KNIGHT
MODERN SEAMANSHIP
1902

CHAPTER III.

SPARS AND STANDING RIGGING.[1]

§ I. MASTS.

Lower masts in modern ships are usually built up of steel plates stiffened in various ways by steel shapes. (Plate 20.)

Built-up masts of wood are no longer used, although lower masts made of single pine sticks are not uncommon in sailing ships of moderate size.

Topmasts and topgallant masts are still made of wood, usually of pine.

The details of masts are shown in Plates 20 and 21.

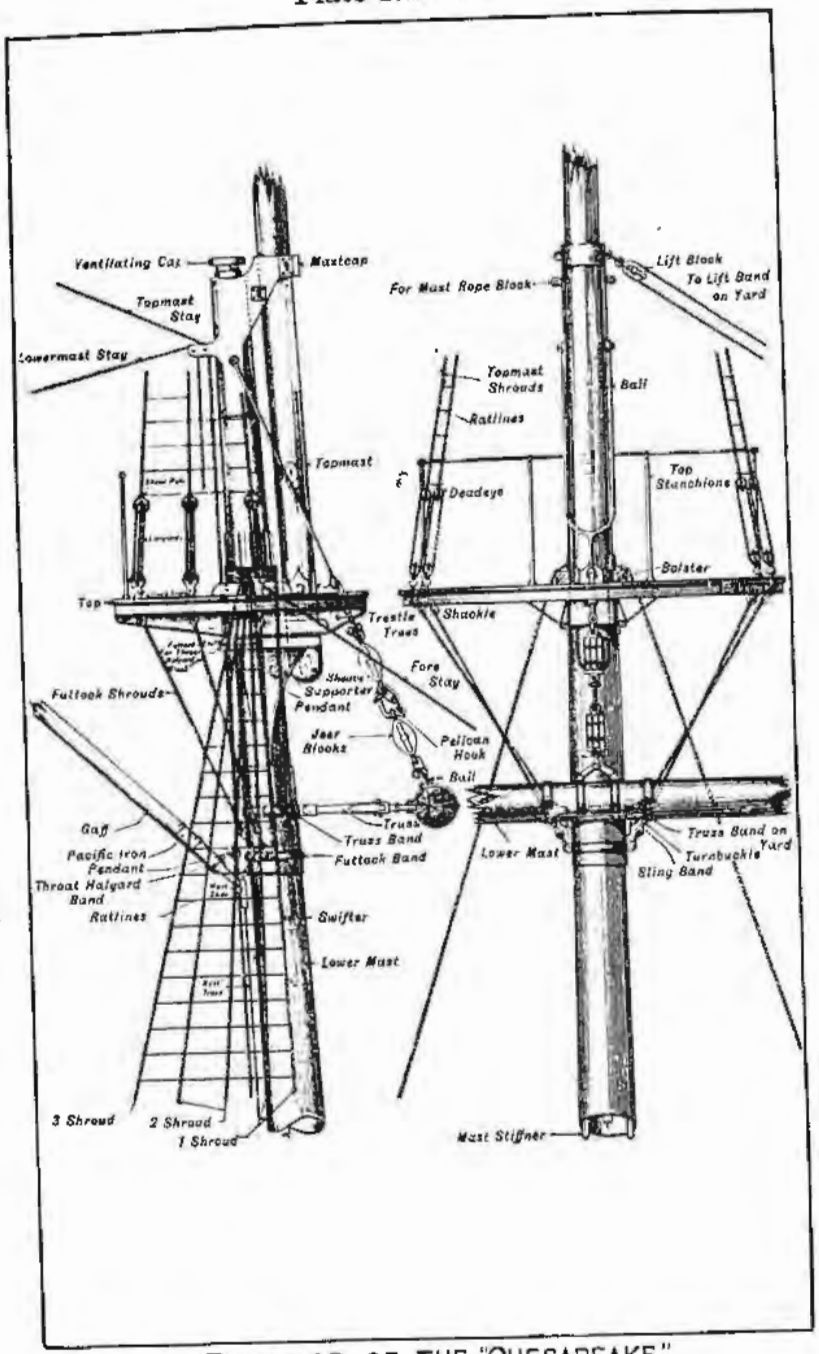
The mast rests on a step, placed as low as possible; usually on the keelson. At the lower end is a tenon fitting into a mortise at the step. Where the mast passes through the successive decks, timbers are built in from beam to beam, forming partners; the space between these and the mast being filled by tightly-fitting wedges.

The masthead is smaller than the body of the mast, and at the shoulder, called the hounds, where the reduction in size is made, heavy knees or bibbs, are bolted on, widening the shoulder and forming a secure support for the trestle-trees; stout fore and aft pieces which, in their turn, support the cross-trees, the top, the topmast, and the eyes of the lower rigging. The cross-trees are athwartship pieces crossing the trestle-trees forward and abaft the masthead, and forming the principal part of the framing of the top. They are jogged down into the trestle-trees, and with the latter form a skeleton to which the comparatively light planking of the top is secured.

The lower masthead terminates in a square tenon, to which

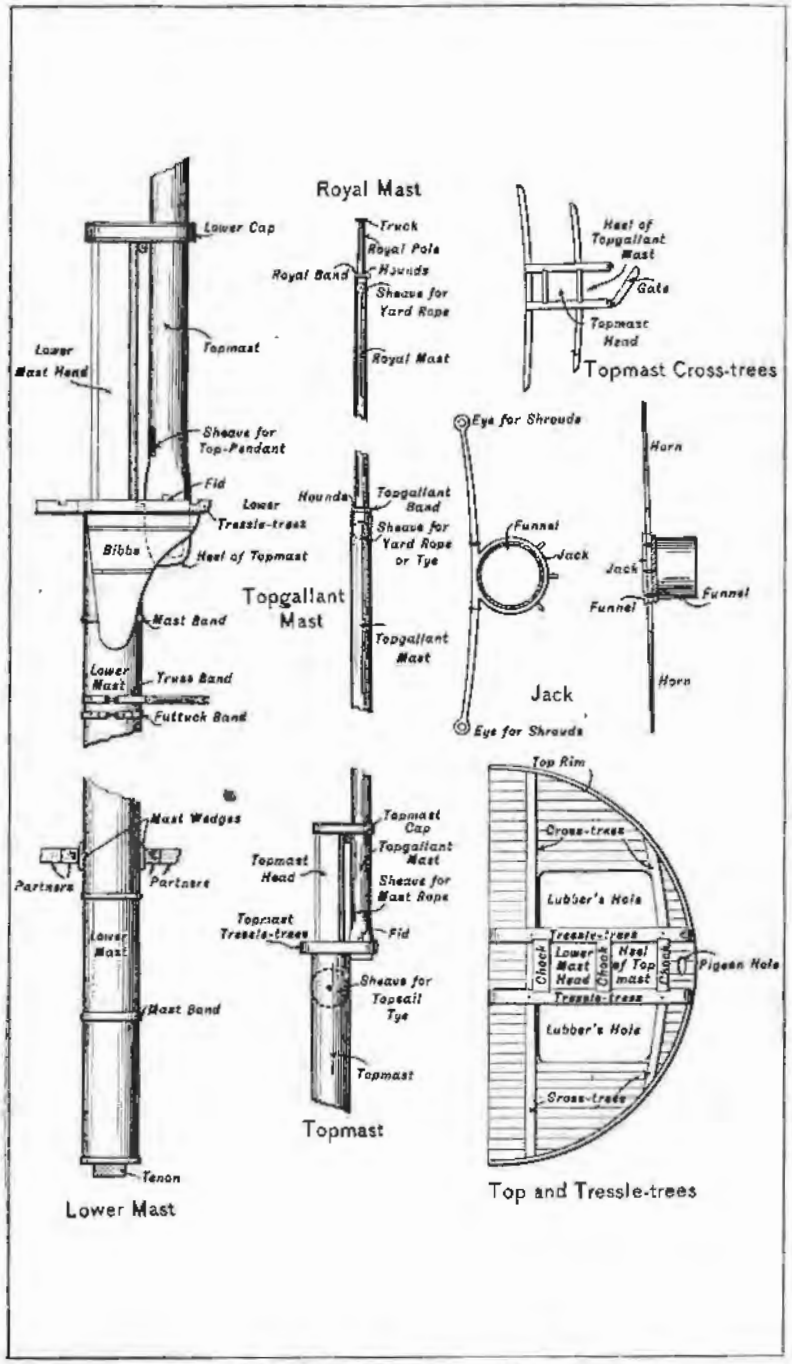
[1] In this and the succeeding chapter (Sails and Running Gear), the text has been made brief because it is considered that the details of Spars, Sails and Rigging can be made clearer by plates than by description. The accompanying plates have accordingly been made unusually full and they should be constantly referred to in reading the text.

Plate No. 20.



FORE TOP OF THE "CHESAPEAKE."

Plate No. 21.



MASTS AND FITTINGS.

the cap is fitted. This may be of wood, iron-bound, or built up of steel as in Plate 20.

The topmast passes through a round hole in the forward part of the cap, which thus binds the two masts together. In the heel of the mast is a thwartship hole, square in section, through which is placed an iron fid, with its ends projecting and resting on the trestle-trees on either side. Two sheaves placed diagonally in the heel of the topmast furnish a lead for the top pendants, by which the mast is sent up and down. The overlapping parts of the lower masts and topmasts are the doublings.

The topmast head is fitted in practically the same way as the lower masthead, and the heel of the topgallant-mast "doubles" upon it similarly. Cross-trees are used here as spreaders for the topgallant rigging, but without a top. The cross-trees serve an important purpose also in furnishing a foothold for men at the topmast head.

Topgallant and royal masts are in one, but the diameter is reduced at the topgallant masthead forming hounds, upon which rests the topgallant funnel;—a composition cylinder, with two thwartship arms forming the "Jack." At the royal masthead is a similar shoulder, with an iron band for the rigging, and above this is the pole terminating in a tenon to which the truck is fitted. The truck usually carries the point of a lightning conductor, the lower end of which makes contact with the hull, or, in the case of a wooden ship, with the copper well below the water-line.

Trysail masts are fitted up and down abaft the lower masts, being stepped on deck and secured at the head by bands connecting by a key to corresponding bands on the lower mast.

Modern men-of-war rarely carry sail, and such masts as they have are usually for military purposes only;—in some cases for carrying light guns in elevated positions, in other cases merely for signalling. Plate 23 shows the military mast of a battleship.

§ II. YARDS.

A full-rigged ship carries a lower, topsail, topgallant, royal, and sometimes a sky-sail, yard, on each mast. The topsail and topgallant yards are often double.

The details of yards are shown on Plates **20** and **22**.

The midship part of a yard is the s l i n g s ; outside of this come the q u a r t e r s , and beyond these the y a r d - a r m s . The lower yards are hung by s l i n g s , usually of chain, and are held to the mast by t r u s s e s , upon which they pivot both horizontally and vertically.

Where the lower topsail yards are double, the lower one is trussed to the lower cap and supported from beneath by a shore. The upper one is held to the mast by a p a r r e l which travels up and down as the yard is hoisted and lowered. The parrel may take the form of a lashing passed abaft the mast between two jaws, or it may be a metal cylinder or "tub," to which the yard is keyed. Where a tub is used, the inner edges, top and bottom, should be rounded off to prevent cutting the mast if the tub cants. The yard is hoisted by a tye, reeving through a block which hooks or shackles to the slings of the yard.

Where a single topsail is used, the yard is fitted as described above for an upper topsail yard.

Topgallant and royal yards are held to the mast by jaws and parrel (Plate **22**), and hoisted by tyes and halliards.

On ships which carry studding sails, booms are fitted on the lower and topsail yards, being secured by *boom-irons*. The booms and their fittings are described in Chapter XXV.

The details of the bowsprit and head booms are shown on Plate **27**; those of gaffs for trysails on Plate **33**.

§ III. STANDING RIGGING.

So great are the variations in the rigging of modern ships, depending in part upon the purposes for which the ships are designed and the amount of sail they are to carry, and in part upon the views of their designers, that it is impossible to give a description of it which shall be anything like universally applicable. The description which follows applies to a sailing man-of-war of recent construction which in its general features is fairly representative of ships which carry sail enough to make their rigging important.

The masts of a ship are supported from the sides by *shrouds*, from forward by *stays* and from aft by *backstays*. The *backstays* contribute also to the sidewise support since they are necessarily led to the sides of the ship. The *stays*, in addition

Plate No. 22.

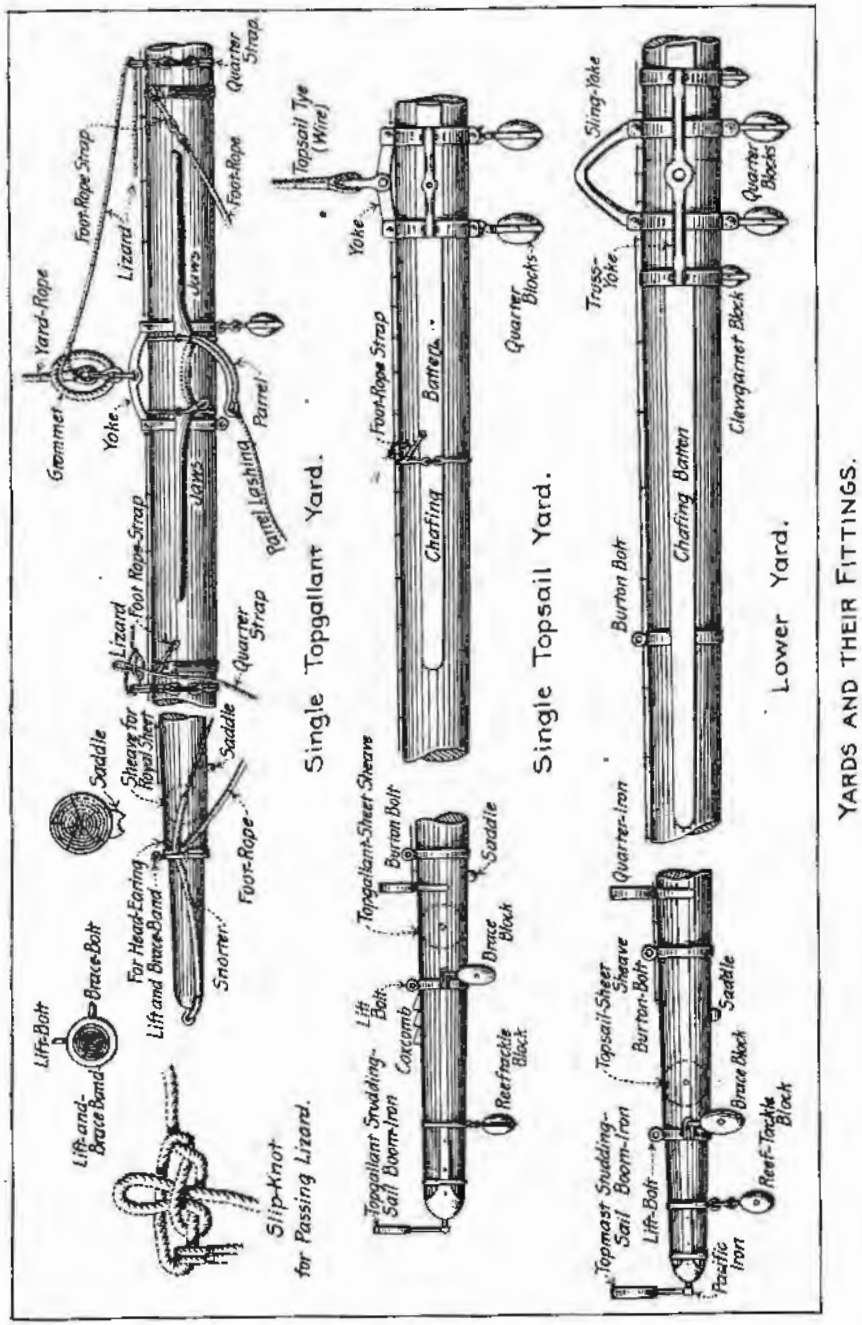
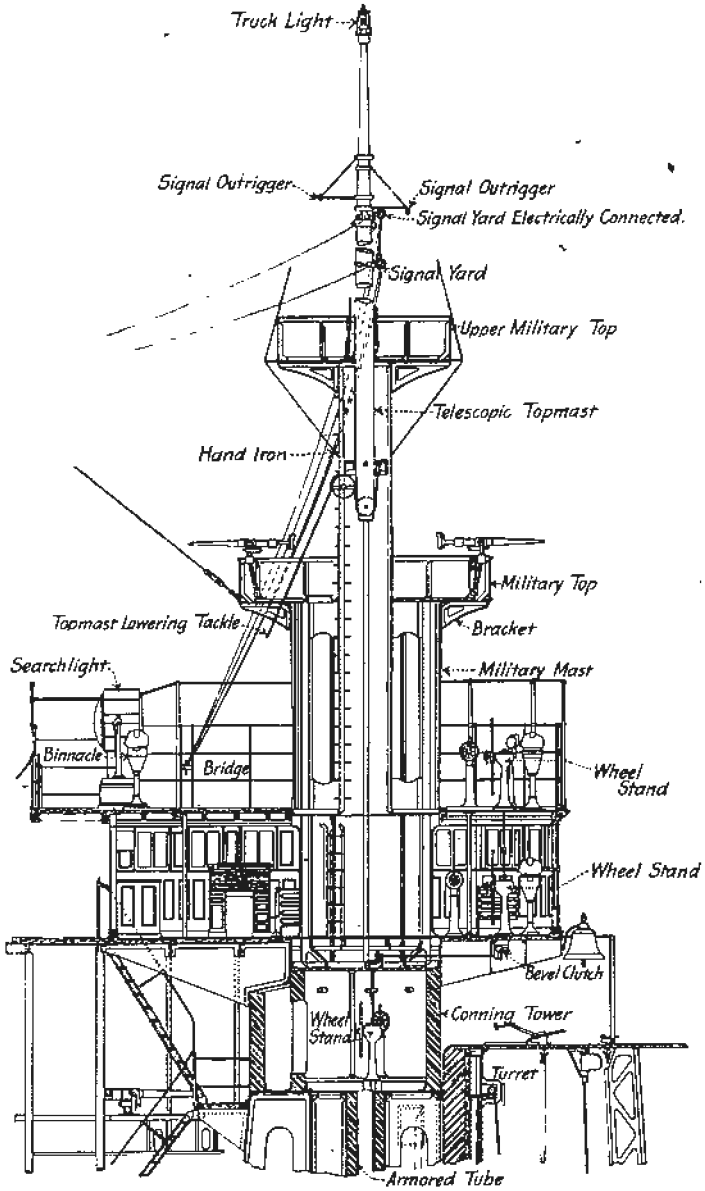


Plate No. 23.



MILITARY MAST
AND
HAND STEERING GEAR OF A BATTLESHIP.

to supporting the masts, serve to carry certain fore-and-aft sails known as *staysails*. For convenience in hooking tackles at the mastheads for various purposes, heavy *pendants* are provided, fitted with thimbles and links and hanging well clear of the other rigging.

The head-booms are supported from beneath, against the pull of the stays and the lifting tendency of the head sails, by *bobstays*, *martingales*, &c., leading to the cut-water; and from the sides by *bowsprit shrouds*, *jib-* and *flying jib-guys*, leading to the bow.

The above constitute the "Standing Rigging" of a ship, shown in outline in Plates **28** and **31**, and in detail in Plates **26** and **27**.

Standing Rigging is usually fitted of galvanized steel-wire rope, plain-laid, of six strands, and is protected from the weather, chafe and wear, by a good coating of red lead and oil, then wormed and parcelled with cotton sheeting so laid on and overlapped as to give two thicknesses over all the rope, thoroughly painted again and served. The layers of parcelling are laid on working from down up (with reference to the way the rope will lead when in place), so that they shall shed rain like layers of shingling on a roof. All nips and bends around thimbles and elsewhere are double-served. Fore and aft stays are double-served and covered with leather in the collars and at other points where they are subject to excessive chafe.

Stays which carry sails are left bare in the wake of the hanks and protected by several coats of good asphaltum varnish.

The eyes of shrouds are double-parcelled with tarred canvas and served, after which they are covered with another layer of tarred canvas, called the "heading," which is marled down over all.

The eye-seizings of the shrouds are hove on over a piece of tarred canvas considerably wider than the seizing is to be, so that after the turns are passed the canvas can be turned down over them protecting them from the weather.

The ends of all stays are turned up beneath the standing parts and the ends of shrouds inside the standing parts.

The rigging goes over the various mastheads in the following order:

Lowermast head.—Pendants, Shrouds (in pairs starboard and port alternately), Stays.

Topmast head.—Shrouds (in pairs), Backstays, Stays.

Topgallantmast head.—Stays, Shrouds, Backstays.

Royalmast head.—All standing rigging makes fast to the royal band.

To increase the *spread* of the lower rigging, broad pieces of heavy planking called "chains" or "channels" are, in old-fashioned ships, firmly secured to the side of the ship, with stout iron straps called "chain-plates" leading from their outer edge downward to the side of the ship. To the upper ends of these straps are shackled the lower dead-eyes of the rigging. In modern ships, the channels are dispensed with and the chain-plates are bolted up and down the side and terminate at the rail in eyes to which the dead-eyes or rigging screws are shackled. In steamers, the rigging often sets up to the deck, inside the rail.

The necessary spread for the topmast-shrouds is given by the top, the dead-eyes or rigging-screws being secured to iron rods called "futtock-shrouds" which shackle to a band on the lower mast below the bibbs.

Similarly, to increase the spread of the topgallant rigging, the topmast cross-trees are made with long arms into the ends of which the topgallant shrouds are clamped. In the same way, the arms of the "jack" act as spreaders for the royal shrouds.

The spread for the jib-guys is given by the "whisker-booms" hooked to the bowsprit-cap and extending out on either side, while the "dolphin-striker," projecting below the bowsprit-cap, gives a favorable lead to the martingales and head stays.

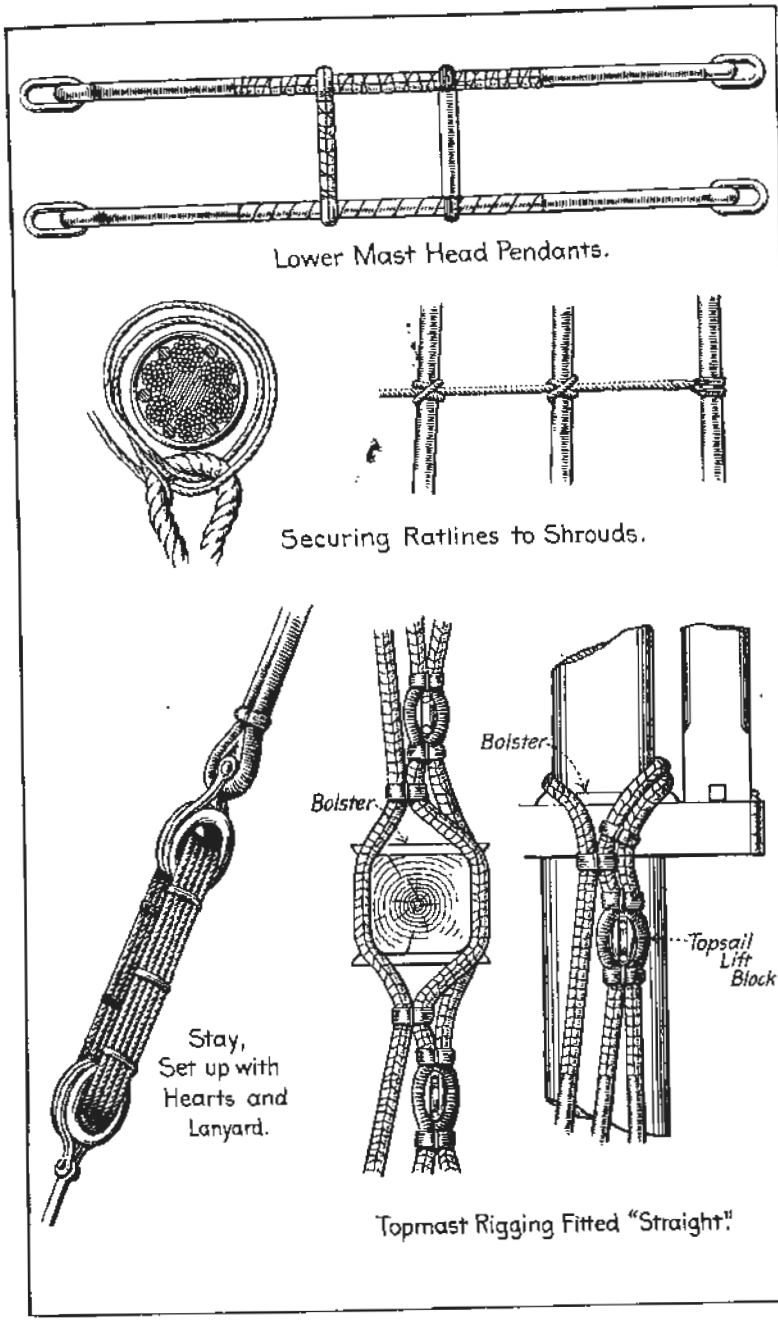
Before the rigging is sent aloft, small blocks of wood, rounded and covered with canvas, are secured on top of the trestle-trees. These are the "bolsters" designed to keep the rigging from sawing across the edge of the trestle-trees.

LOWERMAST HEAD. (Plate 26.)

The Pendants go over first. These are fitted "straight"; that is to say, the forward pendants starboard and port are in one, leading straight across, the forward and after leg on each side being spanned together forming a square eye which fits down snugly over the bolsters.

The Shrouds are fitted with eyes and go over the mast-

Plate No. 24.



FITTINGS OF STANDING RIGGING.

head in pairs, the two legs of a pair coming down on the same side. The forward pair starboard goes over the first, then the forward pair port; and so on.

The shrouds set up to the rail, the deck, or to the "channels" as already described. Fig. 1, Plate **25**, shows a method commonly used in modern ships. Formerly they were set up with dead-eyes and hemp lanyards, and the use of such lanyards was considered of especial importance with wire rigging because of the "give" which came from their use. In recent ships, not only the shrouds but most of the other standing rigging is set up with rigging-screws, which, although entirely lacking in "give," seem to be satisfactory when strong and well secured.

The Lower Stays go over with collars formed of two legs lashing together abaft the mast with "lashing-eyes." The fore- and main-stays are double, the mizzen stay single.

In all cases where two stays go over the masthead together, their collars are seized together and go over as one.

The fore-stays set up to an iron strap around the bowsprit, and the main-stay to iron rods passing through to the berth deck on each side of the foremast. Formerly these stays were set up by lanyards and hearts, but rigging-screws are now used.

The mizzen stay sets up "on-end" to a strap around the mainmast just above the main fife rail.

On many modern ships, the lower shrouds and stays are shackled to a band around the mast, instead of going over the masthead. This is usually the case in men-of-war fitted with military tops.

Other fittings of the lower masthead are shown in Plate **26**.

THE TOPMAST HEAD. (Plate **27**.)

Topmast Pendants are shackled to bolts in the trestle-trees and fitted with thimbles and links in their lower ends.

Topmast Shrouds are best fitted like the lower shrouds, in alternate pairs starboard and port; but in some ships they are fitted "straight," a starboard and port shroud in one, running over the masthead from side to side. In this case, two shrouds, one forward and one abaft, are seized together on each

side to form an eye enclosing the masthead. This method is not as strong as the other one and is not to be recommended.

The topmast shrouds set up to the rim of the top, usually with dead-eyes and lanyards, support being given from below by the "futtock-shrouds," running from the top-rim to a band on the lower mast.

Topmast Backstays are fitted in pairs like lower shrouds and go over the masthead in the same way. They lead down to the rail of the ship or to the channels, abaft the lower shrouds, and set up with dead-eyes and lanyards or with rigging-screws.

Topmast Stays are double and fitted like lower stays. The fore reeve through sheaves on the side of the bowsprit and set up with hearts and lanyards or with rigging-screws at the bows. The main reeve through sheaves in the after part of the fore trestle-trees and set up on deck to heavy bolts abaft the foremast.

The Mizzen Topmast Stay is single and sets up to a bolt in the main top.

On most steamers and on some recent sailing ships, the fore and main topmast stays are single as well as the mizzen.

On ships which carry no sail and have only light topmasts, the topmast shrouds and stays are single and shackle to a band around the topmast head.

The Jib Stay is fitted like the fore topmast stays and goes over the masthead with them. It reeves through the inner sheave in the outer end of the jib-boom, thence under a cleat on the dolphin-striker, and sets up at the bow with a heart and lanyard or with a rigging-screw.

TOPGALLANT MASTHEAD. (Plate 27.)

The Topgallant Rigging is fitted to a composition funnel through which the mast can be lowered for sending down, the funnel and rigging being left above the topmast-cap ready for pointing the mast through when it is sent up.

The Topgallant Stay is single, with an eye fitting snugly around the funnel. The Flying-Jib Stay is fitted in the same way and goes next to the fore topgallant stay, the collars of the two stays being seized together. The fore topgallant stay reeves through the outer sheave in the jib-boom,

Plate No. 25.

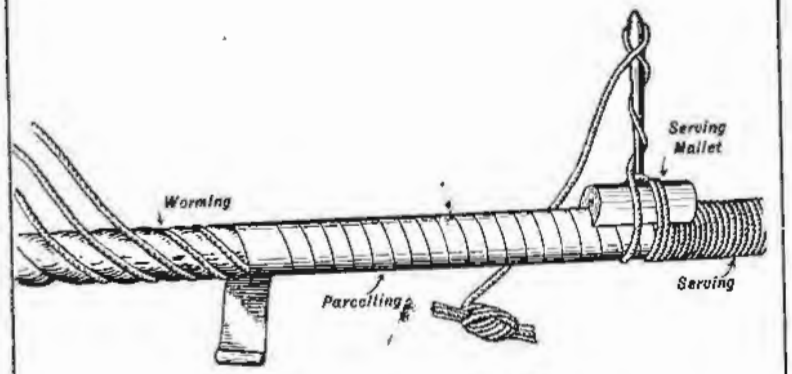


Fig. 1. Worming Parcelling and Serving.

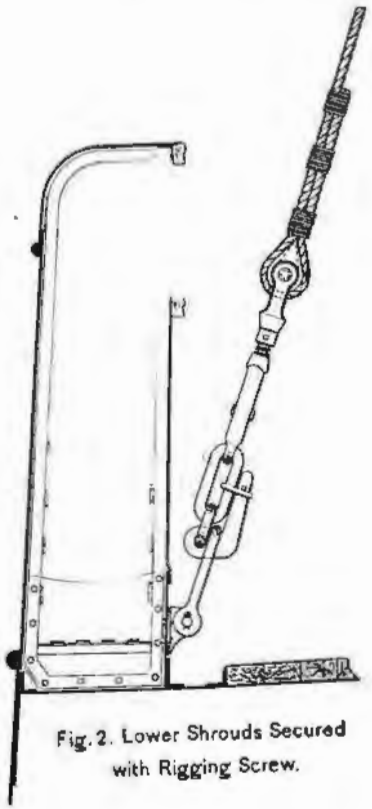


Fig. 2. Lower Shrouds Secured with Rigging Screw.

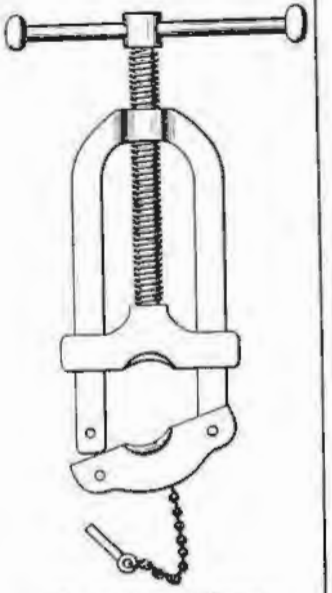


Fig. 3. Rigger's Screw.

the flying-jib stay through the inner sheave in the flying jib-boom and both set up in the head (or to the bow) with hearts and lanyards or with rigging-screws. The main topgallant stay reeves through a fairlead in the after part of the fore cap, and the mizzen through a fairlead in the after part of the main cap, and set up in the tops.

Topgallant Shrouds are fitted in pairs like the lower and topmast shrouds, the eyes fitting snugly over the funnel. The legs clamp into the horns of the cross-trees, which act as spreaders, then lead over an iron bar called the "futtock staff," which is covered with leather and seized inside the topmast rigging below the masthead, then to the top, where they set up with dead-eyes and lanyards.

Topgallant Backstays are single and go over the funnel with snugly-fitting spliced eyes. They lead to the side of the ship, where they set up with lanyards and dead-eyes or with rigging-screws, to the channels or to channel plates on the rail.

ROYAL MASTHEAD. (Plate 27.)

The Royal Stays are spliced around thimbles which are fitted to bolts on the forward part of a band around the royal masthead.

The fore royal stay leads through the outer sheave in the flying jib-boom, under a cleat on the dolphin-striker, and sets up in the head or to the bow. The main royal stay reeves through a chock in the after part of the fore topmast trestle-trees and sets up in the fore top. The mizzen royal stay reeves through a sheave in main topmast trestle-trees and sets up in the main top.

The Royal Shroud and Backstay are in one, reeving through an eye-bolt on the side of the royal band with a seizing just below the bolt to form an eye. The shroud then leads through an eye in the end of the jack and sets up in the top, while the backstay goes direct to the channels or the rail, where it sets up like the topgallant backstays.

THE RIGGING OF THE BOWSPRIT. (Plate 27.)

Bobstays, of chain or wire rope, shackle to bolts at the cut-water and set up with hearts and lanyards or with rigging-screws under the outer end of the bowsprit.

Bowsprit Shrouds, of chain or wire-rope, shackle to bolts on the bow and set up with hearts and lanyards or with rigging-screws to the side of the bowsprit.

JIB-BOOM. (Plate 27.)

The Jib-Guys, of wire-rope, shackle to a band on the jib-boom end, go over the end of the whisker-boom with a cringle, and set up with hearts and lanyards or with rigging-screws to the bow. In ships having no whisker-booms, the foretack bumpkin sometimes acts as a spreader for the guys. Or a spreader may be fitted expressly for them.

The Jib Martingale Stay, of chain or wire, shackles at one end to a band on the jib-boom and at the other to a band on the dolphin-striker. It is tautened by setting up the *back-ropes.*

The Foot-ropes are fitted with eyes in both ends, the outer ends seized to the guys just outside the shackle on the boom, the inner ends to bolts in the bowsprit cap.

FLYING JIB-BOOM. (Plate 27.)

The Flying Jib-Guys, of wire, shackle to a band on the end of the flying jib-boom, reeve through a thimble strapped around the whisker-boom end, and set up with hearts and lanyards or with rigging-screws to the bow.

The Flying-jib Martingale, of wire, shackles to a band on the end of the bow, reeves through a hole or sheave in the dolphin-striker, and sets up at the bow.

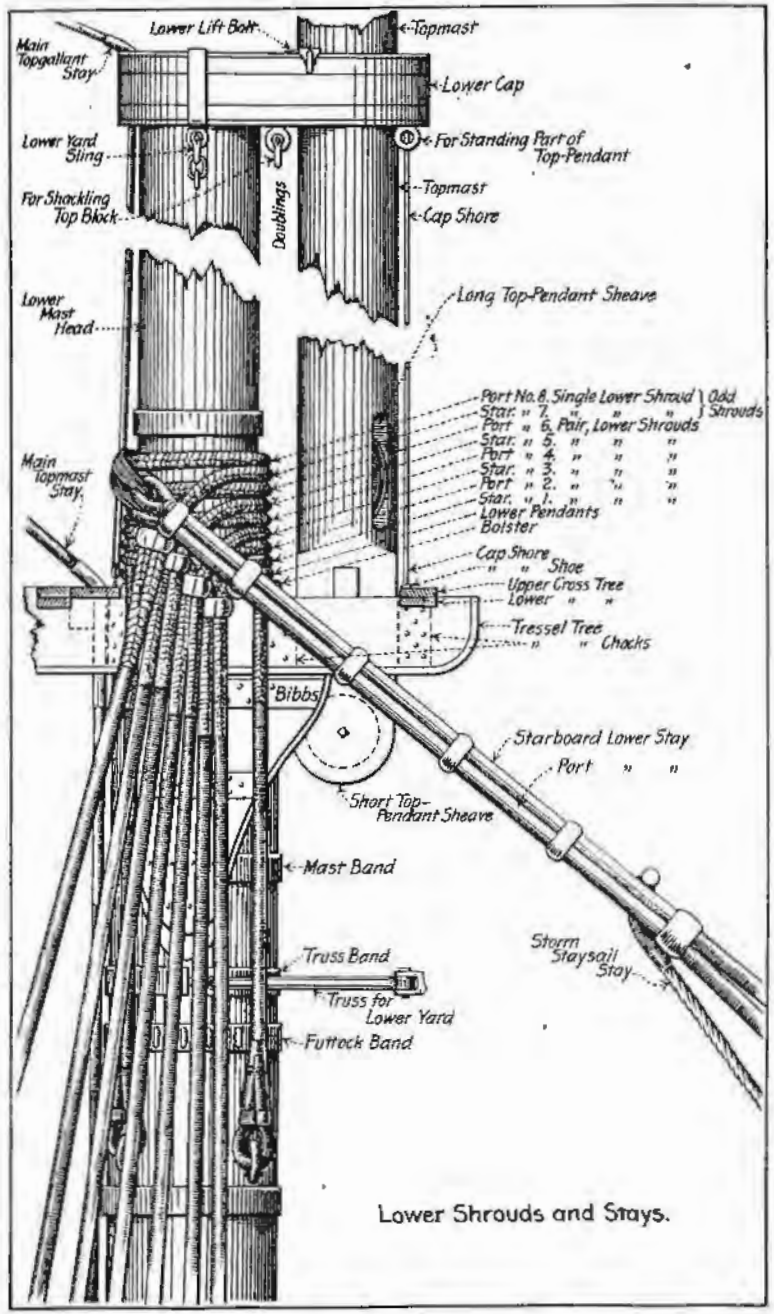
The Foot-ropes, fitted with an eye in each end, are seized at one end to the flying jib-guy close to the shackle, and at the other end to the jib-guy.

WHISKERS AND DOLPHIN-STRIKER.

The Whisker Jumpers, of wire, go over the end of the boom with an eye-splice and set up on-end to a bolt in the cut-water.

The Back-ropes, of wire or chain, shackle to a band on the dolphin-striker and set up at the bow with hearts and lanyards or with rigging-screws.

Plate No. 26.



LOWER MAST HEAD.

§ IV. RIGGING SHIP.

It is assumed that the lower masts, lower trestle-trees, cross-trees, tops, and bowsprit are in place and that the standing rigging has been cut and fitted in the rigging-loft. The bowsprit is secured first of all by setting up the bobstays and bowsprit shrouds. These are triced up by single whips (called in this and similar cases "girtlines") from the bowsprit cap, and set up by their rigging-screws or lanyards. With a lanyard, a purchase, usually two-fold, is needed to furnish the necessary power for setting up. This purchase may be led in any convenient way, but should be kept as nearly as possible in line with the proper lead of the lanyard.

TO SEND UP THE LOWER RIGGING.—This is done by means of two girtlines on each side, the block of one hooking to a strap around the tenon at the masthead, that of the other to a strap toggled through a hole in the planking of the top outside the lubber's-hole.

The pendants are sent up first, and gotten over the masthead and fitted down into place by men stationed in the top. The shrouds go up in pairs, fitted as already described, the forward pair starboard first, the forward pair port next, and so on. The ends of the long girtline (the one hooked to the top), are knotted together and toggled between the two shrouds, from *out in*, and at such a distance below the eye that when the toggle is as high as it will go the crown of the eye will be above the tenon of the mast. The shrouds are then swayed aloft. As the eye comes up, it is pointed through the lubber's-hole, and the short girtline (the one from the tenon), is toggled between the shrouds just below the eye-seizing, from *in out* (Plate 29). This girtline is worked in the top. By the aid of the two girtlines the men aloft slip the eye of the shrouds over the masthead, where it is beaten down snugly into place by heavy wooden mauls. The other shrouds are sent up and beaten down in the same way.

The stays are sent up by the girtlines from the masthead, which are dipped down through the lubber's-hole and bent to the stay at the crotch, the starboard girtline being stopped along the starboard leg, the port one along the port leg. A whip from the forward side of the tenon may be used, if necessary, to take the weight of the stays. The lashing for the legs is passed abaft, forming an eye around the masthead above and

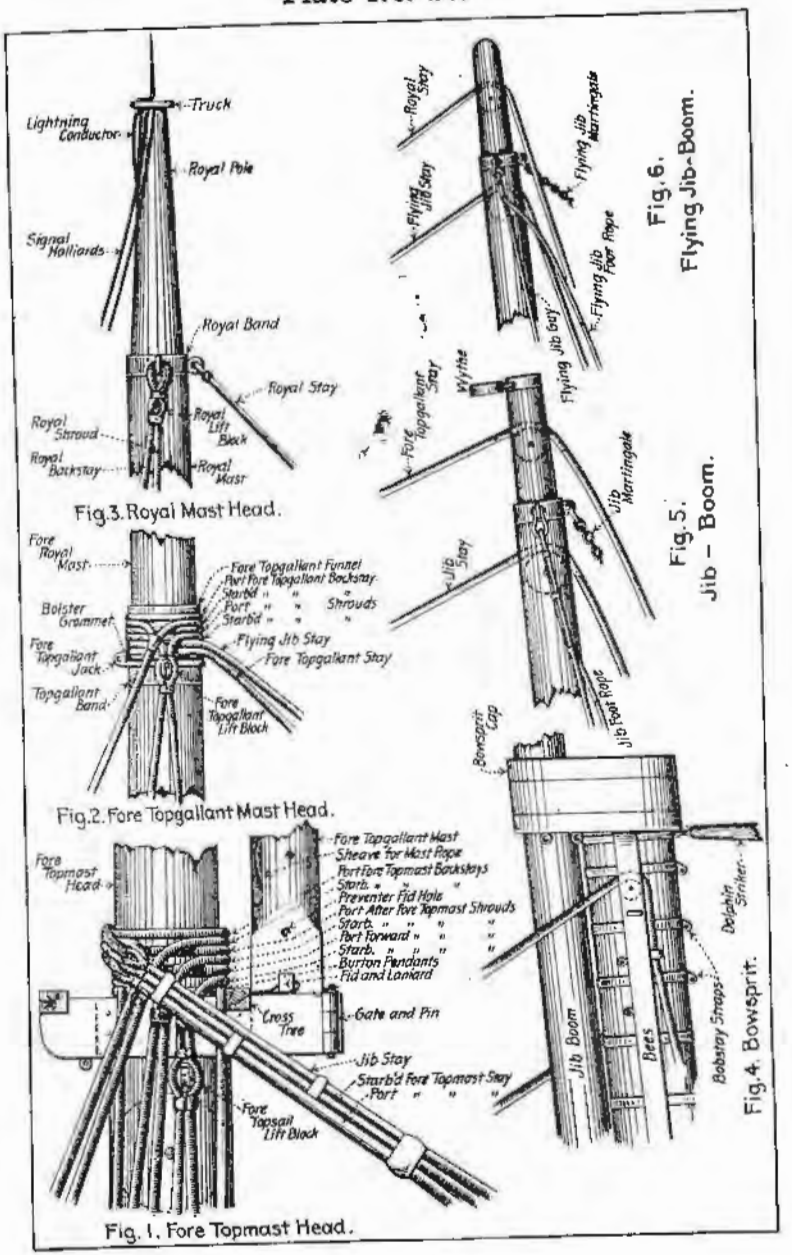
outside of, the shrouds (Plate 26). The next thing to be done is to "stay" the mast; viz., to give it the amount of rake determined upon, if any, and to set up the shrouds and stays. A heavy purchase is used from a strap at the masthead leading well forward, and pendant tackles are hooked to the legs of the pendants, those from the after legs leading aft and those from the forward legs, forward. The wedges are eased up if necessary, and the mast stayed either vertically or with the desired rake, this being fixed by a plumb-line from the masthead to the deck at a calculated distance from the mast. The wedges are then driven in and the stays and shrouds set up by their rigging screws. The stays are set up first, then the shrouds in succession, from forward aft, corresponding pairs starboard and port being set up together. Where dead-eyes and lanyards are used instead of screws, the necessary power for setting up is gained by purchases as in Plate 29. To avoid injury to the lanyard, the purchase is hooked to it by a strap and toggle, as shown in the plate. As the eyes of the rigging require time to settle down into place, the stays and shrouds will gradually slack after the original setting up, and should be set up again later, perhaps more than once, the final setting up being done if possible in warm dry weather.

The lower cap is sent up by the girtlines and placed by the men in the top with its round hole over the hole for the topmast in the forward part of the trestle-trees.

This and the subsequent operations of rigging ship are differently performed by different riggers. The methods which follow are from the practice of a rigger of many years' successful experience, and while perhaps no better than others that have been suggested, they are probably as convenient as any.

TO GET A TOPMAST IN AND SEND IT UP.—Tow the mast alongside with the head forward, say on the starboard side. Pass a long strap, of 5- or 6-inch stuff, through the fid-hole, and bring the bight up toward the head of the topmast for perhaps two-thirds the length of the mast. At this point put a short double strap around the mast, bringing the two bights through the long strap, as in Plate 30, Fig. 1. Overhaul down the starboard pendant-tackle and hook it to the straps as shown. Sway the mast on board and up and down the lower mast. As the topmast is usually longer than the drift between the deck and the top, it will probably be necessary to sway the topmast-

Plate No. 27.



STANDING RIGGING.

head up forward of the top-rim at first, and then to lower the heel down through a hatch or scuttle to admit of pointing the head through the square hole in the lower trestle-trees. A scuttle is usually fitted for this purpose immediately forward of the lower mast. Having pointed the mast in this way, sway it up high enough to admit of closing the scuttle, and rest the heel of the mast on deck. In this position it is perfectly secure provided the head is pointed as has been described. If it happens that the mast is shorter than the drift from the deck to the top, its head may be lashed temporarily to the lower mast. Now put a short strap through the fid-hole (Fig. 2, Plate 30) and hook the port pendant-tackle on this. At the same time shorten in on the strap of the other pendant-tackle. Sway up through the trestle-trees and the lower cap, lash the cap to the masthead, and proceed to ship it.

TO SHIP THE LOWER CAP.—The cap is hung from the topmast head by lashings long enough to admit of slueing it freely (Fig. 3, Plate 30) and the topmast is swayed up until the cap rises above the tenon of the lower mast, when it is cut around square with the tenon and fitted down in place by lowering away the topmast. The topmast may be slued if this is found necessary for placing the cap fair. As soon as the cap is secured, the top-blocks are sent aloft and hooked in place, the top-pendants rove in their places (through the blocks at the cap and the sheaves in the heel of the mast) the top-tackles hooked, and the mast hung by these, the pendant-tackles being gotten out of the way. The topmast is then swayed up three or four feet above the cap.

TO SEND UP THE TOPMAST CROSS-TREES.—Lash two girtline blocks to the tenon of the topmast, lead the girtlines down abaft and bend them to the after horns of the trestle-trees (which are in one with the cross-trees), stopping them to the forward horns along the upper side. Bend on also a guy from aft. Sway up and land the cross-trees on the lower cap, canting them up and down as much as may be necessary, and lash them there with the forward chock (gate) of the trestle-trees resting against the after side of the topmast (Plate 29). Having secured them from slipping, remove the girtline blocks and lower away the topmast until its head is low enough to admit of cutting the cross-trees forward and squaring them up over the topmast-head. Then sway up, land the trestle-trees on the hounds and beat them down into place.

TO RIG THE TOPMAST.—By means of girtlines, send up and fit in place the composition funnel for the rigging, beating it well down in place upon the trestle-trees; then proceed to send up the shrouds, backstays, and stays, and get them in place by practically the same method as that used with the lower rigging. The mast is then swayed up and fidded, and the rigging is set up.

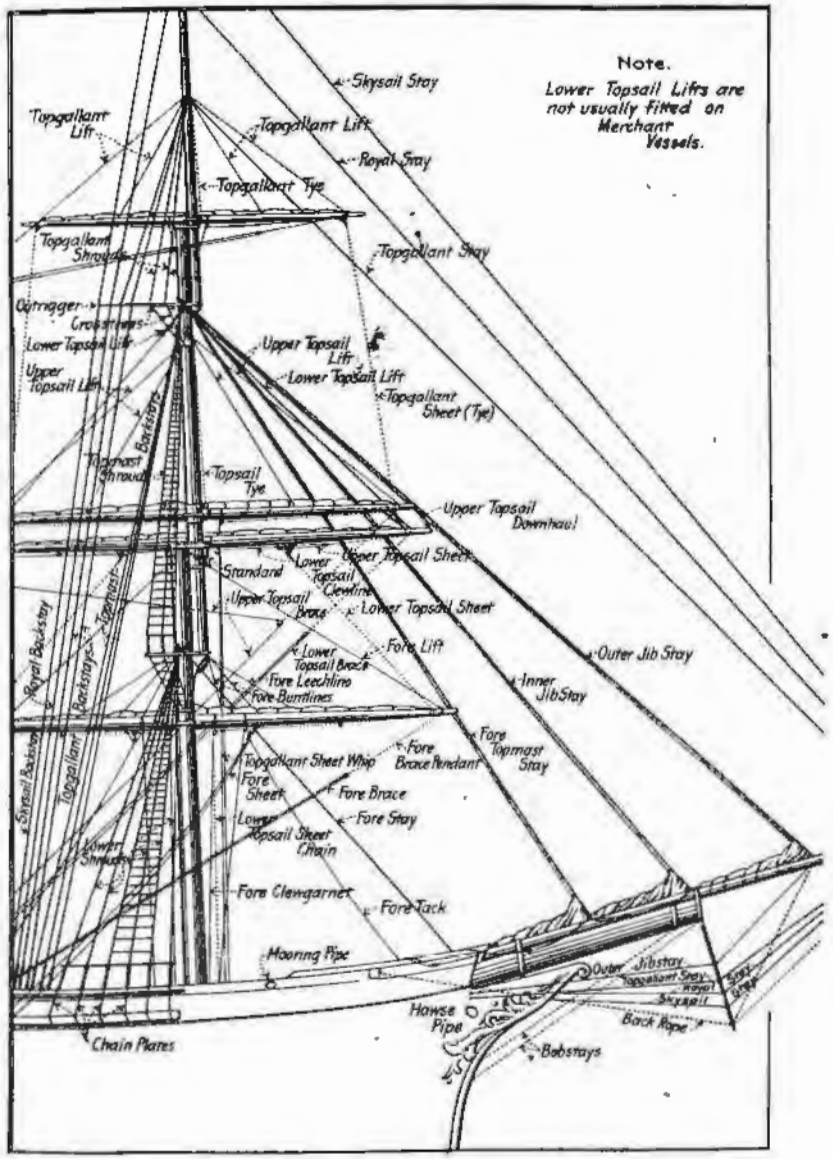
In fidding the mast, as soon as the fid-hole is open above the trestle-trees, shove in a good iron bar as a preventer. The mast often sticks when nearly up, and in the very heavy heaving required for the last inch or so, there is danger that something will give way.

The topmast rigging usually sets up with dead-eyes and lanyards, even on ships where rigging-screws are used for the lower rigging, it being considered necessary to preserve here something of the "give" that comes from the use of a hemp lanyard. The rigging is set up by a purchase like that shown in Fig. 3, Plate 29, the routine observed being practically identical with that of setting up the lower rigging. The stay is rove as has been described in the preceding section, and is set up before the shrouds.

TO SHIP THE TOPMAST CAP.—This may be shipped by the help of the topgallant mast, the method used being identical with that already described for shipping the lower cap. But a simpler method is to rig a derrick, of a capstan bar or a light spar of some kind, lashed up and down the topmast abaft and held off clear of the mast by a block rather thicker than the rim of the cap, thus leaving space for fitting the cap down into place between the derrick and the mast. Girtline blocks are secured at the head of the derrick, and the girtlines are used to send up the cap, which is fitted in place without difficulty.

TO GET IN THE MAIN YARD.—It will be convenient to do this before sending up the mizzen topmast, which is thus available for a derrick. It is stepped in a shoe close out to the rail immediately forward of the main rigging, to the forward swifter of which it is lashed;—the lashing, however, being passed aft from shroud to shroud with a turn around each, in order that all may divide the strain. This strain is not great, as the shrouds serve only to steady the derrick. A light spar, like a royal yard or a flying jib-boom, is lashed across from the derrick to the main mast, to take the thrust upon the derrick when the yard

Plate No. 28.



FORE MAST AND HEAD-BOOMS OF A MODERN SAILING SHIP.

is swung around and hauled in, as hereafter described. The derrick is supported by a topping-lift from the lower masthead, consisting of a good two- or three-fold purchase, and steadied by a guy leading aft outside the rigging and another leading to the foretopmast head. The yard is towed alongside with the port yard-arm forward. A three-fold purchase is used from the derrick head to the slings of the yard, and the jeer-fall, hooked in its place at the lower masthead, is overhauled down and hooked also to the slings. Steadying lines are used on both yard-arms. The fall of the derrick-head purchase is taken to the winch, and the yard is swayed up, the slack of the jeers being taken in at the same time. When the yard is well above the rail, the forward yard-arm is swung around under the main stay and across the deck, the jeer-falls are manned and the derrick-head purchase is eased away, and the yard swings in square across the deck, hanging by the jeers. It may be landed on the rail or sent aloft at once.

To send up the main yard.—Overhaul down the top-burtons and hook them to the quarter straps, reeve the braces, and hook a fore and aft tackle to the slings from forward. Sway up by the jeers, keeping control by the top-burtons, braces, and fore and aft tackle. Hook the slings and key the truss. Reeve and haul taut the lifts.

Shift the derrick forward and get in the fore yard in the same way.

The fore and main yards being in place, the problem of getting in the other spars is much simplified.

To get in a topsail yard.—Tow the yard alongside, say on the starboard side with the port yard-arm forward. Lash a heavy single block at the topmast head and reeve a good line (say a 5-inch), taking the end down to the slings of the yard and lashing it out to the forward quarter. Brace up the main yard by the port brace and secure it by hauling taut both lifts and by hooking and hauling taut a top-burton on each yard-arm. Put a strap on the starboard lower yard-arm and hook there the upper block of a two-fold purchase, hooking the other block to the forward quarter of the topsail yard near the point to which the hawser is stopped out. This purchase need not be very heavy, as it is designed, not to lift the yard, but to hold

it off, preventing it from swinging in too fast as the lower yard-arm rises above the rail. Protect the ship's side well by skids. Take the hauling part of the hawser to the winch and sway up. As the yard rises, it is kept off by the yard tackle until the lower yard-arm is high enough to clear the rail, when it is eased in and landed in the gangway, the lower yard-arm being dragged aft in a shoe to prevent injury to the deck.

TO SEND UP A TOPSAIL YARD.—Hook the upper block of a pendant tackle to a strap at the topmast head and the lower block to the slings of the yard. Overhaul down both top-burtons and hook them to the quarters of the yard, and hook a fore and aft tackle from forward to the slings. Coil the lifts just outside the slings and stop them to the sling-band. Man the pendant tackle and the port top-burton, get the yard up and down and sway aloft, taking down the slack of the lower (starboard) top-burton, and holding the yard well forward with the fore and aft tackle. As the slings rise well above the lower stay, pull up on the starboard burton and begin to sway across, squaring the yard and landing it on the cap with both burtons taut. Pass the parrel or key the truss. Reeve and haul taut the lifts, lash the quarters of the yard to the topmast shrouds, and send hands out to reeve lines through the brace blocks for reeving off the braces. Reeve the tye and hook and haul taut the halliards.

To complete the description of handling heavy spars, it will be convenient to add here the following:

TO SEND DOWN TOPSAIL YARDS.—Hook a pendant tackle and two top-burtons as has been described for sending up, and take the weight of the yard by them. Unhook the halliards, either sending them down or hooking the fly-block to a strap at the cross-trees. Unreeve the tye. Bend the top bowline to the slings for hauling the yard forward. Lash the quarters of the yard to the topmast rigging and unreeve the lifts and braces. Cut the lashings and sway up on the pendant-tackle and upper top-burton, which will be the port one if the yard is to be sent down to starboard. Send the yard down and land it in the gangway with the port yard-arm forward.

TO SEND DOWN THE LOWER YARD.—Reeve off the jeers, hook the top-burtons to the yard-arms, hook on a fore-and-aft tackle from forward to the slings, unkey the truss, unhook the slings,

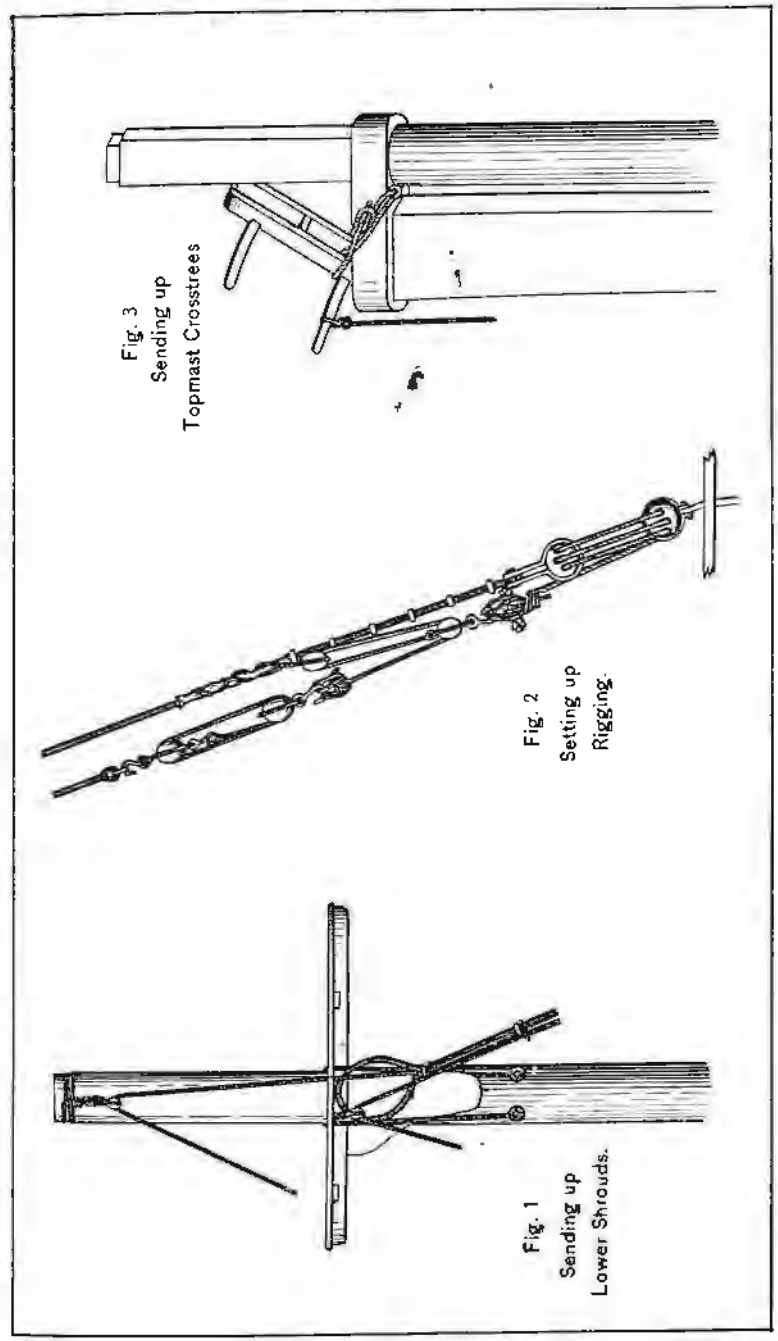


Fig. 3 Sending up Topmast Crosstrees

Fig. 2 Setting up Rigging.

Fig. 1 Sending up Lower Shrouds.

tend the lifts and braces, haul forward and lower away, landing the yard on the rails.

To HOUSE TOPMASTS.—Reeve off the top-pendants and hook the top-tackles in their ends. Come up the topmast rigging. Sway up and unfid. Lower away until the trestle-trees are just clear of the lower cap.

To SEND OUT THE JIB-BOOM.—The boom is pointed out through the hole in the bowsprit cap and rigged out by a heel-rope, which reeves through a block on one side of the bowsprit cap, through the sheave in the heel of the boom, and clinches to a bolt on the side of the cap opposite the bolt for the block. The head of the boom having been pointed through the cap, the band is fitted on, and the guys and martingale hooked to it. The boom is then rigged out to its place, the heel lashing passed and the rigging set up.

To SEND UP TOPGALLANT MASTS.—Suppose the main topgallant mast is in the starboard gangway with the head forward, and that the topmast cap has been shipped. Hook the topgallant top-block at the cap and reeve the mast rope, bringing the end down through the gate in the trestle-trees, through the sheave in the heel of the mast, through the thimble of a lizard hitched in the royal sheave hole, and up to the topmast cap, where it is clinched to a bolt in the cap on the opposite side from the bolt for the top-block. Man the mast-rope, get the mast up and down and sway it aloft, pointing it through the hole in the trestle-trees and the round hole in the topmast cap. As soon as it is pointed through, the lizard is cast off.

Send up the topgallant rigging (fitted on the funnel) by girtlines from the topmast cap, and place the funnel on the cap by hand. If too heavy for this, sway the topgallant mast up above the cap and use the girtlines from the masthead to land the funnel on the cap, then lower away, cut the funnel forward and square it up. Send up the royal rigging in the same way with the truck stopped to it. Sway up the mast, and fit the truck, the royal band, and the topgallant funnel into place in succession as the mast reaches the proper point for each. Fid the mast, reeve and set up the topgallant and royal rigging.

To SEND UP A TOPGALLANT YARD.—The yard-rope is hooked to the slings and stopped out to the quarter to keep the yard up and down. On men-of-war, where drills with light yards are frequent, a "lizard" is fitted permanently for hauling the yard-

rope out to the quarter strap, and in addition to this, a grommet, playing freely on the yard-rope, is slipped over the yard-arm to keep it close in to the yard-rope and prevent fouling as the yard goes up. Preparations for receiving the yard aloft include overhauling the lift and brace for the lower yard-arm to some point at which it will be convenient to put them on when the yard (still up and down) shall have been swayed as high as possible. The upper lift and brace are kept in hand at the cross-trees to be put on when the upper yard-arm reaches that point, the grommet being first taken off. The lift and brace bands having been put on and secured with stops, the lower lift is made fast at the square mark, a turn is taken with the parrel, and the lizard is tended ready for slipping. To sway across, the lizard is slipped and the yard-rope let go on deck. The yard falls across, hanging by the lifts, which, if made fast at the square mark as they should be, bring the yard into place with the slings just clear of the cap.

> With a very long topgallant yard it may happen that when the yard is hoisted as high as it will go (the lizard being jammed up to the jack-block), the lower lift cannot be gotten down to the square mark in the top. The result is that the yard when crossed hangs below the cap. The remedy is to lead the lower lift on deck, man it, and take it in to the square mark at the order *Sway Across!*

To SEND DOWN A TOPGALLANT YARD, the gear is unbent, the yard-rope stopped out, the stops cut on the band of the lift and brace, and a light "tripping line" from deck bent to the "snorter" on the side on which the yard is to go down.

> The snorter is a short length of plaited rope spliced to an eye-bolt at the yard-arm end and brought in under the eye of the lift and brace. When the yard is up and down, with the lift slack, hauling on the snorter pulls off the lift and brace band.

The yard-rope is manned, the lower lift cleared away and tended, and at the order *Sway*, the yard is canted up and down by running the yard up as high as the lizard will permit. The tripping line and snorter pull off the lower lift and brace, the upper one is taken off by hand, and the yard is lowered, a few hands on the tripping line keeping it clear.

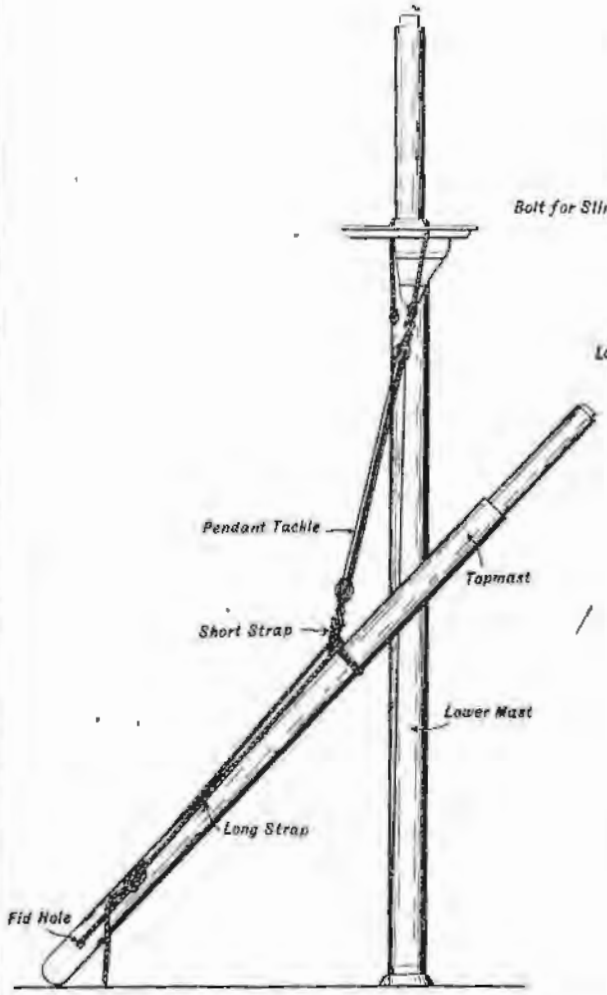


Fig. 1

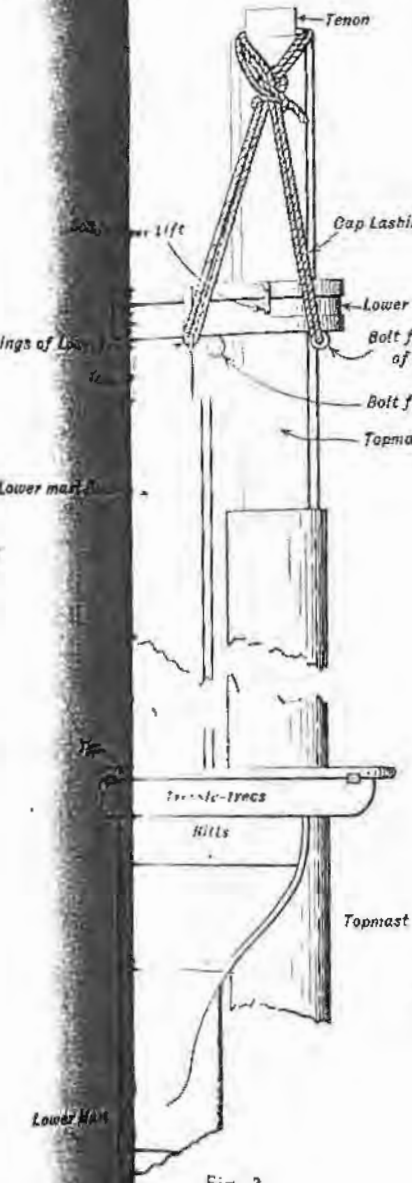


Fig. 3

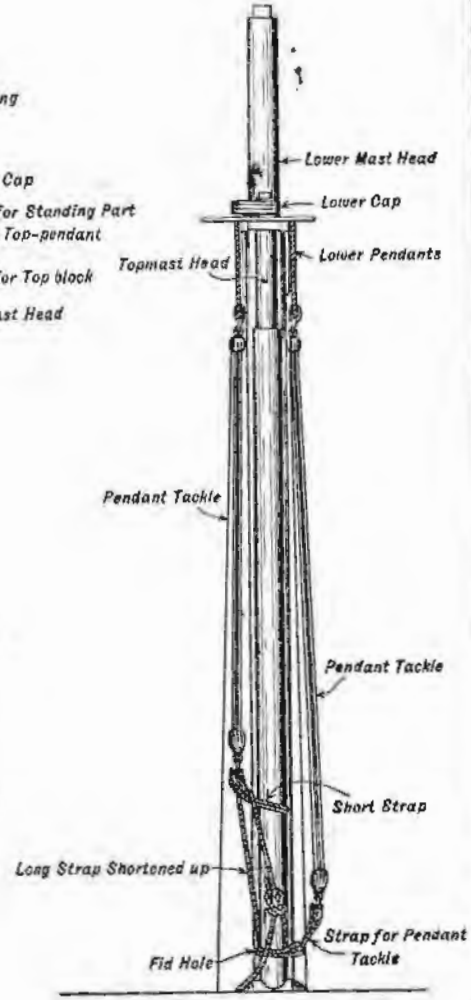


Fig. 2

SENDING UP TOPMAST AND SHIPPING LOWER CAP.

The royal yards are sent up and down like the topgallant yards.

To send down a topgallant mast.—Reeve the mast-rope through the topgallant top-block by means of a reeving-line led through the block and down to the deck abaft. The hauling part of this reeving line is manned on deck or in the top. The mast-rope having been rove through the top-block in this way may be hung by a stop from the crosstrees, leaving a few fathoms of slack on the standing part, which is then rove by hand through the sheave in the mast, through the thimble of a lizard, and clinched to a bolt in the cap opposite the bolt for the block. Come up the topgallant and royal rigging, sway up and unfid the mast, and lower away, landing the topgallant funnel, the royal band and the truck on the topmast-cap, one above the other. As the royal sheave-hole comes below the cap, pass the lizard through the hole and around the mast-rope, taking care to hitch it securely. Lower away and land the mast on deck with the head forward. Lash the rigging securely at the topmast cap.

CHAPTER IV.

SAILS AND RUNNING GEAR.

§ I. SAILS.

Sails are made of canvas, which may be of flax, hemp or cotton. The sails of ships are always of flax, those of boats and small yachts usually of cotton. Cotton canvas is used also on ship-board for a variety of purposes, such as awnings, windsails, hammocks, tarpaulins, &c.

Canvas is manufactured in long strips or *cloths*, varying in width from 16 to 24 inches for flax, and from 20 to 42 inches for cotton, and in lengths of from 40 to 80 yards. The cloths are made up in rolls called *bolts*.

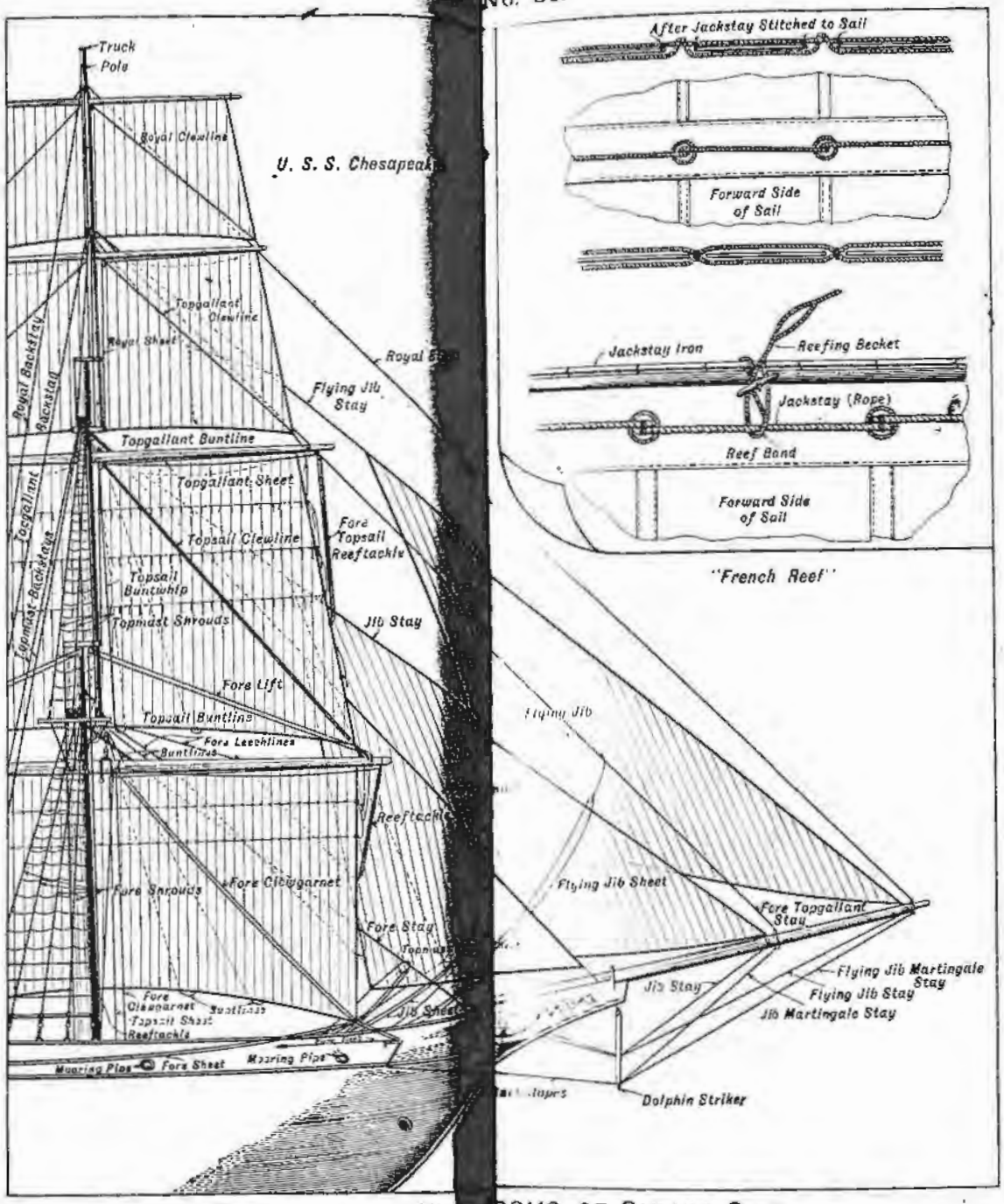
Variations in weight, strength and fineness are indicated by numbers running from 1 to 10; number 1 being the heaviest, strongest and coarsest, and number 10 the lightest and finest.

In the United States Navy, canvas is used as follows:

For the sails of ships, flax canvas, 24 inches wide, issued in bolts of 80 yards. For awnings, screens, etc., cotton canvas, 22 inches wide, in bolts of 90 yards. For hammocks and bags, cotton canvas, 42 inches wide, in bolts of 90 yards. For boats' sails, cotton canvas of the variety known as "raven's duck," 28½ inches wide, in bolts of 65 yards.

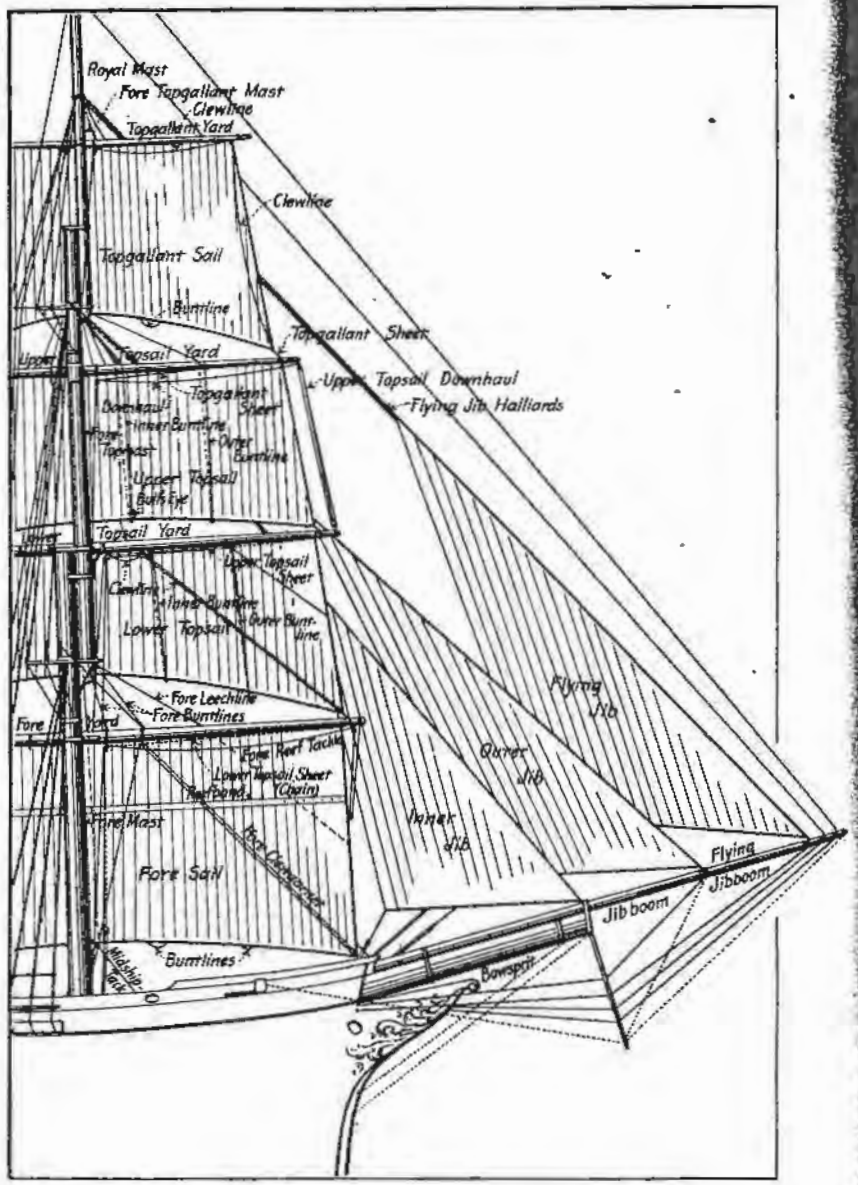
Good canvas is made of long, strong, clean threads, evenly spun and well twisted and without any mixture of tow. In the heavier grades (Nos. 1 to 3), the threads are double, and in all grades the cloths should be closely and uniformly woven, and with a firm, even selvage. To test a sample of canvas, after examining carefully the character of the texture as to the smoothness and closeness of the weaving, it is well to bore through with a fid, when the threads will break easily if of inferior quality, and resist, with a disposition to stretch before yielding altogether, if of good strong staple. A few threads may be drawn and examined as to length, smoothness and freedom from tow; and finally, if two samples are to be compared, similar strips from the two may be knotted together and tested by hanging weights from them to determine which is the stronger.

No. 31.



FOREMAST AND HEADROOMS OF SAILING SHIP.

Plate No. 32.



FORE MAST AND HEAD-BOOMS OF A MODERN SAILING SHIP, SAILS SET.

An 80-yard bolt of No. 1 flax canvas, 20 inches wide, should weigh about 75 lbs. and the successive numbers from this to No. 10 should diminish by about 5 lbs. each, a bolt of No. 2 weighing 70 lbs., one of No. 3, 65 lbs., and so on.

The following numbers are commonly used for the sails of a full-powered sailing ship, the lighter grades specified in each case forming a fair-weather suit of sails, while the heavier ones are bent in anticipation of a stormy passage:

Courses,	Nos. 1 to 3.
Topsails,	" 2 to 3.
Topgallant sails,	" 4 to 5.
Royals,	" 5 to 6.
Topmast staysails,	" 3 to 4.
Jibs,	" 4 to 5.
Other staysails,	" 4 to 5.
Spankers, trysails, &c.,	" 4 to 5.
All storm sails,	No. 1.

The square sails of a ship (Plates **31** and **32**) are the courses (foresail and mainsail), the topsails, topgallant sails and royals. A skysail is sometimes set above the royals. Topsails and topgallant sails may be single or double.

The fore and aft sails are the fore and main trysails, the spanker (which is in reality a mizzen trysail), the staysails, taking their names from the stays on which they are set, and the jibs, which are also staysails, although not so-called. The trysails are called also spencers, and the spanker is often called the driver.

The upper edge of a square sail is called the head, the lower edge, the foot, the sides, leeches, the upper corners the head cringles, the lower corners, the clews.

In the case of a four-sided fore-and-aft sail like a trysail or spanker (Plate **33**) the after edge is the after leech, the forward edge the luff, the upper edge the head, the lower edge the foot, the upper after corner the peak, the upper forward corner the nock, the lower forward corner the tack, the lower after corner the clew.

In a triangular sail (Plate **33**), the edge next the stay is the luff, the after edge the leech, the lower edge the foot.

the lower forward corner the tack, the lower after corner the clew, and the upper corner the head.

The details of sails of various kinds are fully shown in Plates **33**, **34** and **35**.

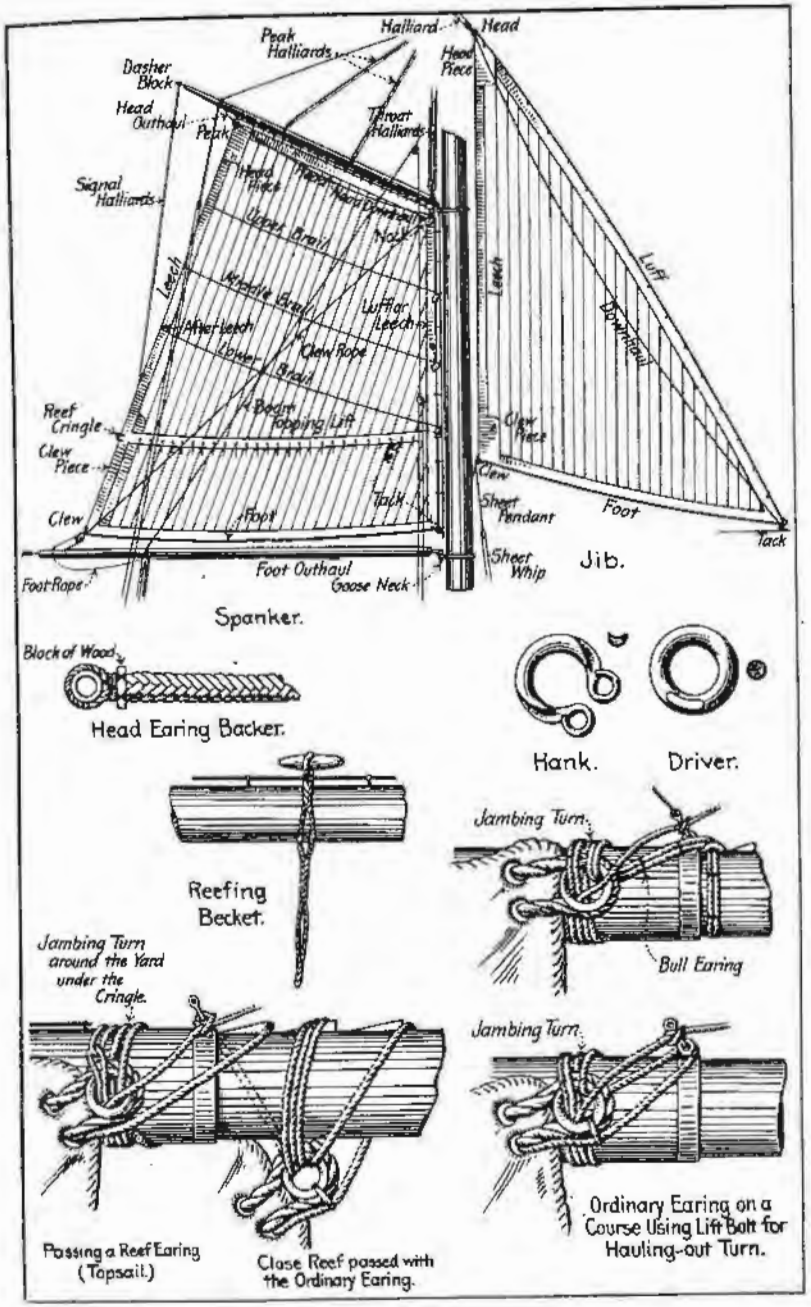
The cutting and making of sails constitute an art in themselves, which it would be beyond the province of this book to attempt to teach. The canvas must be cut with care, not only to economize material in adapting the narrow cloths to the irregular shapes required, but to reduce stretching to a minimum and to distribute such stretch as cannot be prevented, in a way to avoid distorting the sail and allowing it to bag. Canvas stretches very little along the line of the threads of either warp or filling, but may give considerably under a diagonal pull. Owing to the way in which sails are set (being hauled out by their corners), the greater part of the strain to which they are subjected is diagonal, and one of the most difficult points in sail making is to arrange the material in such a way that the cloths may take this strain directly along the threads. When this has been done as far as possible, allowance must be made for the stretch which still remains, and also for the difference in stretching between the canvas and the roping.

The cloths are sewed together with overlapping (double) seams having from 110 to 130 stitches to the yard. The twine used should be of good flax or cotton, spun with from three to eight threads and waxed with pure beeswax.

Sails are hollowed out or roached, on the foot to prevent chafing across stays and on the leech to admit of hauling the successive reef-earings up to the yard clear of each other and clear of the head earings instead of bunching all the cringles on top of each other.

Sails are reinforced at points which are subject to especial strain or chafe. The following strengthening pieces are used in a topsail: Leech and foot linings along the leech and foot; buntline cloths in the wake of the buntlines; reef-tackle pieces running diagonally downward from the reef-tackle cringles; top-linings and mast-linings, in the wake of the top and mast; reef-bands running across the sail at each line of reef points; and a belly-band running across midway between the close reef band and the foot. All of these pieces except the mast and top-linings are on the fore side of the sail.

Plate No. 33.



DETAILS OF SAILS AND FITTINGS.

The edges of the sail all around are turned over, forming a hem or tabling several inches wide. The linings and other strengthening pieces are then sewed on, and lastly the bolt-rope. This is of hemp and should be of the best quality, rather loosely laid up to make it soft and pliable, and tarred with the best Stockholm tar. As there is more stretch to the rope than to the canvas, care must be taken to leave a little slack canvas along the edges, as otherwise the canvas, instead of the roping, would take the strain when the sail is set. A common rule is to allow one inch of slack canvas for every foot along the leeches of topsails and canvas, and one inch for every yard along the foot.

The roping of square sails is always on the after side of the sails, that of fore and aft sails usually on the port side.

The clews of sails are fitted in various ways for securing sheets, clew-lines, &c. With courses and topsails, spectacle-irons are now commonly used (Plate 34), and these are sometimes used with topgallant sails also.

The clews of royals are fitted with toggles to which the sheet is secured by a small eye, while the clew-line is hitched around the clew just above the toggle.

Head-earings, reef-tackles, reef-earings and bowline bridles are attached to cringles on the leech of the sail worked around the bolt-rope and through holes in the sail, as in Plate 18.

All strengthening pieces are made of lighter canvas than that used in the body of the sail, and should be left rather slack in sewing on.

It may be noted here that in repairing sails which are somewhat worn, a lighter grade of canvas should be used than that of which the sails are made.

Courses usually have two reef-bands, and single topsails either three or four. The reef-bands are pierced with holes, usually two for each cloth, punched through the canvas and protected by a small grommet stitched down close around them. These holes and those along the head for securing the sail to the yard are placed alternately in the seams and the middle of the cloths, those in the seams being slightly lower than those in the middle, so that they take more of the weight.

For hooking the bunt whip to haul up the bunt in furling,

two holes are worked in the sail, one on each side of the midship seam about eighteen inches below the head, and through these are rove the parts of a short span having a thimble seized in the bight abaft the sail. This is a glut. Sometimes additional gluts are worked for furling with one or more reefs.

The holes in the reef-bands are fitted with reef-points, for holding the bands up to the yard when the sail is reefed. On the topsails, these points consist of pieces of small manila stuff, long enough to go around the yard and tie on top. They are rove through the holes in the reef-bands, one-third of the length being left forward and two-thirds abaft, and are stitched to the sail to prevent unreeving. The reef-points of courses are middled and stuck through from the after side of the sail so that both ends hang down forward. A rope jackstay is rove through the bights and stitched to them and to the sail.

In reefing, the points of a topsail are passed around the yard itself, those of a course only around the jackstay on top of the yard. Both are tied with "reef-knots."

The first and second reefs of topsails are often fitted with rope jackstays on the sail and beckets on the yard. The jackstay runs along the reef-band from hole to hole as in Plate 31, forming a series of bights on the forward side of the sail, through which the becket is passed for reefing. This is called a "French reef."

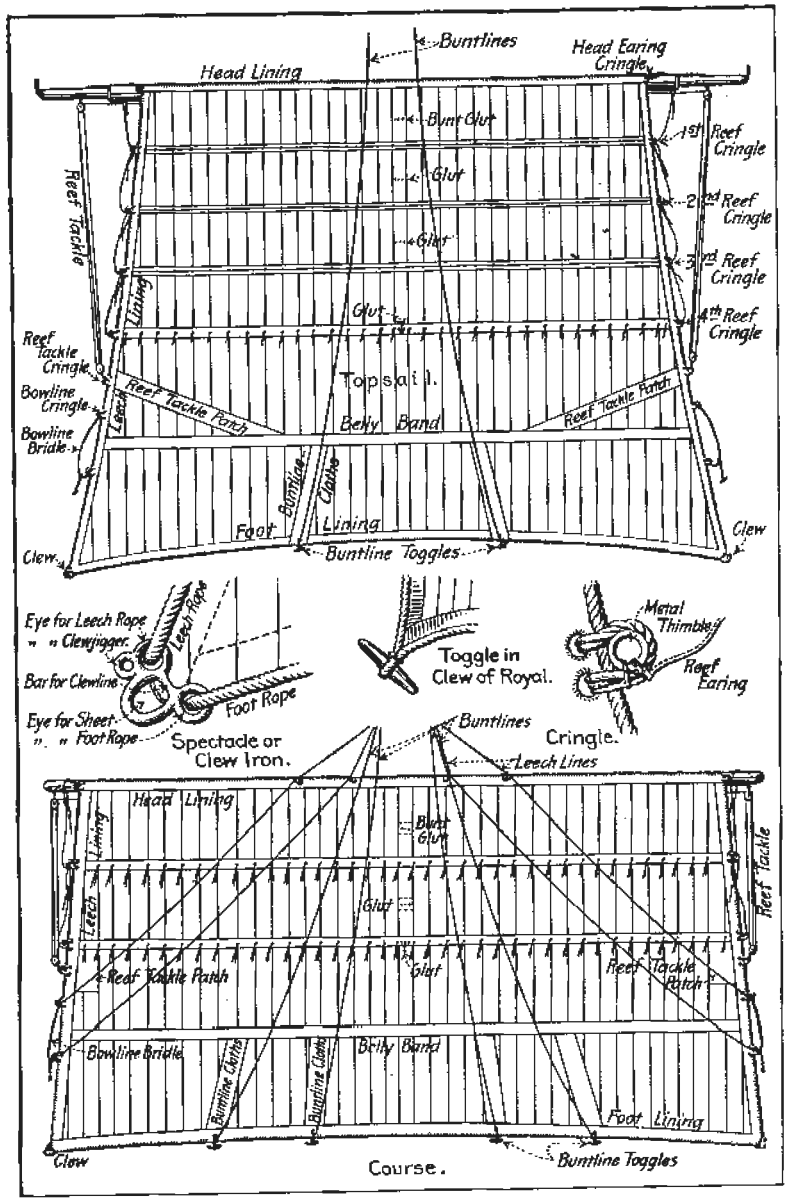
Reef-earings are of 2¼ to 2½-inch manila, spliced into the lower cringle-hole, seized to the lower side of the cringle, and secured with a bowline when not in use, to the cringle of the reef above, or to the head-earing cringle. They haul the cringle up and out on the yard in reefing, and hold it there. (See Chapter on Making and Taking in Sail.)

With French reefs, as above described, "bull-earings" are used. There are fixtures on the yard instead of on the sail.

Harbor gaskets, as used for neatness on men-of-war, are of sennit, long enough to go around the sail when furled, and are stitched to the head of the sail abaft, between the roping and the canvas. A tail in the end of the gasket is made fast to a staple on top of the yard.

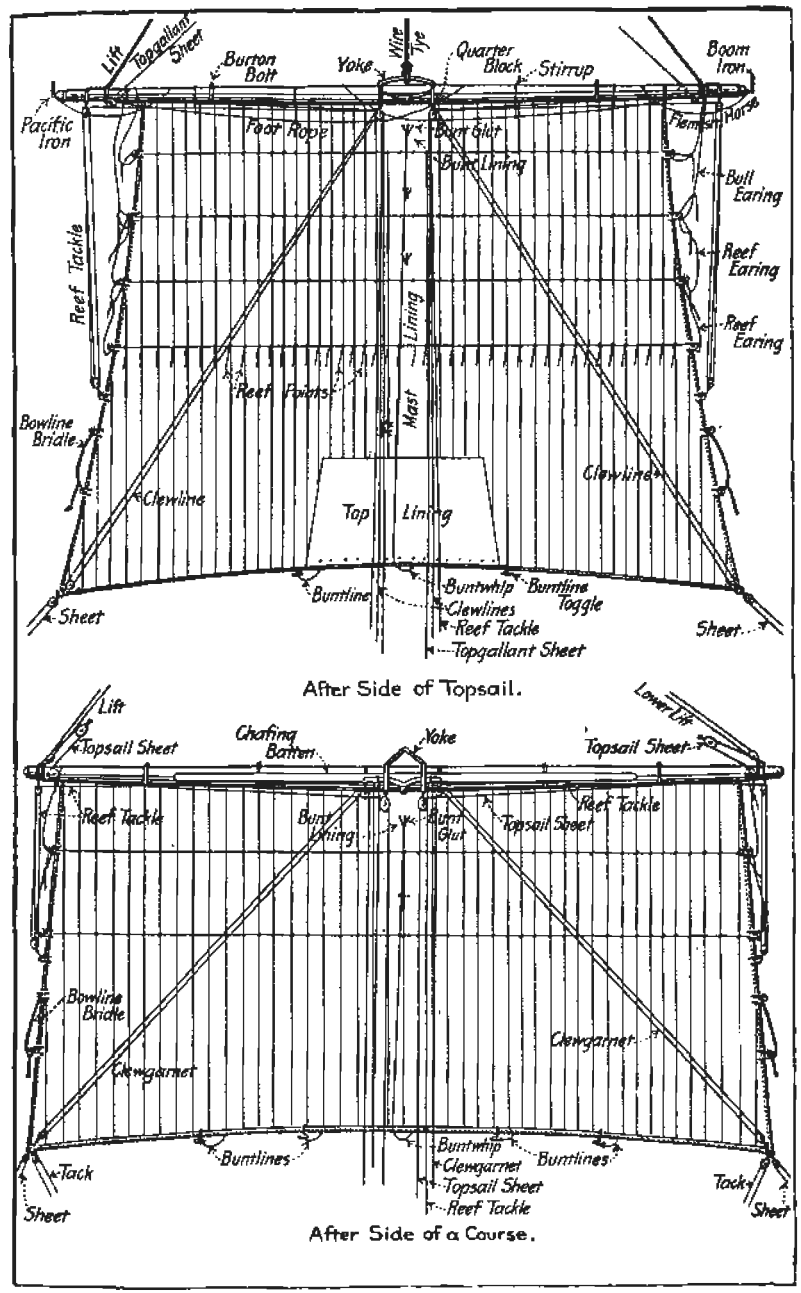
Storm sails are the sails used in lying to for riding out a gale. The sails commonly used for this are the close-reefed main topsail, the main trysail, the fore storm-staysail, and the storm-mizzen or the mizzen

Plate No. 34.



SQUARE SAILS, MAN-OF-WAR.
(FORWARD SIDE)

Plate No. 35.



SQUARE SAILS, MAN-OF-WAR.

storm-staysail. Of these, only the three last-named are exclusively storm sails.

The fore storm-staysail sets on a special stay which toggles temporarily into the collar of the fore stay and sets up on the forecastle.

The storm-mizzen is a triangular sail which is set on the mizzen mast, its luff being secured by good stops around the mast. The mizzen storm-staysail sets on the mizzen stay.

Any or all of these sails may be used for lying-to in any given case, according to the build and trim of the ship, and the conditions of wind and sea.

Studding sails ("Stun sails") are sometimes set beyond the leeches of the foresail, fore topsail and fore and main topgallant sails in running free, being hauled out to booms which project beyond the yard-arms. They are more fully described in Chapter XXV.

Double Topsails and Topgallant Sails.—Modern sailing ships almost without exception have double topsail yards and in many cases double topgallant yards as well. This rig was first proposed by an American shipmaster named Howe, and its many advantages were promptly recognized (Plates **28** and **32**).

In this rig, the lower topsail yard is fixed, while the upper yard hoists and lowers, the sail having half the depth of a single topsail. The lower (topsail) yard is trussed to the main cap, and the upper yard, when lowered, lies close above it. Thus by lowering the upper topsail, sail is reduced in a moment to the area of an old-fashioned topsail when close-reefed, the upper topsail, when lowered, hanging forward of the lower topsail, where it is to a great extent becalmed.

Downhaul tackles are fitted from the yard-arms of the upper to those of the lower (topsail) yards to haul the yards down. This takes the place of "clewing-down" with a single topsail. The downhauls also support the lower topsail yard-arms, for which, usually, no lifts are fitted.

The lower topsail is fitted with sheets and clew-lines like an old-fashioned topsail, but as the leech is short, the clew-line blocks are placed well out on the yard. As a rule, the clews of the upper topsail shackle permanently to the lower topsail yard-arms.

In furling the upper topsail the sail is gathered directly up to the yard as in reefing;—that is to say, it is not passed in to

form a bunt at the slings of the yard. The buntlines assist in gathering the sail up, being rove as shown in Plate 32.

Sea-gaskets are always used and are passed from the yard-arms in. As the clews remain shackled to the yard below, a few turns of the gasket are taken around them between the two yards.

As the foot of the upper topsail does not span a stay, it is cut with only a slight roach. In the first ships fitted with this rig it was cut perfectly straight, and laced to the yard below it.

Although the general practice is, as above stated, to leave the clews of the upper topsails permanently shackled to the lower topsail yard-arms, many officers like to use sheets for hauling out the clews of these as of other sails. This admits of easing away a little in reefing and furling, and, in general, gives better control of the sail. It does not, however, change the principle upon which the sail is handled, since the sheet is not accompanied by a clew-line, and *the sail is never clewed up.*

The upper topsail usually has one reef and sometimes two, fitted as in the case of other topsails.

The details of rigging and fitting double topsails are shown in Plates 28 and 32.

§ II. RUNNING GEAR.

The ropes, purchases, &c., by which the yards and sails are controlled constitute the Running Gear of the ship. Most of this gear is shown so clearly on Plates 28, 31, 32, 33, 34 and 35 that a detailed description of their lead is unnecessary.

Halliards.—Yards are hoisted by purchases consisting usually of a pendant, called a tye and a purchase called the halliards. The topsail tye is of flexible wire, reeving through the gin-block at the masthead, down through the tye-block on the yard and up to the topmast head, where the standing part is secured, usually by hitching it around the masthead. The halliards consist of a two-fold purchase, the upper block hooking to a thimble in the after end of the tye and the lower block in the chains or on deck. In large ships, two tyes and halliards are used, one on each side, rove as above, the two tye blocks on the yard being separated by the diameter of the mast. In smaller ships, having only a single tye and halliard, a large single block (called a fly-block) is hooked to the after end of the tye, and through this is rove a runner, having the upper block of the halliards hooked to one end while the other end makes fast to the ship's rail or to the deck.

The topgallant tye reeves through a sheave in the mast and hooks to a band on the slings of the yard. The upper halliard-block hooks to a thimble turned in the after end of the tye in such a way that it can be easily turned out for unreeving the tye. The lower block of the halliards hooks in the top and the fall is led on deck.

The royal tye and halliards are rove like the topgallant.

On men-of-war, where topgallant and royal yards and topgallant masts are sent up and down frequently, long yard-ropes are used in addition to the tyes, the tyes being unbent for sending down the yards, and unrove for sending down the masts. To avoid the necessity of unreeving the long yard-ropes also (for sending down the masts) they are rove through "jack-blocks" hooked to straps on links under the eyes of the rigging.

The halliards of a staysail are bent to the head of the sail, lead up along the stay to a block at the masthead and thence on deck. For heavy sails, the halliards are double, and reeve through the blocks at the head of the sail, the standing part being made fast aloft and the hauling part leading as before.

The gaffs of trysails are supported by spans from the lower mast to the throat and peak, and when necessary may be hoisted and lowered by t h r o a t and p e a k halliards (Plate 33).

Studding-sail halliards are bent to their yards, rove through jewel-blocks at the ends of the yard-arm or booms, through blocks hooking to long straps at the masthead and thence to the deck. For the inner halliards of a lower studding sail, a clew-jigger is used, one block hooking at the cap, the other at the inner head cringle. There is a difference of practice as to leading studding-sail halliards forward or abaft the yard-arms, but experience proves that there is less chafe if they are led forward.

Braces.—Yards are controlled as to their horizontal movement by b r a c e s leading from the yard-arms aft or forward. They are always led aft if circumstances permit this without requiring too much of a downward lead. In three-masted ships, the braces of yards on the fore and main are led aft, those of yards on the mizzen, forward.

The manner of reeving braces on modern ships is shown in Plates 28 and 32.

Method of reeving braces in old-fashioned sailing ships:

The standing part of the fore brace hooks to a bolt at the main bibbs, leads through a block on the yard-arm, back through a block at the bibbs and so to the deck. The fore topsail brace leads from the main topmast head through a block on the yard, down to a block on the main stay (to clear the foot of the topsail), through a block at the main bibbs, and then to the deck. The fore topgallant brace hooks to the lift and brace band on the yard-arm, reeves through a block on the collar of the main topmast stay, then through another block under the eyes of the main topmast rigging and so to the deck. In large ships, a whip is hooked to the end of this part and led on deck. The fore royal brace hooks to a band on the yard-arm, leads through a block under the eyes of the main topgallant rigging and thence on deck.

The standing part of the main brace hooks to a bumpkin projecting from the quarter, reeves through the block on the yard, back through a block on the bumpkin, and through a sheave in the rail, and belays at the mizzen-pin rail. The standing part of the main topsail brace hooks to a band which travels up and down the mizzen topmast, reeves through the block on the yard, then down to a block on the mizzenmast between the top and the deck.

The main topgallant and royal braces reeve like the fore, substituting "mizzen" for "main."

The crossjack, mizzen topsail and mizzen topgallant and royal braces lead forward to the main mast, very much as the other braces lead aft.

The boom-brace of the topmast studding sail goes over the end of the boom with a running eye, reeves through a block tailed on to the forward swifter of the main rigging, and belays to the main pin rail.

Lifts.—Yards are supported at the yard-arms by lifts, leading through blocks or fair-leaders at the masthead and thence to the top or the deck. Lower lifts are double, the standing part hooking to the strap of a block at the lower cap, reeving through a single block at the yard-arm, back through the block at the cap, and then on deck. The lifts of single topsail yards are single, hooking to a bolt at the yard-arm and leading through a fair-leader between the forward swifters of the topmast rigging to the deck. The lifts of upper topsail yards are double and rove through a block at the masthead, one end hooking to the yard-arm, the other to the quarter of the yard.

Lower topsail yards usually have no lifts, being supported at the yard-arms by hauling taut the downhaul tackles of the upper yards.

Topgallant and royal lifts are single, hooking to the same yard-arm bands as the braces, and leading through fair-leaders between the shrouds and thence to the top.

Sheets.—The clews of square sails are hauled out to the yards below them by sheets, reeving through sheaves in the yard-arms, thence through quarter-blocks under the yard and so to the deck. Topsail sheets are usually of chain, rove as above but with a whip from deck hooking to the chain below the quarter-block. The fittings for the clews of upper topsails have been described in the preceding section. Topgallant and royal sheets are single.

In old-fashioned men-of-war the topsail sheets are rove as follows: The standing part hooks to the yard-arm, reeves through a block at the clew of the sail, through the sheave in the yard-arm, through the quarter-block, thence on deck.

Staysail and trysail sheets consist of pendants and whips, and are usually double, each sail having its port and starboard sheet. In the case of a sail hauling out to a boom, the purchase for controlling the boom is the "sheet" and the sail is hauled out by an "outhaul."

Tacks.—To control the clews of the courses, not only sheets, but tacks, are needed, the tack hauling the weather clew down and forward, the sheet hauling the lee clew down and aft.

Midship tack.—A "midship tack" is often fitted, as in Plate 32. This makes fast to a bolt on one side of the deck, reeves through a bull's-eye on the foot of the sail and belays to a cleat on the other side of the deck. By keeping this fast and hauling the clews up forward of the yard, a triangular reef is put in without the necessity of sending a man aloft.

Clew-lines.—In taking in the sails, the clews are hauled up to the quarters of the yard by clew-lines leading from the clews to the quarter-blocks and down on deck. For topsails and courses the clew-lines are double, and reeve through a block at the clew, the standing part being clinched around the quarters of the yard.

The clew-lines of courses are called clew-garnets.

Secret blocks are used at the clews of topsails and courses to avoid danger of fouling reef points.

Owing to the limited "drop" of a lower topsail as compared with its spread, the clew-line blocks are well out on the yard, and the sail—instead of being furled like a course, with a full bunt and lean yard-arms, is to a great extent rolled up;—indeed it is sometimes clewed up directly to the yard-arm, the clew-line block being placed outside the head-earing. This, however, is not usual.

Clew-lines or clew-ropes are fitted to trysails for hauling the clew up to the jaws of the gaff, and on gaff topsails for hauling the clew up to the head.

A clew-line is used with a square lower studding sail to haul the clew up to the inner yard-arm.

Leech-lines are used to haul the leeches of courses and sometimes of topsails along the yard. They reeve through blocks at the masthead or the top-rim, then through blocks on top of the yard, and make fast to the leech at a distance from the head-earing cringle equal to the distance from the same cringle to the block on the yard.

Buntlines.—Buntlines haul the foot of the sail above and forward of the yard for convenience in furling. They are rove through blocks at the masthead or the top rim, lead down forward and toggle to the foot of the sail some distance outside the midship line on each side. The buntlines of an upper topsail or topgallant sail lead through blocks some distance out on the yard (as in the case of leech-lines), and instead of toggling to the foot-rope, are rove through thimbles there and brought up abaft the sail, where they are made fast around the yard close to their respective blocks. There are usually two of these on each side, and one amidships. They thus act like brails, gathering up the foot and body of the sail and binding it to the yard.

Bunt-whips.—Bunt-whips or bunt-jiggers hook to the bunt-gluts on the after side of the sail a little below the head, to haul the bunt up in furling.

Reef-tackles.—Reef-tackles are whips leading from the yard-arms of topsails and courses to cringle on the leeches of the sails, for hauling the leech up and out in reefing, affording slack for passing the earing and rousing the cringle up to its place.

Bowlines.—Bowlines lead forward from the bowline bridles on the leeches of courses and topsails, and are used, when sailing on the wind, for hauling the leech well forward so that it shall hold the wind.

Outhauls.—The head of a trysail is hauled out by a head outhaul, reeving through a sheave in the end of the gaff and a block at the mast, and then to the deck. The foot of a boom-sail is hauled out by a foot-outhaul reeving through a sheave in the boom. (For lower studding sail outhaul, see **Tacks.**)

Downhauls.—Staysails are hauled down by downhauls leading from the head of the sail along the stay to a block at the tack of the sail.

The head of a trysail is hauled down by a head downhaul from the head of the sail to the jaws of the gaff. Upper topsail and upper topgallant yards are hauled down by downhauls leading from their yard-arms to those of the yards below. These are rendered necessary by the absence of clew-lines. When the yards are lowered, the downhauls are kept taut and serve to support the lower topsail and topgallant yards, which have no lifts.

Topgallant studding-sail downhaul is bent to the inner yard-arm and leads abaft the topsail yard through the lubber's-hole to the deck.

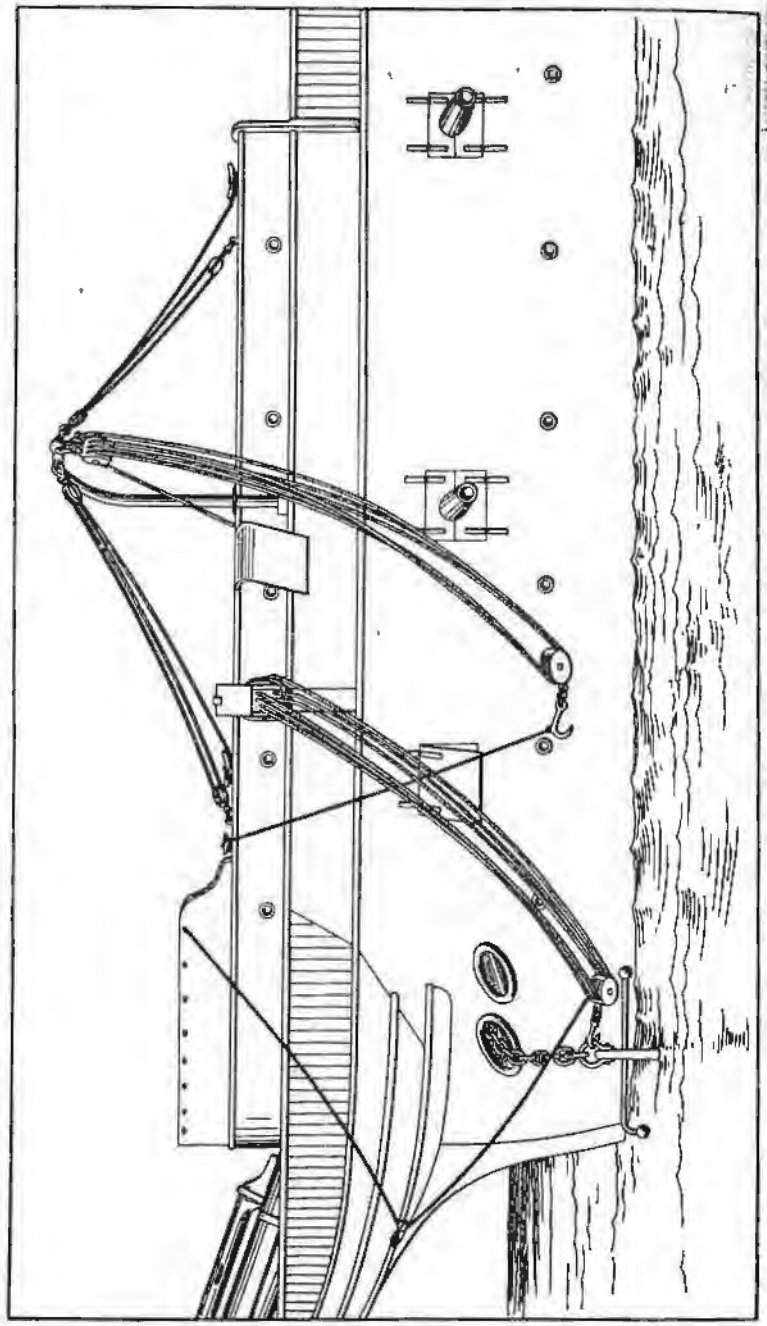
The topmast studding-sail downhaul is bent to the *outer* yard-arm, reeves through a thimble seized to the outer leech of the sail midway of its length, through a block at the tack of the sail, and down, forward of the boom to the forecastle.

Brails.—Gaff sails—trysails, spankers, &c.—are gathered in to the mast for furling, by brails middled and stopped to the after leech, with a hauling part on each side reeving through a block on the mast at a point corresponding to the point at which they are stopped to the leech.

Vangs.—Vangs are fitted to gaffs at the after end—one on each side—and led to the ship's side. Their office is to steady the gaff *when the sail is not set.*

The details of the lead of running gear aloft are subject to change and are not of great importance. The details of their lead to the deck and especially of the points at which they belay, are of the greatest possible importance, and should be as nearly uniform and invariable as they can be made. *It should be possible for any seaman on a strange ship to go at once to any piece of running gear on the darkest night.*

Plate No. 77.



CATTING AND FISHING ANCHOR IN AN OLD-FASHIONED SHIP.

and in the design of the cable-holders have greatly reduced the difficulties described above. In cables like the latest ones for the United States Navy, where there is neither a shackle nor a swivel between five fathoms and forty-five, it is impossible for either of them to come to the windlass in breaking ground.

STOWING ANCHORS.

Plate **77** shows the details of handling and stowing the bower anchor of an old-fashioned ship. The anchor being up, and the cat-and-fish overhauled, the cat is hooked and manned. When the chain is ready for surging, the cat is hauled taut, the order given to "surge," and the ring is run up to the cathead, where it is hung by a "ring-stopper," the cat being slacked to let the stopper take the weight. The fish is hooked over the inner fluke (from forward, aft), and the fluke hoisted to the bill-board and hung there by the "shank-painter." If the stock takes against the bow in fishing, it may be canted clear by a "stock-tackle" hooked to a strap on the outer (upper) end, and led across the forecastle. The inner links of the ring-stopper and shank-painter are engaged by tumblers controlled by a single lever. This arrangement admits of releasing both ends of the anchor simultaneously in letting go.

The next step is to "ring up"; viz., to get the ring close up to the cat-head. The cat-fall is unrove, the cat-block gotten out of the way, and the ring-rope, a stout line of proper length with a thimble in the hauling end, is rove through the sheaves of the cat-head and the ring of the anchor and made fast to the shank of the anchor or to the cat-head. A tackle is hooked to the thimble in the inner end and led across the forecastle, and the ring is bowsed up close to the cat-head, the slack of the ring-stopper being taken in at the same time. If the anchor is to be kept in readiness for letting go, it is now left hanging by the ring-stopper and shank-painter with its inner fluke resting upon the outer (sloping) surface of the bill-board. If it is to be secured for sea, the "stock-tackle" is hooked to a strap on the stock, and a "bill-tackle" to a strap on the inner arm, and this arm is roused inboard until the palm overhangs the inner edge of the bill-board. Extra lashings are then passed, on the inner fluke, the shank and the stock. When off soundings, the chain is unbent and the hawse-bucklers closed.

To get the anchor off the bow ready for letting go, the lashings

are cast off, the stock- and bill-tackle hooked as before, the arm lifted by an "anchor-bar" to the surface of the bill-board, the shank-painter slacked, and the anchor eased out into place for letting go.

The arrangements for stowing anchors in modern ships differ widely with different types of ships. A number of such arrangements are shown in Plates **78**, **79**, **80** and **81**. A comparison of the figures there given brings out clearly the inconvenience of a stock (as an obstruction to gun-fire) on a man-of-war. This inconvenience is met in some cases by unkeying the stock and laying it along the shank, but this entails both trouble and delay and can hardly be considered a satisfactory solution of the difficulty. In many French, and a few American, men-of-war, the old-fashioned anchors are stowed up and down on the outside of the ship, either in a cradle bolted to the side or in a recess shaped into the plating. This is a clumsy arrangement in itself, and has the serious disadvantage of breaking the waves when steaming into a sea, and throwing great quantities of spray on board.

CATTING AND FISHING IN ONE.

Most anchors, of whatever type, are now fitted with a "balancing link" on the shank, and catted and fished in a single operation by a purchase or pendant from a heavy iron davit, as shown in Plate **80**. This davit turns about a vertical axis, plumbing the proper point of the bill-board at one part of its train and swinging out well clear of the bow at another part.

In small ships it is handled by guys, in larger ones by a winch, usually on the deck below. In men-of-war it is hinged to turn down flat upon the deck, out of the way of gun-fire.

At the davit head may be hooked either a heavy single block, swivelled and carrying a pendant, or the upper block of a heavy purchase, usually three-fold.

Where a pendant is used, it leads down to a block at the heel of the davit and then aft. In some cases a thimble is turned in the end and a deck tackle hooked to this, the fall going to a capstan or a winch; in others, the pendant is taken direct to the capstan and the end there made fast, the length being such that there are several turns around the barrel when the cat is hooked and set taut ready for surging chain. The method