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## *ANATOMY OF A SAILBOAT*



DIGITAL EDITION

Captain Robert L. Figular

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**MARINERS**  
LEARNING SYSTEM™

*ANATOMY OF A  
SAILBOAT*

by Captain Robert L. Figular

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Princeton, New Jersey

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# Anatomy of a Sailboat

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## Sailing Hulls and Hull Shapes

Sailboats can have one, two, or three hulls. Boats with one hull are known as monohulls, while those with two or more are known as multihulls. Multihulls can be further subdivided into catamarans (two hulls), and trimarans (three hulls).

A sailboat is turned by a rudder, which itself is controlled by a tiller or a wheel, while at the same time adjusting the sheeting angle of the sails. Smaller sailboats often have a stabilizing, raisable, underwater fin called a centerboard (or daggerboard); larger sailboats have a fixed (or sometimes canting) keel.

Multihulls use flotation and/or weight positioned away from the centerline of the sailboat to counter the force of the wind. This is in contrast to heavy ballast that can make up to one-third of the weight of a monohull sailboat. In the case of a standard catamaran, there are two similarly sized and shaped slender hulls connected by beams, which are sometimes overlaid by a deck superstructure. In the case of trimarans, which have an unballasted center hull similar to a monohull, two relatively smaller outriggers are situated parallel to the center hull to resist the sideways force of the wind. The advantage of multihull sailboats is that they do not suffer the performance penalty of having to carry heavy ballast, and their relatively lesser draft reduces the amount of drag, caused by friction and inertia, when moving through the water.

## Keel

A sailboat's keel is made effective by a combination of weight, depth, and length. Most modern monohull sport sailboats have fin keels, which are heavy and deep, but short in relation to the hull length. More traditional yachts carried a full keel that is generally half or more of the length of the sailboat.

A recent feature is a winged keel, which is short and shallow, but carries a lot of weight in two "wings" which run sideways from the main part of the keel.

Even more recent is the concept of canting keels, designed to move the weight at the bottom of a sailboat to the upwind side, allowing the boat to carry more sails.

### Types of Sails and Layouts

A mainsail is the most important sail raised from the main (or only) mast of a sailboat. On a square-rigged vessel<sup>1</sup>, it is the lowest and largest sail on the main mast. On a fore-and-aft rigged vessel, it is the lowest and largest and often the only sail rigged aft of the main mast, and is controlled along its foot by a spar known as the boom. The modern Bermuda rig uses a triangular mainsail as the only sail aft of the mast, closely coordinated with a jib for sailing upwind.

- **Genoa**

The term **genoa** is often used somewhat interchangeably with jib, but technically there is a clear delineation. A jib is no larger than the foretriangle, which is the triangular area formed by the mast, deck or bowsprit, and forestay. A genoa is larger, with the leech going past the mast and overlapping the mainsail. To maximize sail area, the foot of the sail is generally parallel and very close to the deck when close hauled.

Genoas are categorized by the percentage of overlap. This is calculated by looking at the distance along a perpendicular line from the luff of the genoa to the clew, called the LP (for “luff perpendicular”). A 150% genoa would have an LP 50% larger than the foretriangle length. Sail-racing classes often specify a limit to genoa size.

Maximizing the sail area causes more difficult handling. It is harder to tack a genoa than a jib, since the overlapping area can become tangled with the shrouds and/or mast unless carefully tended during the tack.

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<sup>1</sup> **Square rig** is a generic type of sail and rigging arrangement in which the primary driving sails are carried on horizontal spars which are perpendicular to the keel of the ship and the masts. These spars are called *yards*, the tips of which, beyond the last stay, are called the *yardarms*. Square rig was the main design in the age of sail, (1571–1863). A ship at least partially so rigged is called a square rigger.

- **Jib**

A jib is a triangular staysail set ahead of the foremost mast of a sailboat. Its tack is fixed to the bowsprit, to the bow, or to the deck between the bowsprit and the foremost mast. Jibs and spinnakers are the two main types of headsails on a modern sailing yacht.

On a vessel with two staysails, the inner sail is called the staysail, and the outer (foremost) is called the jib. This combination of two staysails is called a cutter rig or a Yankee pair and a vessel with one mast rigged with two staysails and a mainsail is called a cutter.

A fully rigged schooner has three jibs. The foremost one sets on the topmast forestay and is called the jib topsail, a second on the main forestay is called the jib, and the innermost is called the staysail. All three sails are both jibs and staysails in the generic sense.

On sailboats with only one jib, it is common for the clew of the jib to be further aft than the mast, meaning the jib and mainsail overlap. An overlapping jib is called a genoa jib or simply a genoa.

On cruising vessels with more than one jib, it is common for the innermost one to be self-tacking, either by using a boom along the foot of the sail, or by cleating the jib sheet to a track, or both. On other cruising vessels, and nearly all racing sailboats, the jib needs to be worked when tacking. On these yachts, there are two sheets attached to the clew of the jib. As the vessel sails head-to-wind during a tack, the active sheet is released, and the other sheet (the lazy sheet) on the other side of the sailboat is pulled in. This sheet becomes the new active sheet until the next tack.

The Hoyt Jib Boom™ is a self-tacking jib used on some sailboats where there is only a single jib to facilitate single-handed sailing or sailing with unskilled crew. The Hoyt Jib Boom™ consists of a swiveling angled boom connected at the bow of the sailboat and which sweeps back under the jib and attaches to the clew of the jib. The jib sail tracks the main sail through a tack. In addition, a more efficient use of the jib sail is possible due to the better jib shape as it is held by the jib boom.

- **Spinnaker**

A spinnaker is a special type of sail that is designed specifically for sailing off the wind from a reaching to a downwind course. The spinnaker fills with wind and balloons out in front of the sailboat when it is deployed, called flying. It is constructed of very lightweight, usually nylon, fabric, and is often brightly colored.

The spinnaker is often called a chute, as it somewhat resembles a parachute in both construction and appearance, or a kite. It may be optimized for a particular range of wind angles, as either a reaching or a running spinnaker.

- **Asymmetric Spinnakers**

Asymmetric spinnakers operate more like a jib, generating lift from the side, rather than the top like a symmetric spinnaker. The asymmetric has two sheets, very much like a jib, but is not attached to the forestay along the length of the luff, but only at the corners.

Unlike a spinnaker, the asymmetric does not require a spinnaker pole, since it is fixed to the bow or bowsprit.

The asymmetric is very easy to jibe since it requires only releasing one sheet and pulling in the other one, passing the sail in front of the forestay.

It is also particularly useful in cruising yachts in the form of a cruising spinnaker or cruising chute, where the ease of handling is important and it is less likely to be used with a bowsprit.

- **Symmetric Spinnakers**

The symmetric spinnaker is the classic. It runs symmetrically alongside the sailboat and is controlled by lines known as a sheet and a guy<sup>2</sup> that run from the lower two corners of the sail.

The windward line, or guy, is attached to the corner called the tack of the sail, and is stabilized by a spinnaker pole.

The leeward (downwind) line is called the sheet. It attaches to the clew of the spinnaker and is used to control the shape of the sail.

The spinnaker pole must be moved in each jibe and is quite difficult for beginners to use, but it can be sailed in all downwind wind directions.

Symmetric spinnakers, when sailing across the wind (reaching), develop most of their lift on the forward quarter, where the airflow remains attached. When correctly set for reaching, the leading edges of a symmetric spinnaker should be nearly parallel to the wind, so the flow of air over the leading edge remains attached. When reaching, the sail camber allows only some attached flow over the leeward side of the spinnaker.

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<sup>2</sup> A **guy** is a term for a line (rope) attached to and intended to control the end of a spar on a sailboat. On a modern sloop-rigged sailboat with a symmetric spinnaker, the spinnaker pole is the spar most commonly controlled by one or more guys.



## Parts of a Sail

The parts of a sail have common terminology. Most sails are now triangular; for such sails, there are six separate terms, one for each corner and edge.

- **The Corners**

In a triangular sail, the upper point is known as the **head**; the halyard, the line that raises the sail, is attached to the head.

The lower two points of the sail, on either end of the foot (the bottom edge of the sail), are called the **tack** (forward) and **clew** (aft).

The tack is shackled to a fixed point on the sailboat, such as the gooseneck in the case of a mainsail, or the deck at the base of a stay, in the case of a jib or staysail.

The clew is movable and is positioned with running rigging. A symmetrical sail may be said to have two clews. The clew of a jib or other headsail is the free corner (not attached to any standing rigging), to which port and starboard jib sheets are attached to control the angle of the sail to the wind. In a sail with a boom (such as a mainsail on a sloop), the clew is attached to the boom and can often be tightened along the boom using the outhaul to adjust the sail shape.

- **The Edges**

The **foot** of a sail is its lowest edge, bounded by the clew and the tack or on some sails by the two clews.

The forward (leading) edge of the sail is called the **luff**. A Cunningham may be rigged on the luff of the mainsail to help control the sail shape.

The aft edge of a sail is called the **leech**. If incorrectly tensioned, the leech of a sail may “flutter” noisily; some larger mainsails are provided with a line that runs along a pocket in the leech, called a leechline, for the purpose of tightening the leech to prevent this fluttering.

- **The Roach**

The shape of a sail is seldom a perfect triangle. It is common for sailmakers to add an arc of extra material on the leech, outside a line drawn from the head to the clew. This additional part of the sail is known as the roach; mainsails usually have roaches, but they are very occasionally found on specialized jibs as well. They provide additional power for a given mast/boom size.

Since the roach cannot be supported by tension in the sail material (applied from the corners), it would flap uselessly unless some other provision were made for it. It is therefore supported by battens<sup>3</sup>, held in batten pockets, which extend into the main portion of the sail.

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<sup>3</sup> A **batten** is a thin strip of solid material (usually wood). Battens are used for various purposes in various fields.

### Sail Plan

A sail-plan is a formal set of drawings, usually prepared by a naval architect.<sup>4</sup> It shows the various combinations of sail proposed for a sailing vessel. The combinations shown in a sail plan almost always include three configurations:

- A light air sail plan. Over most of the Earth, most of the time, the wind force is Force 1<sup>5</sup> or less. Thus, an effective sail plan should include a set of huge, lightweight sails that will keep the ship underway in light breezes.
- A working sail plan. This is the set of sails that are changed rapidly in variable conditions. They are much stronger than the light air sails, but still lightweight. An economical sail in this set will include several sets of reefing ties, so the area of the sail can be reduced in a stronger wind.
- A storm sail plan. This is the set of very small, very rugged sails flown in a gale to keep the vessel under way and in control.

In all sail plans, the architect attempts to balance the force of the sails against the drag of the underwater keel in such a way that the vessel naturally points into the wind. In this way, if control is lost, the vessel will avoid broaching (turning edge-to-the wind), and being beaten by breaking waves. Broaching always causes uncomfortable motion, and, in a storm, the breaking waves can destroy a lightly built sailboat.

The architect also tries to balance the wind force on each sail plan against a range of loads and ballast. The calculation assures that the sail will not knock the vessel sideways with its mast in the water, capsize, and possibly sink.

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<sup>4</sup> **Naval architecture** is an engineering discipline dealing with the design, construction, and repair of marine vehicles.

<sup>5</sup> The **Beaufort scale** is an empirical measure for describing wind velocity based mainly on observed sea conditions. Its full name is the **Beaufort wind force scale**.

## Spars Found on Sailboats

In sailing, a spar is a pole of wood, metal, or lightweight material such as carbon fiber. Spars of all types (booms and masts) are used in the rigging of sailing vessels to provide (direct or indirect) support of the sails and to resist bending forces.

## Boom

A boom is a spar (pole), along the foot (bottom) of a fore-and-aft rigged sail, which greatly improves control of the angle and shape of the sail.

The primary action of the boom is to keep the foot of the sail flatter when the sail angle is away from the centerline of the sailboat.

The boom also serves an attachment point for more sophisticated control lines. Because of the improved sail control it is rare to find a non-headsail without a boom. In some modern applications, the sail is rolled up into the boom for storage or reefing (shortening sail).

- **Boom Attachments**

The forward end of the boom attaches to a mast just below the sail, with a joint called the gooseneck. The gooseneck pivots allowing the other end of the boom to move freely.

The clew (back corner) of the sail attaches to the free end of the boom.

The entire foot of the sail may be attached to the boom or just the clew. If the foot is not attached to the boom, the rig is known as loose-footed.

A boom may be found on small headsails. There, the forward end of the boom is attached to the same stay as the sail's luff (forward edge).

### • Lines on the Boom

The outhaul runs from the clew of the sail to the free end of the boom. Hauling in on (tightening) the outhaul increases foot tension in the main sail.

Modern loose-footed sails are cut so that the outhaul is also able to pull the clew downwards towards the boom. The sheet is attached midway along the boom or at the free end. In smaller sailboats it is used to control the angle of the sail to the wind on each point of sail. On larger sailboats, the traveler largely assumes this function and the main sheet is used to adjust the twist of the sail to present the luff of the sail to the wind all of the way up the mast.

The traveler is a track running from one side of the sailboat to the other upon which sits a car to which the other end of the sheet is attached. Moving the car from side to side alters the angle of the boom to the centerline of the sailboat while minimizing the effect on the twist of the sail.

A boom will frequently have these additional sail control lines attached:

- A downhaul may be attached to the boom near the gooseneck to pull the boom down and increase tension on the luff (forward edge) of the sail.
- The boom vang, kicking strap, or kicker is an intricate set of pulleys (and, on yachts, a hydraulic ram) running diagonally between the boom and the lower portion of the mast. The kicker pulls the boom downwards.
- The preventer prevents the boom from jibing. This line is run from a point on the boom to a point forward such as a deck cleat or the base of a stanchion.
- Reef lines are used to tie off excess sail when sails are reefed (shortened). Some modern systems known as “jiffy reefing” or “slab reefing” have permanent lines running through the boom for purposes of reefing.
- Other lines that may be found on a boom include:
  - A topping lift holds up the free end of the boom when the sail is lowered.
  - Lazy jacks guide the sail onto the top of the boom for furling when the sail is lowered.

## Bowsprit

The bowsprit of a sailing vessel is a pole extending forward from the vessel's prow. It provides an anchor point for the forestay(s), allowing the foremast to be stepped further forward on the hull.

On large tall ships, the bowsprit may be a considerable length and have several forestays<sup>6</sup> attached. When not in use, the foresails are stowed by being tied onto the bowsprit. The crew must then work out on the bowsprit to stow or prepare the sails.

To minimize the risk of the bowsprit (and any crew working on it) being buried in large waves, the bowsprit is normally angled upwards from the horizontal.

## Masts

The mast of a sailing ship is a tall vertical pole that supports the sails. Larger ships have several masts, with the size and configuration depending on the style of ship.

A ship's masts are named from bow to stern (front to back):

- Foremast—the first mast or the mast fore of the main mast
- Main mast—the tallest mast, usually located near the center of the ship
- Mizzen mast—the third mast or the mast immediately aft of the main mast; typically shorter than the foremast

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<sup>6</sup> On a sailing vessel, a **forestay**, sometimes just called a stay, is a piece of standing rigging which keeps a mast from falling backwards. It is attached either at the very top of the mast or in fractional rigs between about one-eighth and one-quarter from the top of the mast. The other end of the forestay is attached to the bow of the boat.

Often, a sail is attached to the forestay. This sail may be a jib or a genoa. In a cutter rig, the jib or jibs are flown from stays in front of the forestay, perhaps going from the masthead to a bowsprit. The sail on the forestay is then referred to as the staysail or stays'l.

A forestay might be made from stainless steel wire on a modern yacht, solid stainless steel rod or carbon rod on a high-performance racing boat, and galvanized wire or natural fibers on an older cutter or square-rigged ship.

### Topmast

The masts of traditional sailing ships were not single spars but were constructed of separate sections or masts, each with its own rigging. The topmast is one of these.

The topmast is semipermanently attached to the upper front of the lower mast, at the top. Its shrouds run to the edges of the top, rather than to the sides of the hull, though long shrouds leading well aft to the hull, more in the manner of backstays, are sometimes seen. In accordance with the standard square-rig sail plan, the topmast carries the topsail.

In the late nineteenth century, topsails became so big that merchant ships began to divide them into two separate sails for easier handling. Because these were still on the topmast, they were known as upper and lower topsails to preserve the consistency of the naming scheme.

The majority of large square-riggers today carry separate upper and lower topsails.

The main topmast carries the upper end of the main-topmast-staysail; a mizzen-topmast may carry the equivalent. The fore-topmast will carry a staysail, but depending on where the lower end of the stay is attached it may be called a fore-topmast-staysail or an inner jib.

When steel masts were introduced, with their lengths no longer limited by the height of a tree, ships were often constructed with single spars serving as both lower mast and topmast. In every other respect, however, the topmast lived on, with separate shrouds to the lower mast and a top between the two.

The section of mast immediately above the top was often painted white, as the lower masthead used to be, with the section of the steel mast representing the topmast continuing on above in its usual color.

## Yard

A yard is a spar on a mast from which sails are set, constructed from either timber or steel.

Some types of fore-and-aft rigs have yards; the term is usually used to describe the horizontal spars used with square sails. In addition, for some decades after sails were dispensed with, some yards were retained for deploying wireless (radio) aerals and signal flags.

- **Parts of a Yard**

- Bunt—the short section of the yard between the slings that attach it to the mast
- Quarters—the port and starboard quarters form the bulk of the yard, extending from the slings to the fittings for the lifts and braces<sup>7</sup>
- Yardarms—the outermost tips of the yard, outboard from the attachments for the lifts

Note that these terms refer to stretches of the same spar, not to separate component parts.

- **Modern Masts**

Although sailing ships were superseded by engine-powered ships in the nineteenth century, recreational sailing ships and yachts continue to be designed and constructed. In the 1930s, aluminum masts were introduced on large J-class yachts. Aluminum has considerable advantages over wooden masts, being lighter, stronger, and impervious to rot. Also, an aluminum mast can be extruded as a single piece for the entire height as the mast.

After the Second World War, extruded aluminum masts became common on all dinghies and smaller yachts. Higher performance yachts would use tapered aluminum masts, constructed by removing a triangular strip of aluminum along the length of the mast and then closing and welding the gap.

From the mid-1990s, racing yachts introduced the use of carbon fiber and other composite materials to construct masts with even better strength-to-weight ratios. Carbon fiber masts could also be constructed with more precisely engineered aerodynamic profiles.

Modern masts form the leading edge of a sail's airfoil and tend to have a teardrop-shaped cross-section. On smaller racing yachts and catamarans, the mast rotates to the optimum angle for the sail's airfoil.

If the mast has a long, thin cross-section and makes up a significant area of the airfoil, it is called a wing-mast; sailboats using these have a smaller sail area to compensate for the larger mast area.

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<sup>7</sup> The **braces** on a square-rigged ship are lines used to rotate the yards around the mast, to allow the ship to sail at different angles to the wind.

### Spinnaker Pole

A spinnaker pole is a spar used in sailboats to help support and control a variety of headsails, particularly the spinnaker.

It is also used with other sails, such as genoas and jibs, when sailing downwind with no spinnaker hoisted. (Because the load on a spinnaker pole is very light on this point of sailing, sometimes a special light spinnaker pole, called a whisker pole, is used in these circumstances.)

The spinnaker pole is rigged to run from the base of the mast, where there is a special fitting for attaching one end of the pole, out to windward over the side of the boat. There, one of the control lines of whichever sail it is to be used with it is run through a fitting on the other end of the spinnaker pole. This allows for more precise control of the corner of the sail to which the line is attached.

For a spinnaker, the line is the guy, and the corner is the tack. For other headsails, such as a jib, the line would be the sheet, attached to the clew.

A special line, the topping lift, runs from the middle of the spinnaker pole up to a block on the mast and is used to support the weight of the spinnaker pole. Another line referred to as the “downhaul,” or more correctly, the “foreguy” runs down so that the height of the pole is under positive control at all times.

### Rigging

Rigging is a generic term for the mast, boom, shrouds, stays, sails, and all of the other bits and pieces that form a sailing vessels “engine.”



## Running Rigging

Running rigging is the term for the rigging of a sailing vessel that is used for raising, lowering, and controlling the sails.

Traditionally, the running rigging was easily recognized because, for flexibility, it was not coated with tar and therefore was of a light color, while the standing rigging was tarred for protection and therefore black or dark in color.

On modern vessels, running rigging is likely to be made from polyester and other synthetic fibers, while the standing rigging is frequently made of steel cable for strength.

Some types of running rigging include:

- Halyards are used to raise sails (or yards on square-rigged vessels).
- Sheets are attached to the clews of the sails to control their angle to the wind.
- Downhauls lower a sail or a yard and can be used to adjust the tension on the luff of a sail.
- Cunninghams tighten the luff of a sail.
- Guys control spars.
- Topping lifts hold up booms or yards.
- Barber hauls adjust the sheeting angle of a foresail (jib).

Older ships (particularly square-rigged vessels) required even more running rigging, such as:

- Braces were used to adjust the fore and aft angle of a yard.
- Tacks were used to haul the clew of a square sail forward.
- Topping lifts adjust the up-and-down angle of a yard.
- Buntlines, clewlines, and leechlines allow a square sail to be raised to its yard.

- **Halyard**

Halyard is a line (rope) that is used to hoist (pull up) a sail, a flag, or a yard.

A triangular (Bermuda or “Marconi”) sail has only one halyard that is attached at its uppermost point (the head).

A gaff-rigged sail has two: a throat halyard to lift the end of the gaff nearer the mast, and a peak halyard to lift the outer end.

A square-rig sail with a halyard is mounted on a lifting yard that is free to slide on a short section of the mast. The halyard is used to raise the yard when setting the sail.

- **Halyard Materials**

Halyards, like most other parts of the running rigging, were classically made of natural fiber like manila or hemp. Today, polyester is most often used, but stainless steel or galvanized steel may be found on some older yachts, and lightweight carbon fiber on racing vessels. The term halyard comes from the phrase “to haul yards.”

- **Halyard Fastenings**

Halyards can be attached a number of ways to the head of a triangular sail. The most common methods are as follows:

- A shackle<sup>8</sup> through a headboard on the sail
- A bowline through a hole in the head
- A half hitch with a figure-of-eight knot (this knot is preferred over a bowline because it allows the sail to get closer to the top of the mast)

The other end of the halyard is usually attached to the mast at its foot by way of a cleat. It is convention in some places to fasten the main halyard (for the mainsail) on the starboard side of the mast and the jib halyard to the port side. This allows quicker access to the lines in a time-critical situation.

- **Downhaul**

The downhaul is a line that is part of the rigging on a sailboat; it applies downward force on a spar or sail. The most common downhaul on a modern sailboat is attached to the spinnaker pole, although the term is also commonly applied to the Cunningham on the mainsail.

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<sup>8</sup> A **shackle** is a U-shaped piece of metal secured with a pin or bolt across the opening, or a hinged metal loop secured with a quick-release locking pin mechanism. They are used as a connecting link in all manner of rigging systems, from boats and ships to industrial crane rigging. As an automotive term, it refers to a link connecting the leaf spring to the frame.

- **Cunningham**

- A Cunningham or Cunningham's eye is a type of downhaul used on a Bermuda rigged sailboat to change the shape of a sail. The Cunningham differs from a typical downhaul in the way that it attaches to the sail.
- The system usually consists of a line that is secured at one end to the mast or boom below the foot of the mainsail. It is then passed through a cringle in the luff of the sail near the foot, but above the tack, and then led down on the other side to a fitting on the mast or boom or on deck.

- **Guy**

A guy is a term for a line attached to and intended to control the end of a spar on a sailboat. On a modern sloop-rigged sailboat with a symmetric spinnaker, the spinnaker pole is the spar most commonly controlled by one or more guys.

There are two primary types of guys used to control a spinnaker pole:

- The afterguy, working guy, or simply guy is attached to the windward clew of the spinnaker and runs through the jaws on the outboard end of the pole and back to the cockpit. The afterguy is used to rotate the outboard end of the pole around the mast in order to optimize the sail's effectiveness, depending on the direction of the wind. Because a spinnaker has two clews, there is always a second line identical to the afterguy attached to the leeward clew of the spinnaker. This is called the sheet and serves a slightly different function. When the sailboat jibes, the spinnaker pole will be moved from one side of the sailboat to the other, causing the sheet to become the guy and vice versa.
- A foreguy may also be used to control the height of the spinnaker pole. It is attached either to the end of the pole or to a bridle on the bottom of the pole, and runs through a pad eye on the foredeck rather than directly aft to the cockpit. The foreguy is used to keep the end of the pole from lifting up under heavy wind. In addition, it can be used to change the shape of the spinnaker slightly to make the sail more efficient. The foreguy may be referred to as a downhaul if it is attached to a bridle at the pole's midpoint, but this term is used for other parts of a sailboat's rigging as well.

- **Outhaul**

An outhaul is a line that is part of the running rigging of a sailboat, which is used to extend a sail and control the shape of the curve of the foot of the sail. It runs from the clew (the back corner of the sail) to the end of the boom. The line is pulled taut to the appropriate tension (to provide the desired shape to the foot), and then secured to a cleat on the boom.

- **Preventer**

A preventer is a mechanical device on a sailing vessel that limits the boom's ability to swing dangerously across the sailboat during an accidental jibe.

All sensible sailors fear the uncontrolled jibe. The heavy boom can potentially inflict severe head injuries or dispatch crewmembers overboard while the mainsheet or traveler can also inflict serious injury. Uncontrolled jibes may also damage the sailboat itself.

Rigging a preventer on a yacht's mainsail is often performed when the wind is behind the beam (i.e. when it's coming from more than 90 degrees off the bow). It can also be useful at other times when there is more swell than wind, a situation when the wind may not have the strength to keep the boom in place as the sailboat dips and rolls.

- **Boom Brake**

Another form of preventer is the boom brake, which is used when sailing downwind and can also be used to jibe the mainsail in a slow, measured action.

The brake usually rides on a line running perpendicular to the boom. When the boom brake is actuated, it grabs the line and either works as a preventer or slows the boom's speed while jibbing.

The brake is actuated by either tensioning the line upon which it rides or using a second line to tension the brake relative to the main line.

- **Boom Vang**

A boom vang is a line or piston system on a sailboat used to exert downward force on the boom and thus control the shape of the sail. The vang typically runs from the base of the mast to a point about a third of the way out the boom. The boom vang holds the boom down and flattens the mainsail.

Due to the great force necessary to change the height of the boom while a sailboat is under sail, a line-based boom vang usually includes some sort of a pulley system. Hydraulic piston vangs are used on larger sailboats and are controlled by manual or electric hydraulic pumps.

By controlling leech tension, the boom vang is one of the three methods of controlling sail twist. A vang works with the sheet to apply the downward force on the boom at all horizontal angles, allowing the sheet to be used to control the horizontal angle of the boom. While under sail, the opposite force to the vang is supplied by the sail itself. When the sail is furled, a topping lift supplies the upward force on the boom. Some line vang systems incorporate a piston to provide the topping lift force and to damp oscillations. Hydraulic vangs can inherently act in the topping-lift role.

- **Topping Lift**

The topping lift is a line that is part of the rigging on a sailboat; it applies upward force on a spar or boom.

Topping lifts are also used to hold a boom up when its sail is lowered. This line would run from the free end of the boom forward to the top of the mast. The line may be run over a block at the top of the mast and down to the deck to allow it to be adjusted.

For small booms, the topping lift may be run from end of the boom to the backstay or next mast aft. When the sail is raised again, the topping lift is loosened or removed.

## **Standing Rigging**

Standing rigging generally refers to lines, wires, or rods that are more or less fixed in position while the boat is under sail.

Standing rigging is placed under tension to keep the various spars (mast, bowsprit) securely in position and adequately braced to handle loads induced by sails.

On modern yachts, standing rigging is often stainless steel wire or stainless steel rod.

Typically, a modern sailboat rigged as a sloop will carry the following pieces of standing rigging: a forestay, a backstay, and upper and lower shrouds.

- **Shrouds**

Shrouds are pieces of standing rigging which hold the mast up from side to side and help resist sideways movement. There is frequently more than one shroud on each side of the sailboat.

Usually a shroud will connect at the top of the mast, and additional shrouds might connect partway down the mast, depending on the design of the sailboat.

On most sailboats, shrouds then terminate at their bottom ends to the side of the boat. Shrouds are attached symmetrically on both the port and starboard sides.

For those shrouds that attach high up the mast, a structure projecting from the mast must be used to increase the angle of the shroud at the attachment point, providing more support to the mast. On most sailboats, such structures are called spreaders, and the shrouds they hold continue down to the deck. Spreaders work in conjunction with the shrouds to control side bend of the mast.

On large sailing ships, however, particularly square-riggers, the shrouds end at the projections (called tops or crosstrees) and their loads are carried into the mast slightly further down by futtock shrouds.

- **Stays**

Stays are the heavy ropes, wires, or rods on sailing vessels that run from the masts to the hull, usually fore-and-aft along the centerline of the vessel. The stay that runs aft is called backstay and the stay that runs forward is called forestay or just stay.

Shrouds and stays are part of the vessel's standing rigging that support the mast in the fore-and-aft and athwartship directions.

- **Backstay**

A backstay is a piece of standing rigging that runs from the mast to the transom of the boat, counteracting the forestay and jib. The backstay is an important sail trim control and has a direct effect on the shape of the mainsail and the headsail.

There are two general categories of backstays:

- A permanent backstay is attached at the top of the mast and may or may not be readily adjustable.
- The running backstay is attached about two-thirds of the way up the mast (sometimes at multiple locations along the length of the mast).

Most modern sailboats will have a permanent backstay and some will have a permanent backstay combined with a running backstay.

- **Forestay**

A forestay, sometimes just called a stay, is a piece of standing rigging which keeps a mast from falling backwards. It is attached either at the very top of the mast, or in fractional rigs between about one-eighth and one-quarter from the top of the mast. The other end of the forestay is attached to the bow of the boat.

Often a sail is attached to the forestay. This sail may be a jib or a genoa. In a cutter rig, the jib or jibs are flown from stays in front of the forestay, perhaps going from the masthead to a bowsprit. The sail on the forestay is then referred to as the staysail or stays'l.

A forestay might be made from stainless steel wire on a modern yacht, solid stainless steel rod or carbon rod on a high-performance racing boat, and galvanized wire or natural fibers on an older cutter or square-rigged ship.

## Gooseneck

The gooseneck is a fitting used to connect the boom to the mast that allows the boom to swing freely. The boom moves from side to side and up and down by swiveling on the gooseneck.

Goosenecks on older rigs may be formed by a loop attached to the end of the boom that fits loosely about the mast.

## Block

A block is a single or multiple pulleys<sup>9</sup> where one or a number of sheaves are enclosed in an assembly between cheeks or chocks. In use, a block is fixed to the end of a line, to a spar, or to a surface. Rope or line is run through the sheaves, and maybe through one or more matching blocks at some far end to make up a tackle<sup>10</sup>.

The purchase of a tackle refers to its mechanical advantage<sup>11</sup>. In general, the more sheaves in the blocks that make up a tackle, the higher its mechanical advantage. The matter is slightly complicated by the fact that every tackle has a working end where the final run of rope leaves the last sheave. More mechanical advantage can be obtained if this end is attached to the moving load rather than the fixed end of the tackle.

## Cleat

A cleat is a device attaching a rope. The traditional design is attached to a flat surface and features two “horns” extending parallel to the deck. The proper method of attaching running rigging to a cleat is by using a round turn, figure eights, and a half hitch.

Other cleat designs include the following:

- A cam cleat in which one or two cams pinch the rope but allow the rope to easily be pulled tighter
- A jam cleat in which the line is pinched in a v-shaped slot
- A clam cleat in which the rope is held between two fluted stationary pieces

## Clevis Pin

A clevis pin is a type of fastener that will allow rotation of the connected parts about the axis of the pin. A clevis pin consists of a head, a shank, and a hole. The hole passes through the shank at the opposite end of the pin from the head. A cotter pin is inserted through the hole to keep the clevis pin in place after assembly of the parts to be fastened.

Commonly the clevis pin is used with a shackle. A straight shackle looks like the letter C, with holes at each end; when you insert the clevis pin; you create a D with the clevis able to rotate about the axis of the pin. A twist shackle provides a loop at a right angle to the axis of rotation.

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<sup>9</sup> **Pulleys** change the direction of a tension force on a flexible material, e.g., a rope or cable. In addition, pulleys can be “added together” to create mechanical advantage, by having the flexible material looped over several pulleys in turn. More loops and pulleys increase the mechanical advantage.

<sup>10</sup> A **block and tackle** is a system of two or more pulleys with a rope or cable threaded between them, usually used to lift or pull heavy loads.

<sup>11</sup> **Mechanical advantage (MA)** is the factor by which a mechanism multiplies the force put into it.

### Gasket

Gaskets are lengths of rope or fabric used to hold a stowed sail in place. In modern use, the term is usually restricted to square-rigged ships, the equivalent items on yachts being referred to by the more prosaic “sail ties.”

On most ships, gaskets are made of rope. They are attached to the top of the yard and, left loose, would hang behind the sail.

### Chafing Gear

Chafing, when used as a nautical term, describes the process of wear on a line or sail caused by constant rubbing against a hard, usually metallic, surface.

Various methods are used to prevent chafing:

- Chafing can be prevented by putting a protective material (sometimes as simple as a piece of old garden hose) around the line.
- Chafing of a sail rubbing against a cable can be prevented on large ships by tying baggywrinkle<sup>12</sup> around the cable.

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<sup>12</sup> **Baggywrinkle** is a soft covering for cables (or any other obstructions) to reduce sail chafe. There are many points in the rig of a large sailing ship where the sails come into contact with the standing rigging; unprotected sails would soon develop holes at the points of contact. Baggywrinkle provides a softer wearing surface for the sail.



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