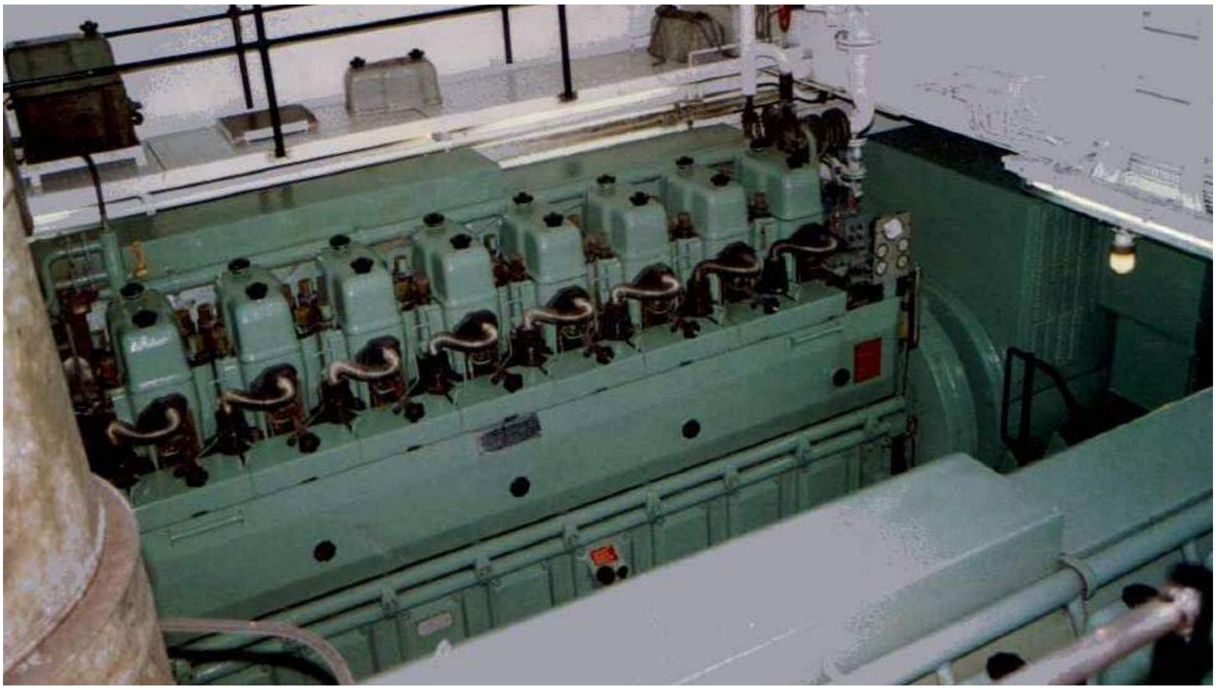
A model of a 6-cylinder marine diesel engine c 1935
SLR2116 © National Maritime Museum, Greenwich, London

Early diesel engines employed blast injection of fuel oil into the cylinder and that system was used in ships until the 1960s (one of the last ships to be fitted with an engine using blast fuel injection was the Cunard White Star liner *Britannic*). Solid injection of fuel was used by Vickers for submarine engines in 1914 and Doxford developed an independent solid injection system in 1920. The Doxford opposed piston engine was the last British-designed direct drive diesel engine to remain in production (the company ceased building engines in 1982). The Fullagar engine was another British-designed opposed piston engine and the Still engine (built by Scotts of Greenock and put in the Blue Funnel ships *Dolius* and *Eurybates* during the 1920s) was a combined diesel and steam engine.



A Gleniffer high-speed diesel engine for small craft, c 1945
From The Motor Boat Annual

Harland and Wolff gained a licence from the Danish Burmeister and Wain Company to build B&W engines. During the Second World War, they developed their own brand of engine, based on the basic Burmeister and Wain design, as the Nazi occupation of Denmark prevented any contact with the company. Direct drive propulsion engines, apart from the Doxford and Fullagar types generally operated on the four stroke cycle but since the Second World War there has been a move towards fewer engine designs (now only Sulzer, Burmeister and Wain, and Mitsubishi design crosshead engines) and these operate on the turbocharged two stroke cycle.



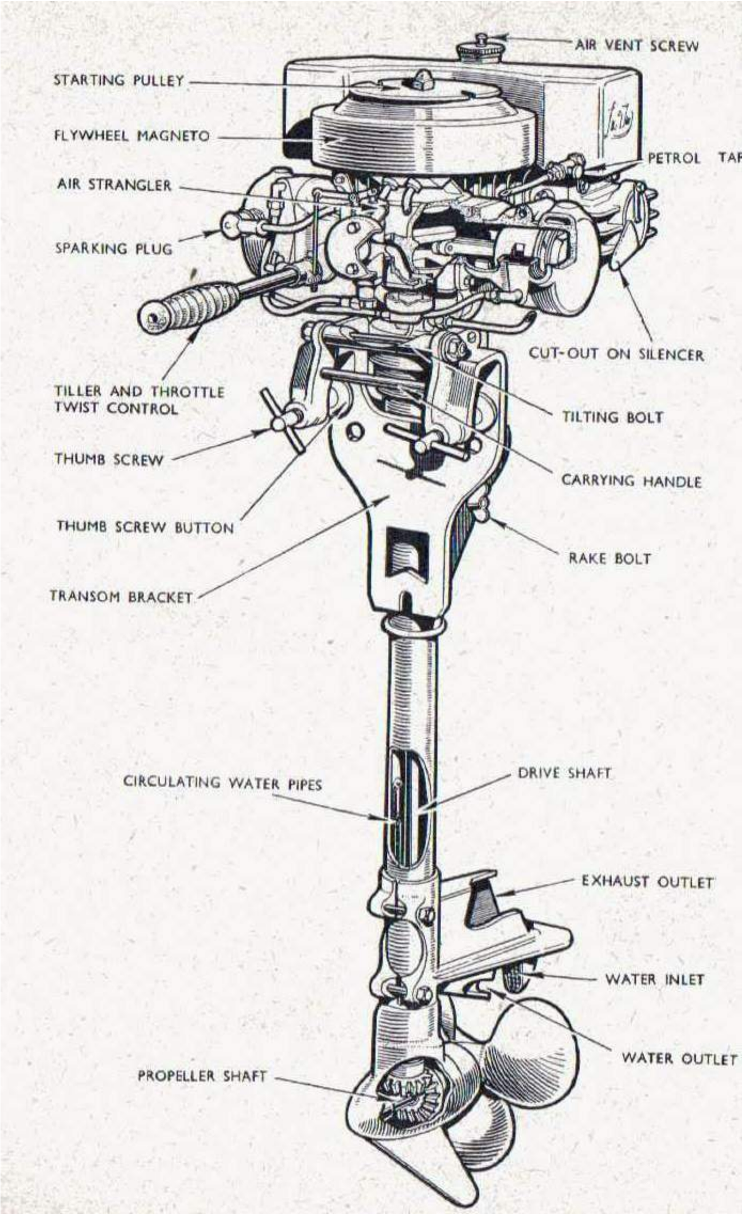
The engines and control room of a P&O ferry, 1992
© Brian Lavery

Trunk piston diesel engines operate on the four-stroke cycle and there have been many engine manufacturers in the business; engines may be used for propulsion and driving dynamos. After WWI the British admiralty produced a standard design of engine for submarine work but apart from Motor Torpedo Boats (MTB), few naval vessels adopted diesel engine propulsion.

OTHER COMMON ENGINES

Further engine type variations were developed in the early 20th century, particularly when the designers sought simple lightweight motors to drive smaller boats and fishing vessels. The semi-diesel – by makers such as Gardner of Patricroft, Manchester – is a diesel engine that has a lower compression pressure, and hence can be built more lightly than a full diesel. A semi-diesel usually has distinctive dome-shaped cylinder heads with paraffin blowlamps fitted alongside. The blowlamps serve to heat the cylinders until the raised internal temperature ignites the diesel fuel at the lower pressure. The modern diesel with greatly improved power to weight ratios made the semi-diesel extinct.

The petrol/paraffin engine was very popular among smaller fishing boats, and being much simpler and much cheaper to operate than a steam engine, was quickly adopted in the early decades of the 20th century. Makers such as Kelvin of Glasgow developed these simple engines that could be started with a little petrol, and switched over to the cheaper, but less volatile, paraffin when the engine was sufficiently hot.



Details of a small, 4 hp, outboard motor, c 1939
from The Motor Boat Annual, 1939

Perhaps the biggest innovation for the small boat user was the development of the first successful outboard motors. Evinrude began building lightweight and portable outboard petrol engines for the burgeoning leisure industry in the USA immediately after the First World War. The early motors are simple two-stroke machines, sometimes with a small rudder attached. They quickly developed in sophistication and quality, and a modern two- or four-stroke outboard can sometimes be more effective and powerful than its inboard equivalent. Outboard motors are not well represented in museum collections as yet.

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8 STEERING

BY BRIAN LAVERY, CURATOR EMERITUS, NATIONAL MARITIME MUSEUM

A ship is usually long and narrow so it will tend to move in a straight line if all things are equal. But there are normally forces tending to upset this, the wind or the torque of a propeller. The helmsman of a sailing ship usually has to correct for 'weather helm', the tendency for the ship to point up into the wind unless it is corrected. In multi-masted ships it was common to balance the sails so that they assisted the steering, and the rudder was only needed to trim it, or for manoeuvres such as tacking. In a powered vessel with a single propeller, the torque will tend to turn it in one direction, or the opposite direction if it is put into reverse. In a ship with two or four propellers, they are usually rotated in opposite directions to counteract this.

OARS

An admiral's barge c 1750
SLR0332 © National Maritime Museum, Greenwich, London, Greenwich Hospital Collection

A rowing vessel can be steered using the oars alone, but a rudder is useful to give a more accurate direction, or when coming alongside after the oars have been raised out of the water.

SIDE RUDDER

The earliest rudders were shaped like oars and were hung over one or both sides of the stern. They had the advantage that they pivoted about the centre, so they were balanced and needed less force to operate them. They could also be raised when the vessel was in shallow water, or removed when it was drawn up on shore.

A model of the Viking ship known as Skuldelev 3, showing the side rudder.
AOA0275 © National Maritime Museum, Greenwich, London

The side rudder of the Oseberg ship at the Viking Ship Museum in Oslo.
© Brian Lavery

The 14th-century seal of the town of Winchelsea showing a ship with a single side rudder.

SEC0025 © National Maritime Museum, Greenwich, London

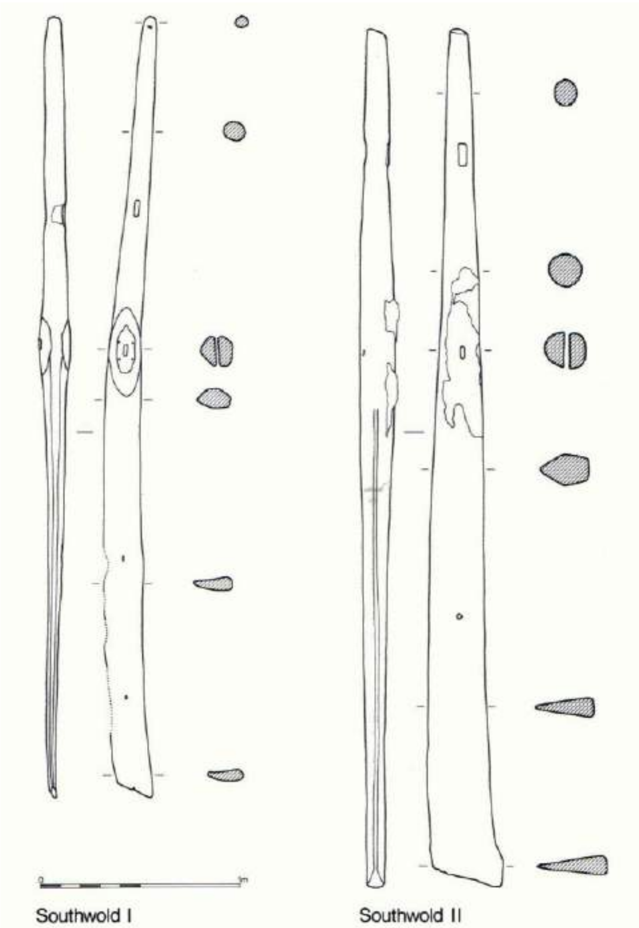
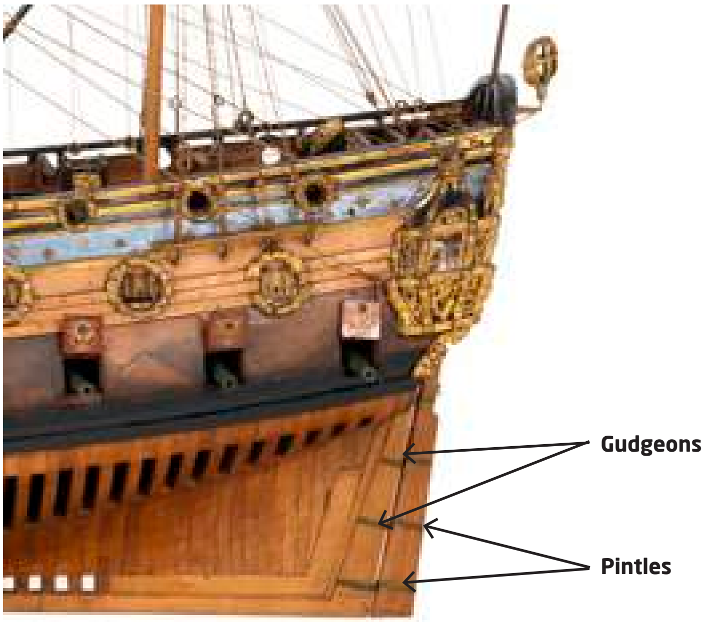


Diagram of two medieval side rudders discovered off Southwold in Suffolk.

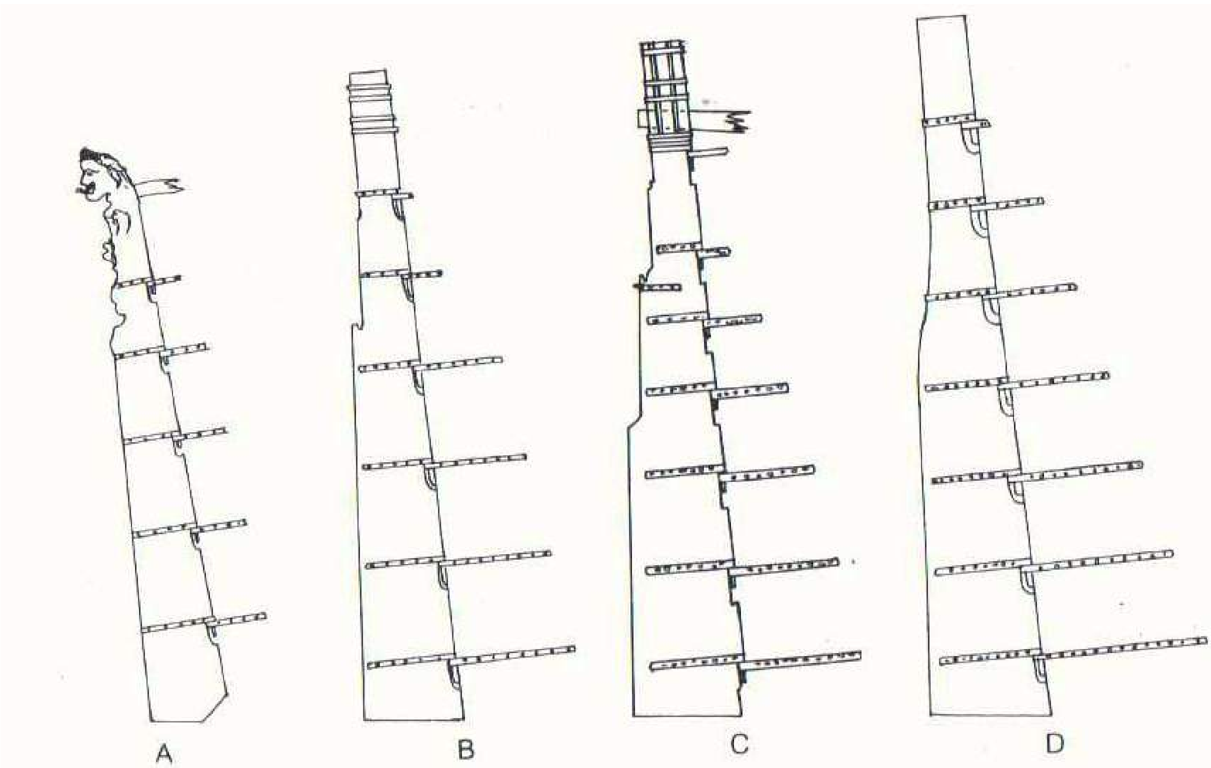
AOA0471 and AOA2278
© National Maritime Museum, Greenwich, London

THE STERN RUDDER

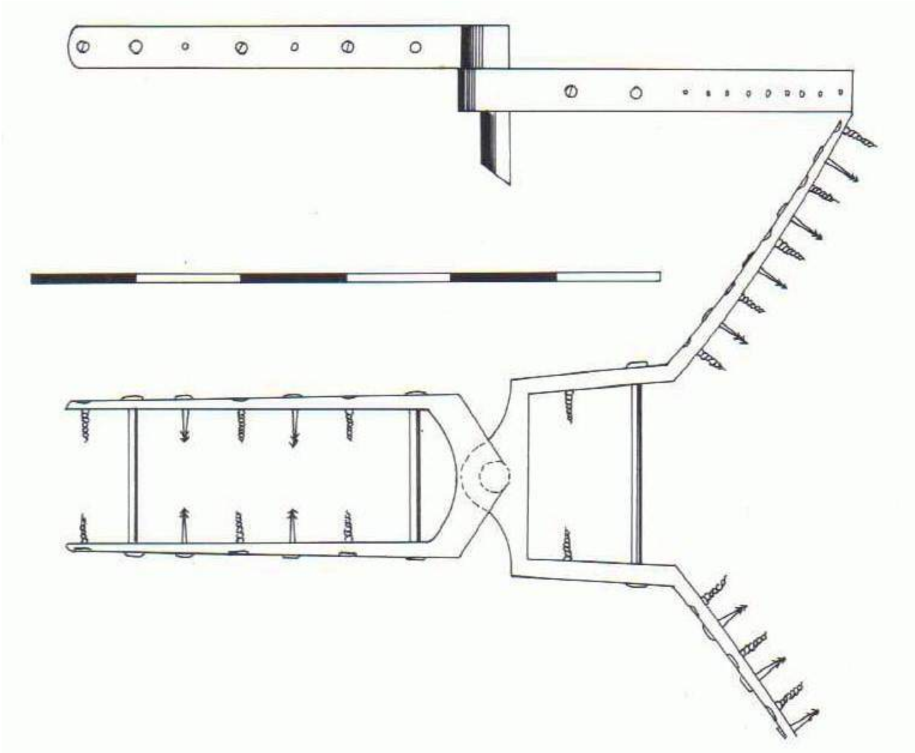
The stern rudder was fitted on north European ships from the middle of the 14th century. It was no longer balanced like the side rudder and it was more difficult to remove, but it allowed a longer tiller with greater leverage and was a step towards bigger ships. It affected the design of ships in that the stern post had to be straight to hold it, and the hull shape had to be narrower in the area for water to reach the rudder.



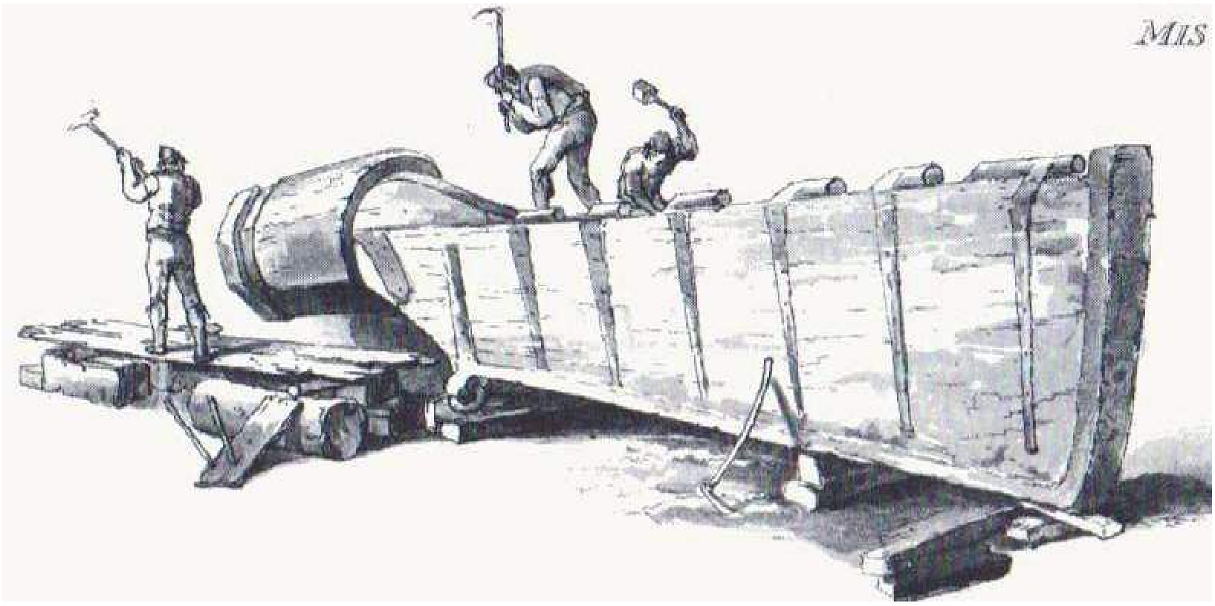
The rudder of a 50-gun ship, c 1695
© National Maritime Museum, Greenwich, London



Some warship rudders, 1690–1808
A. Decorated at the head, from the Phillips print of c 1690 B. The Anson of 1781 C. The Victory in the 1800s
D. The Caledonia of 1808, with a much more rounded shape
© Brian Lavery



The gudgeons of a rudder were fixed to the hull and had a receptacle for the pintle, on the left, which was fixed to the rudder, forming a hinge. This shows a proposed system of using screws and nails c 1780. Gudgeons and pintles were often made in copper alloy after that time, so they might survive shipwrecks.

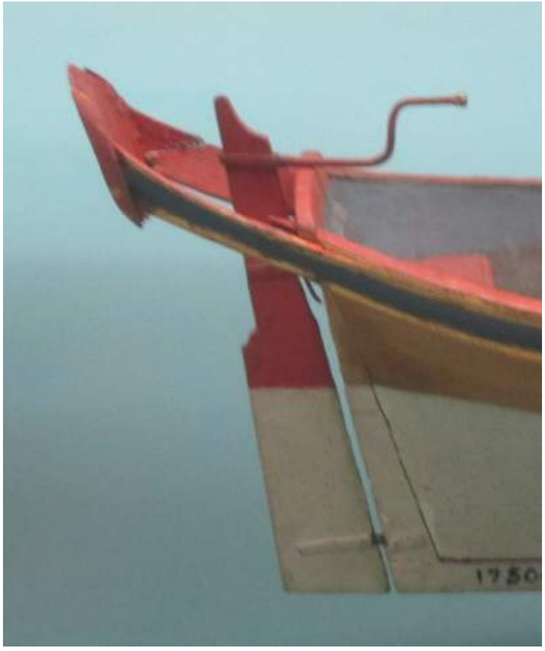


Shipwrights making a rudder, c 1805. Its large rounded head (the end furthest from the observer) was the characteristic type used by ships of the East India Company.

from 'Microcosm: Or, A Picturesque Delineation of the Arts, Agriculture, and Manufactures of Great Britain in a Series of Above a Thousand Groups of Small Figures for the Embellishment of Landscape', by William Henry Pyne, 180

THE TILLER

The tiller was the simplest means of operating a rudder – simply a bar fitted to its end which was moved from side to side to steer the ship. It is still used in small boats but it is limited in size.



The rudder and tiller of a naval pinnace, c 1750 SLR0334
© National Maritime Museum, Greenwich, London

'Voyage to Margate', etching by W Hinton, 1786, showing the helmsman at the tiller enjoying his beer while the passengers suffer from seasickness.
PAF3880 © National Maritime Museum, Greenwich, London

The marine artist W L Wyllie crosses the North Sea with family on his yacht Ladybird in 1888, showing the use of rope to get extra purchase on the tiller.

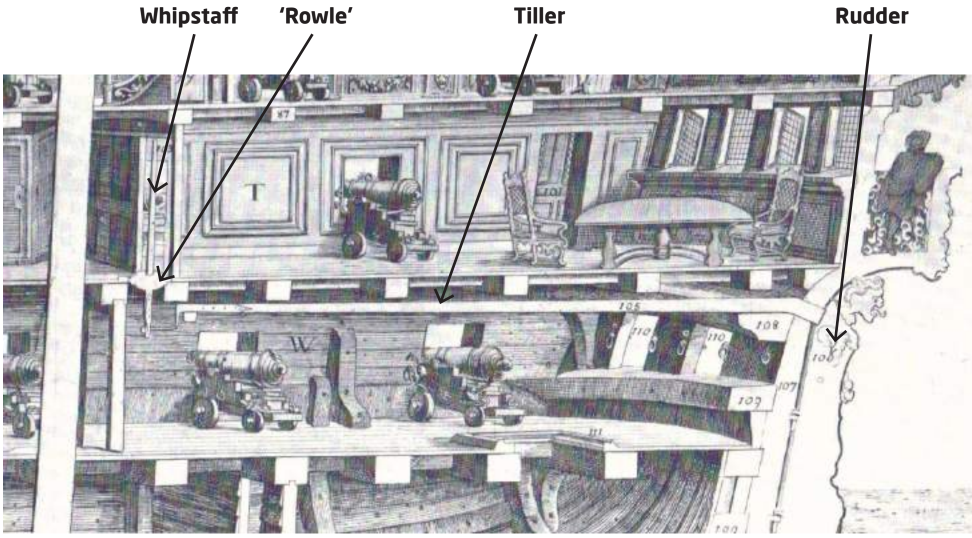
B8503 1888 © National Maritime Museum, Greenwich, London

An RNSA (Royal Naval Sailing Association) dinghy from 1920 showing the tiller, rudder and rudder extension.

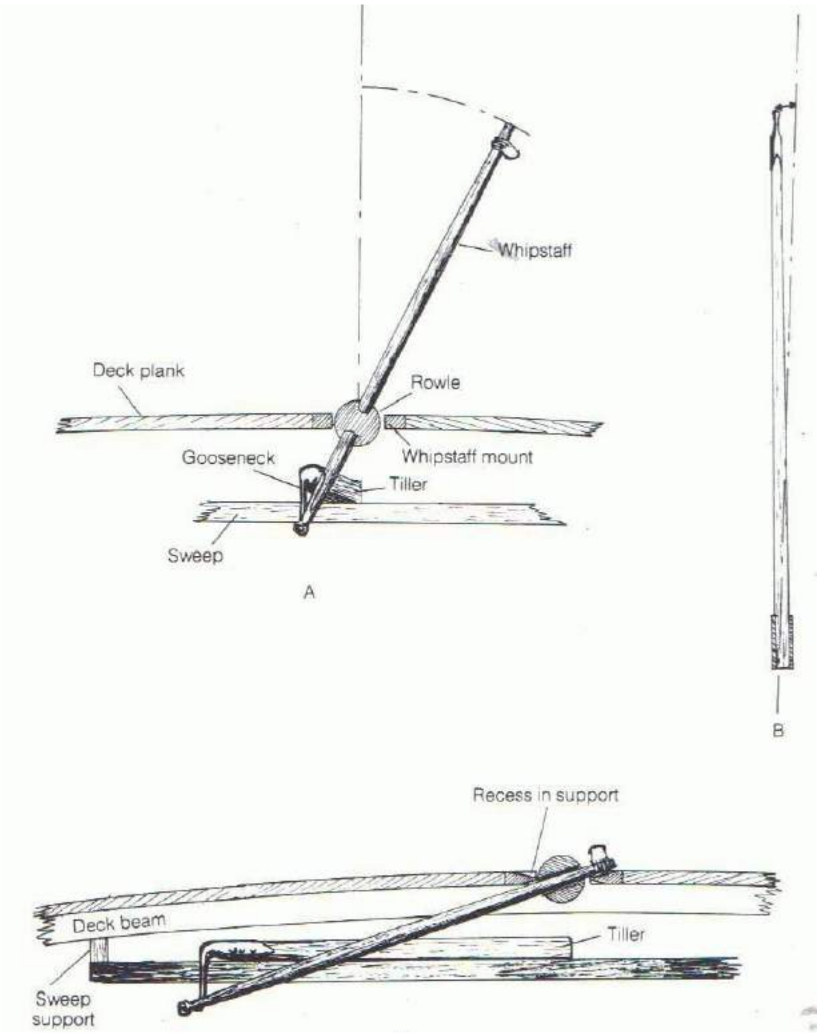
SLR0239 National Maritime Museum, Greenwich, London. We regret that Museum enquiries have not been able to identify the copyright holder and would welcome any information that would help us update our records. Please contact the Picture Library

THE WHIPSTAFF

The whipstaff was a wooden bar attached to the end of the rudder and pivoted through the 'rowle' to give extra leverage. It was the standard method of steering larger ships during the 17th century.



Detail from 'Section through a First-Rate, about 1690', oil on canvas, 1701, after Thomas Phillips.
BHC0872 © National Maritime Museum, Greenwich, London



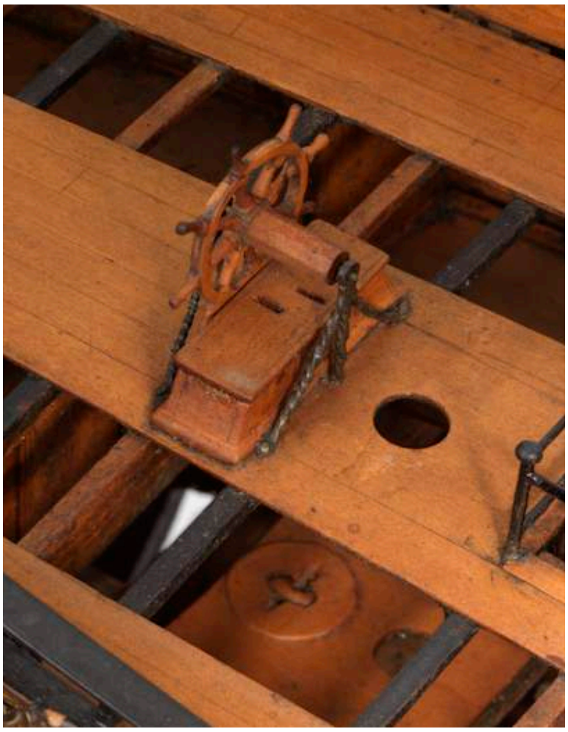
The whipstaff was vertical in the neutral position and had very limited movement from side to side. That could be increased if it was able to slide through the rowle, but only with the loss of leverage.
© Brian Lavery

THE STEERING WHEEL

The invention of the steering wheel very early in the 18th century allowed much greater leverage to be applied to the tiller and therefore the rudder, and it greatly increased the range of the rudder movement.

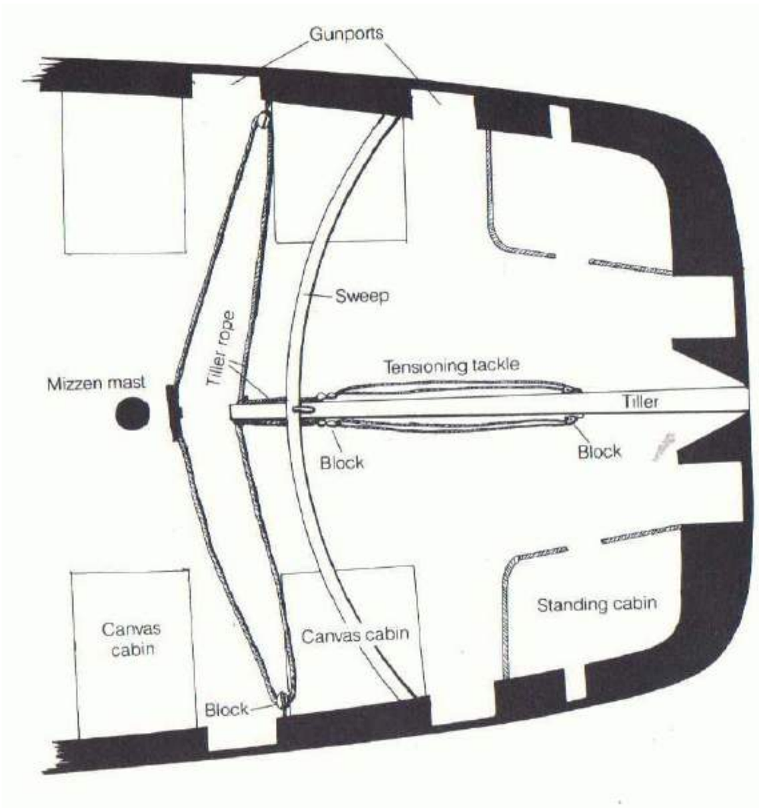
The windlass on a model of a 96-gun ship c 1703 is mounted across the ship rather than fore and aft, but its rope is connected to the tiller and it may be a step towards the steering wheel.

SLR0386 © National Maritime Museum, Greenwich, London

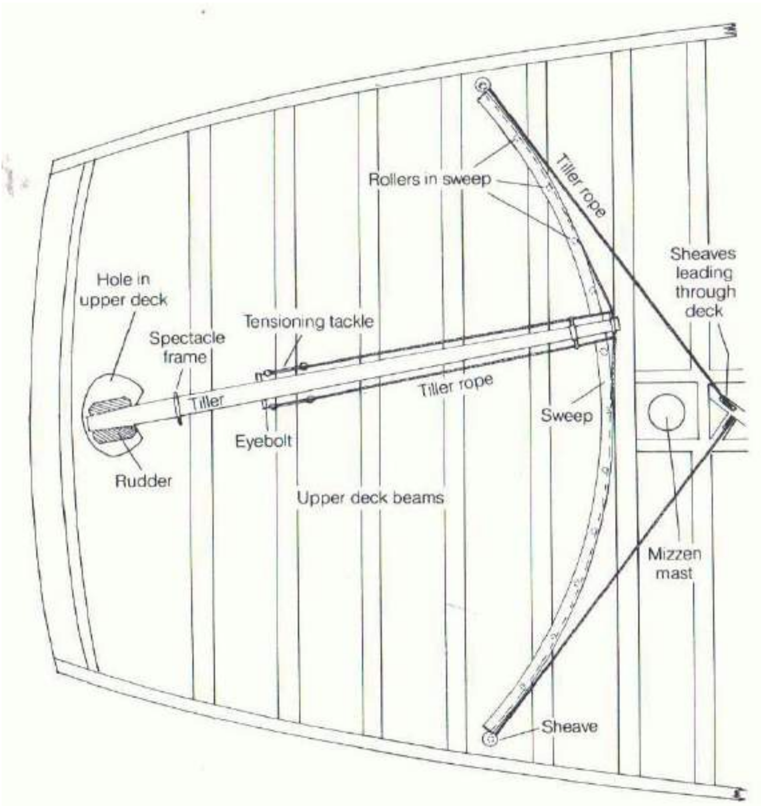


This is the first known example of a steering wheel shown on a model of a 50-gun ship, c 1703. The rowle for the whipstaff can be seen below, so it is possible that the wheel was fitted later.

SLR0218 © National Maritime Museum, Greenwich, London



The system of connecting the wheel to the tiller, c 1780. The ropes passed up through the decks to the wheel in the place marked by an arrow. Some slack had to be left in the ropes due to the geometry of the system, which could sometimes cause problems.
© Brian Lavery



A more sophisticated system as fitted on the Victory c 1805. The tiller ropes pass round rollers on the sweep and it is no longer necessary to keep them slack.
© Brian Lavery

The Warrior of 1860 was difficult to steer because of her great length, and had four wheels so that up to eight helmsmen could work at once – in extreme conditions they might be combined with a similar set of wheels below decks.

© Brian Lavery, with kind permission of Warrior Preservation Trust

BALANCED RUDDER

The SS Great Britain was the first major ship to use the balanced rudder, pivoted aft of its leading edge so that the pressure on the helm was reduced.

© Brian Lavery, with kind permission of ss Great Britain Trust

The rudder of the Atlantic liner Aquitania in 1914

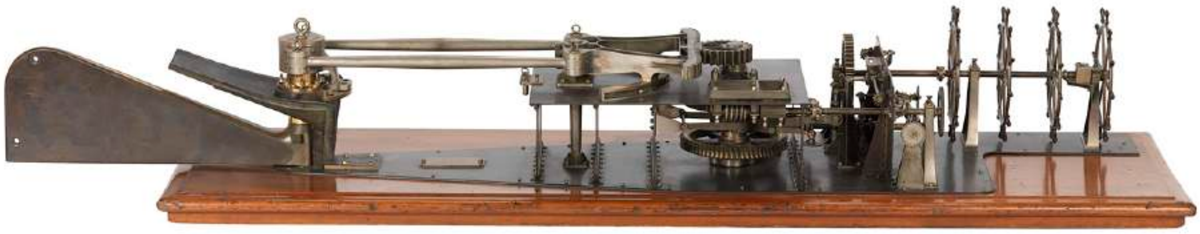
Glass plate negative, G10805 © National Maritime Museum, Greenwich, London

MECHANICAL TYPES

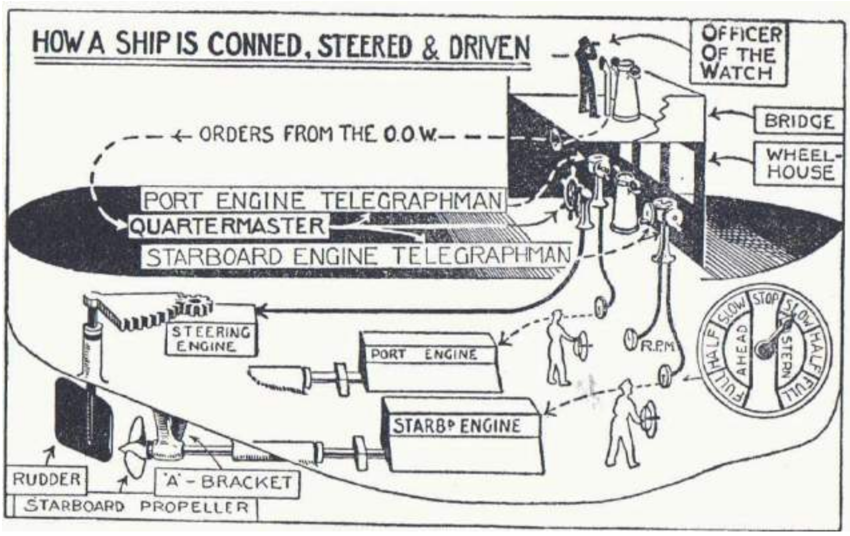
Since the 19th century, many mechanical devices have been developed to transmit the power from the steering wheel to the rudder.

An undated model of an eight-spoke steering wheel

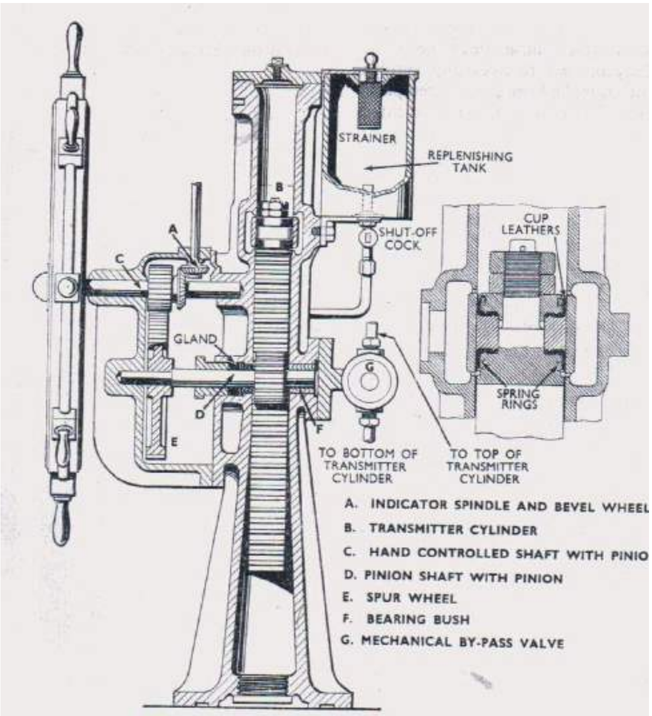
SLR2353 © National Maritime Museum, Greenwich, London



The steering system on HMS Goliath of 1898
SLR2366 © National Maritime Museum, Greenwich, London

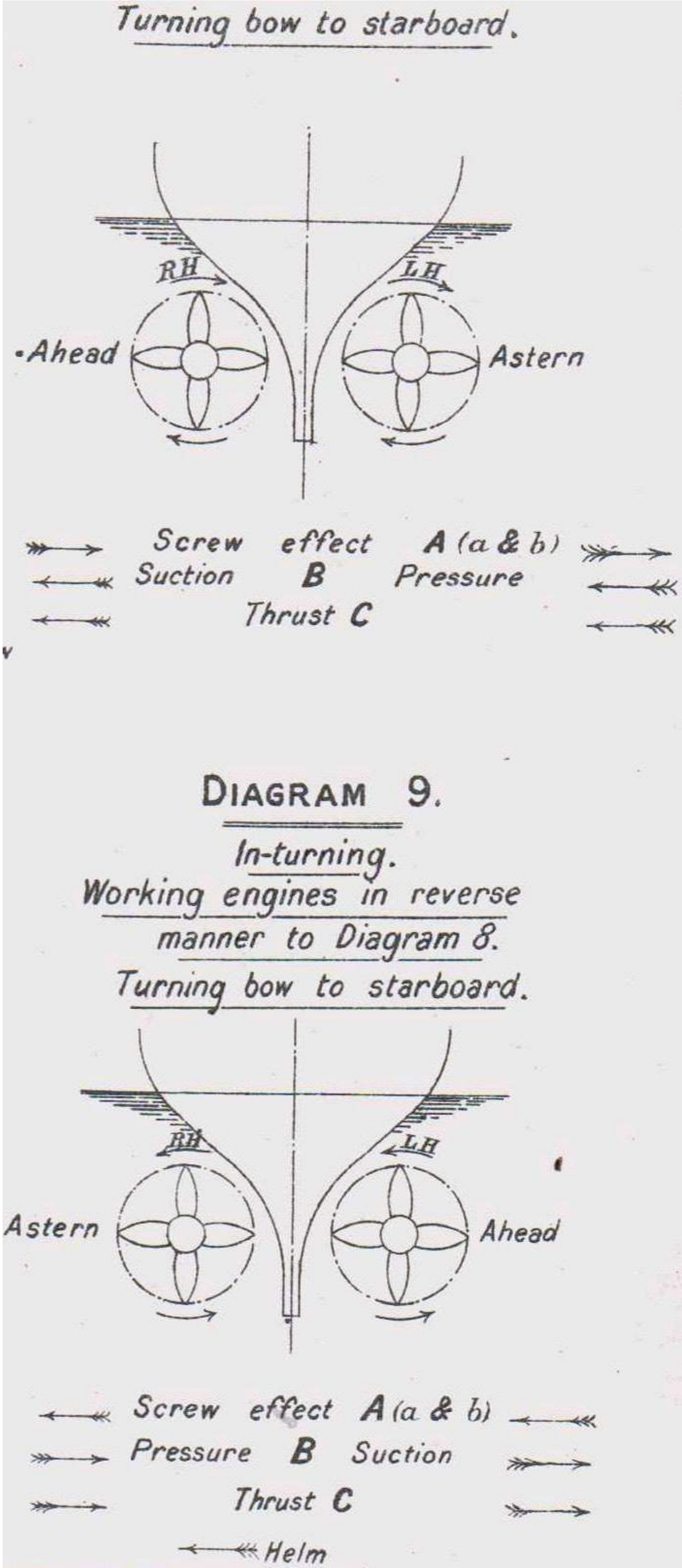


The steering system on a naval ship c 1943, showing how orders are transmitted from the bridge to the wheelhouse below by means of a voice pipe.
from the Admiralty's 'A Seaman's Manual', 1943



The telemotor which operated the power steering of a naval ship, c 1960.
From the Admiralty Manual of Seamanship, 1960

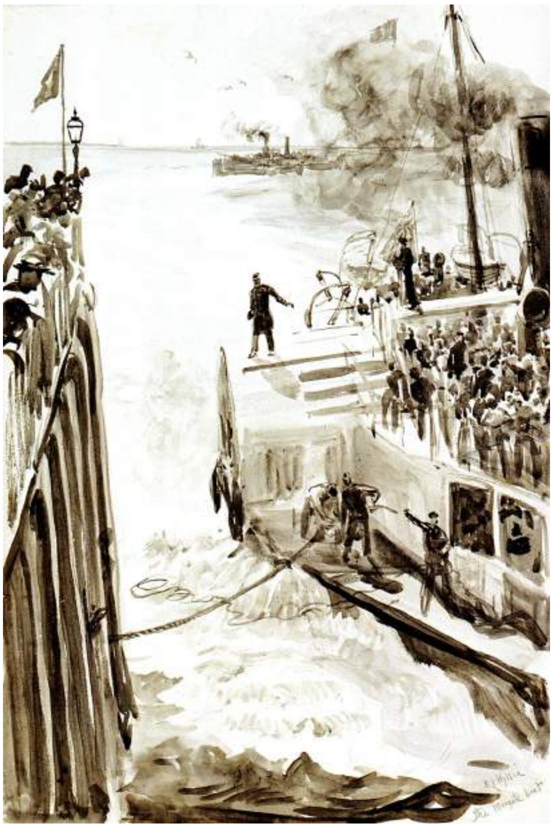
TWIN SCREWS



The effects of twin screws

From Admiralty Manual on Ship-handling c 1905

PADDLE STEAMERS



Paddle steamers could use their paddles in opposite directions to increase manoeuvrability, but only if each was operated by a separate engine. 'The Margate Boat', watercolour, by W L Wyllie.

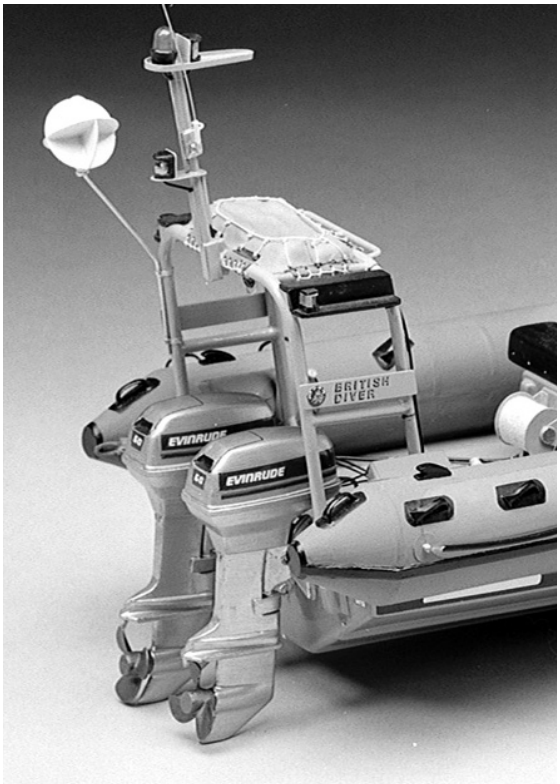
PAE0831 © National Maritime Museum, Greenwich, London

MOVEABLE PROPELLERS

The ship needs to be moving above a certain speed for the rudder to be effective – known as 'steerage way'. However if the propeller itself can be pivoted on its axis, manoeuvrability can be greatly improved. It requires sophisticated gearing, unless the engine is also tuned with the propeller.

Tucker's patent steering gear of 1863, an experimental idea by which the propeller was turned to turn the ship.

SLR2552 © National Maritime Museum, Greenwich, London



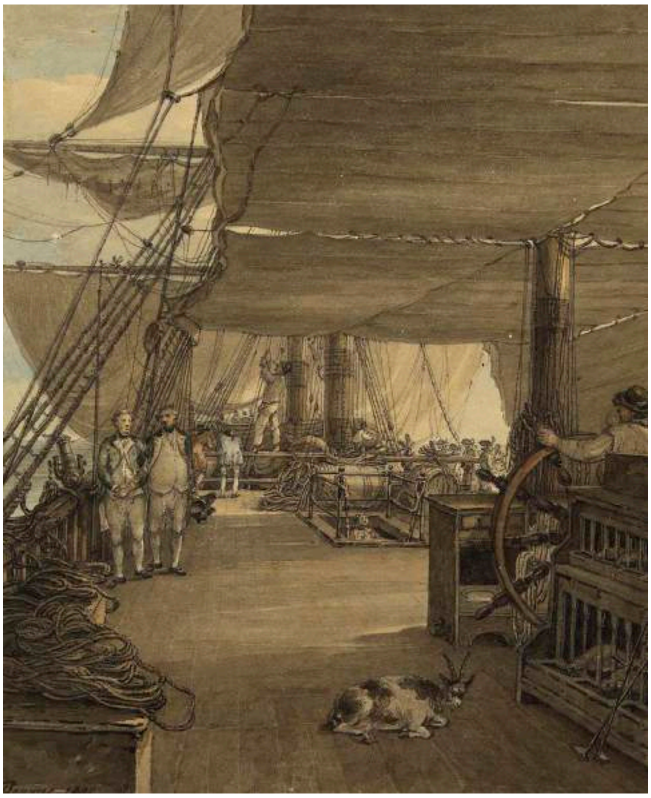
With outboard motors, seen here on a model of a 1984 lifeboat, the engine is mounted above the propeller and turns with it.

SLR1756 © National Maritime Museum, Greenwich, London. Reproduced with kind permission of Kelvin Thatcher, modelmaker

The Schottel rudder-propeller can be turned in different directions for steering. It is used in many tugs, exploration vessels, etc. See: *http://www.schottel.de/marine-propulsion/*

THE HELMSMAN'S POSITION

In small vessels such as racing dinghies the skipper invariably steers. In a yacht or fishing boat he might take the helm at key moments. In larger vessels the captain rarely if ever steers himself, he usually has a skilled seaman to do so. In sailing ships the helmsman usually stood to the windward side of the wheel. He might have a lee helmsman on the other side to assist him with heavy work and to learn the technique. Many sailing ships had double wheels so that four men could operate them in strong winds.



In sailing ships the helmsman stood near the stern so that he could have a good view of the sails, as shown in this view by Thomas Hearne of HMS Deal Castle in 1775.

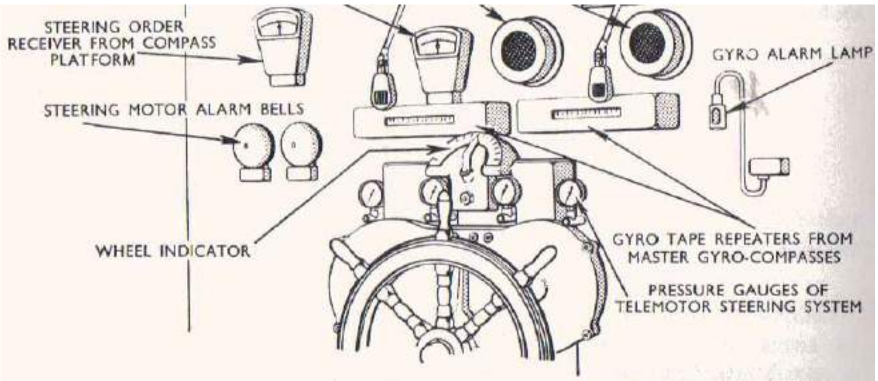
PAJ0773 © National Maritime Museum, Greenwich, London

A steering indicator on HMS Gannet, used to show the officer of the watch which way the rudder was angled.

© Brian Lavery, with kind permission of Chatham Historic Dockyard Trust

Originally the bridge was the link between the paddle boxes on a steamer. On merchant ships the steering wheel was mounted there from the middle of the 19th century. This shows the bridge structure of the tramp steamer Sizergh Castle of 1904.

SLR0054 © National Maritime Museum, Greenwich, London



Twentieth-century naval ships were usually steered from a wheelhouse well below decks to protect it from battle damage. This shows the instruments the helmsman might need, c 1965.

From Admiralty Manual of Seamanship

The helm of HMS Cavalier

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The enclosed bridge of the cruise ship Minerva in 2009. The helmsman operates a small wheel, whereas in other ships he would use a joystick. A modern ship is only steered manually when entering or leaving port; otherwise, it is normally set on autohelm.

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