There are many excellent online resources about fitting out Mirrors for racing, some of which are listed at the end of this document. But having built a wooden Mirror, not for racing but to introduce my grandkids to the joys of sailing, rowing and motoring, I experienced gaps in online guides for fitting out a basic Mirror, and information was widely dispersed. Hence this one-stop basic resource that I hope will assist boat builders unfamiliar with the Mirror on how to fit it out for social sailing, rowing and motoring. The information was drawn from the Mirror regulations and a range of internet resources and expert advice.

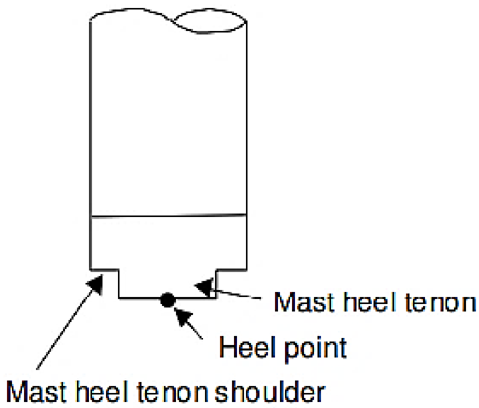
Mast

The following description applies to fitting out a bare aluminium Bermuda (straight) mast (new Mirrors don't use gunter masts).

The mast may be tapered and must be cut to the correct length at its base before fitting the **mast foot/heel**.

Rivet the heel to the mast only after all fittings have been fixed to the mast and slots made for the halyards and the topping lift exits, and the halyards and topping lift have been threaded down the mast and through the exit slots.

Note that measurements on the mast are taken from the **heel point** of the **heel tenon of the mast foot/heel** and that the height of the mast foot and its tenon must be factored in when marking the length of the mast and the positions of the mast fittings for the spinnaker halyard, the forestay and shrouds, and the gooseneck for the boom as per the Mirror regulations. Positions of all other fittings and exit slots for halyards are not regulated and hence discretionary.



Fitting forestay, shrouds, sheaves, spinnaker pole eye and gooseneck, and limit marks

The **only measurements in the** [Mirror regulations]() (taken from the **heel point** of the **heel tenon of the mast foot/heel**) are the height of the mast, and the attachments of the mast hounds for the forestay and shrouds, the spinnaker hoist and the height of the boom.

- Mast upper point: 4857mm (Max)
- Forestay: 3173mm - 3193mm
- Shrouds: 3173mm - 3193mm
- Spinnaker hoist: 3283mm
- Top edge of boom: 669mm ± 10mm
- Limit marks on Mast and Boom
    - Permanent black bands must be painted around the mast and boom to define the limits of setting the mainsail along the mast and the boom. They must be at least 10mm wide
    - The mainsail must be set between the upper (4857mm from heel point) and lower (659mm from heel point) limit marks on the mast
    - Boom outer limit mark is 2300 mm from the aft side of the mast to the outermost limit mark on the boom

Discretionary positions

- Jib halyard sheave (pulley): Just below the forestay
- Topping lift (spinnaker pole uphaul) sheave (pulley): Approx 600mm below jib halyard sheave (pulley) on the front of the mast
- Spinnaker pole eye: Approx 330mm above the gooseneck fitting

Mainsail halyard sheave and access for internal halyard

Drill a hole at the forward side of the top of the mast for the halyard to feed from the sheave into the mast.

Sheaves for spinnaker and jib halyards and the topping lift

Below are **examples of pulleys (sheaves)** for the spinnaker and jib halyards and the topping lift (spinnaker pole uphaul). They must accommodate the thickness of the ropes to be used.

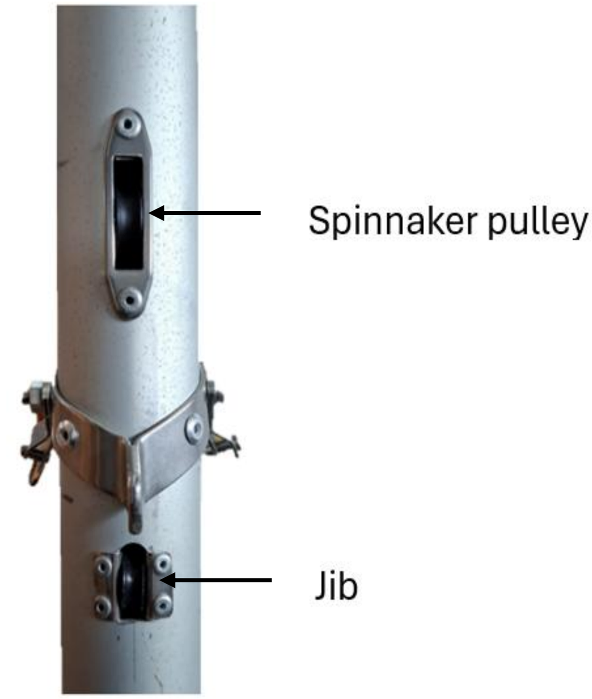


Slots in lower section of mast for exit of halyards and topping lift

Cut 4 vertical slots, 2 on each side of the mast, below the level of the boom as shown for the mainsail, jib and spinnaker halyards and the topping lift. The slots are made by drilling holes at the ends and cutting the slots with a small angle grinder.

The suggested placement of the slots is shown in the photographs below:

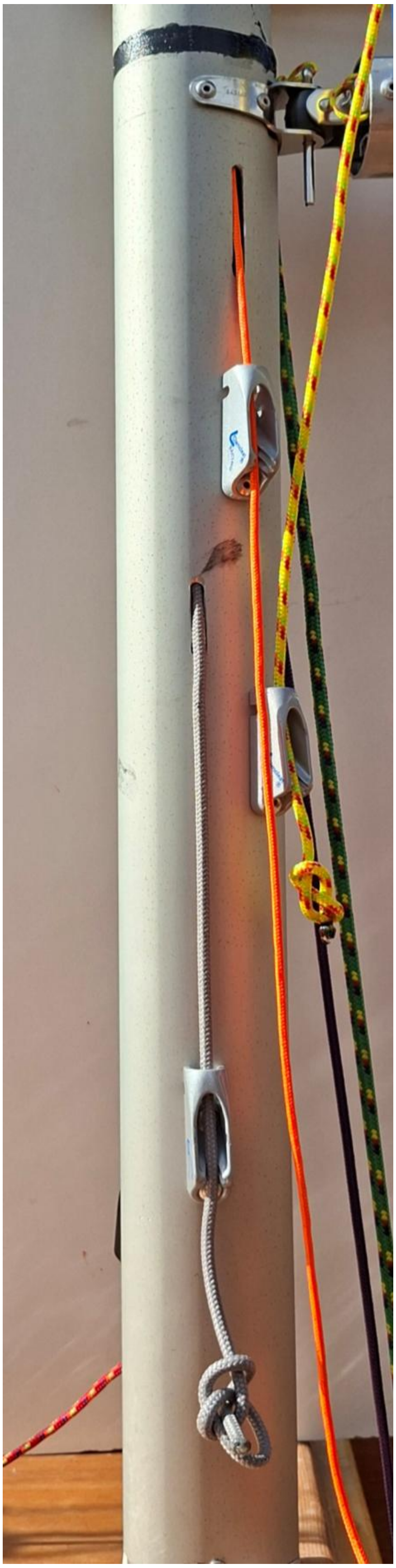
- Left side of mast: Jib (grey); Topping lift (orange)
- Right side of mast: Mainsail (black) and Spinnaker (purple)



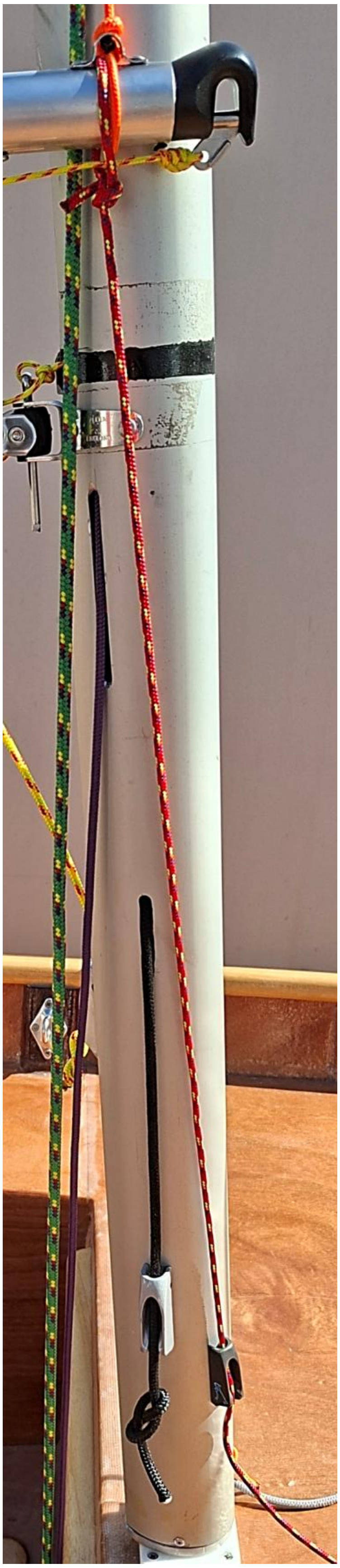
*Tip: It is easier to feed the ropes down the mast **before** riveting the sheaves to the mast*

The halyards for the mainsail, jib and the topping lift lead to **clam cleats** fitted to the mast.

The **spinnaker halyard** (purple) exits the starboard side of the mast just forward of the mainsail track and just below the gooseneck of the boom. Note the longer slot for the spinnaker to ensure frictionless up and downhaul, and that the spinnaker slot has been placed posteriorly on the right so that it can lead vertically to the pulley on the face of the stowage bulkhead. The pulley is attached low down on the bulkhead to keep the halyard out of the way of the crew's feet. It then runs back to a jam cleat fixed to the starboard side of the daggerboard casing (See pictures below).



Jib halyard (grey), Topping lift (orange), Cunningham downhaul (yellow)



Mainsail halyard (black), Spinnaker halyard (purple), spinnaker pole downhaul (red & yellow)

Halyards and Topping Lift

- **Mainsail halyard:** 11 metres of 4mm dyneema/spectra or Kevlar with polyester cover
- **Jib halyard:** 8 metres of 3mm or 4mm dyneema/spectra, Vectran or Kevlar with polyester cover
- **Topping lift/spinnaker pole uphaul** (Flyaway pole system with cleat on mast): 5.3 metres of 3mm dyneema/spectra or Kevlar with polyester cover
- **Spinnaker halyard and retriever line** (with cleat on aft edge of daggerboard case): 12 metres of 3mm dyneema/spectra or Kevlar with polyester cover *Note: spinnaker halyard and retriever line are continuous*

Mast Step

The mast step holds the foot of the mast in place along the centreline of the foredeck.

- Position the centre of the mast step 2160mm +/-15mm forward from the forward face of the aft transom at deck level and fix it to the mast step web with self-tapping screws
- A 2nd mast step 254mm forward of the aft mast step adds the option of cat rigging (sailing only with the mainsail)

Mast gate / sail entry

Cut a slot in the integrated track on the mast for the mainsail to enter the track using a small angle grinder and hand files.

Shrouds and anchor plates

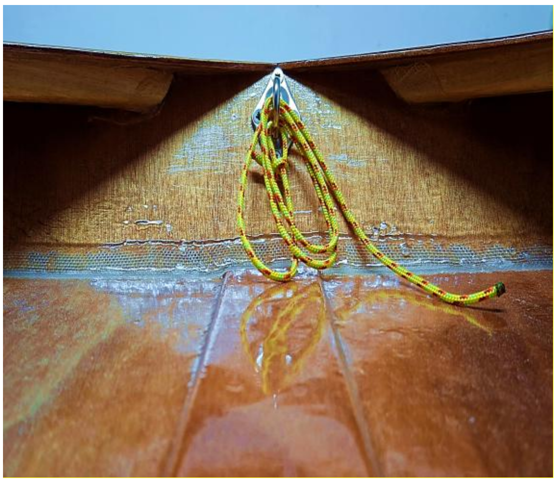
Fix the **shroud anchor plates** to the aft shroud blocks with long self-tapping screws and/or bolts, close to the deck to avoid excessive flex of the gunwales and side panels in heavy weather.

Fit anchor plates to the forward shroud blocks for sailing with a **cat rig configuration.**

The recommended **thickness of stainless-steel shrouds** is 2– 3mm, with a minimum of 2mm required by class rules. The **length** varies according to the positions of the mast hounds and the chain plates attached to the anchor plates. A length of 3170-3180 mm between the bearing surfaces of the two thimbles in the eyes is advised.

Forestay

Fix the **forestay anchor plate** high up on the bow transom with long self-tapping screws and/or bolts.



The recommended thickness of the **stainless-steel forestay** is 2.5 – 3mm, with a minimum of 2mm required by class rules. The length can be variable given that the forestay is attached to the anchor plate with high-performance **3mm rope.** Mine is 2950mm long between the bearing surfaces of the two thimbles in the eyes. If the forestay is too long, the eye splice will be too close to the forestay anchor plate making it impossible to tension the rig with the rope forestay system described below.

Attach the forestay to the anchor plate with high-performance **3mm rope** with a dyneema/spectra core and polyester braided cover so the required rig tension can be precisely set and maintained.

Traditionally the rope is tied to the eye on the end of the forestay, then passed around the anchor plate, then back around the eye on the end of the forestay, and back around the anchor plate another 2 times, finishing by passing through the eye on the end of the forestay. When the 3mm line is tensioned, the line "binds" on itself in the eye on the forestay. Therefore, when the rig is tensioned, it is easy to secure the line with a few half hitches. https://www.ukmirrorsailing.com/index.php?option=com_content&view=article&id=722&Itemid=385

Alternatively, one may use an aero cleat as shown below.

Setting Mast Rake with Bermuda rig

"Mast rake" is the angle the mast leans aft when viewed from the side and is adjusted by changing the lengths and/or tension of the forestay and shrouds. The mast rake determines balance and performance of the boat. More rake (leaning back) increases weather helm and powers up the boat in light winds. Less rake (more upright) helps balance the helm in stronger winds and improves pointing. A neutral or slightly raked setup (~50 mm) gives a good all-around performance.

- Step the mast, with the foot seated in the mast step
- Attach the forestay and shrouds keeping them loosely tensioned
- Use a long tape measure to measure the distance between the masthead and the top of the centre of the transom by attaching one end of the tape measure to the mainsail halyard and pulling it to the top of the mast to a height 4200mm above the top of the boom
- A recommended distance from the masthead to the transom for a wooden hull is 4950 – 5000mm
- Adjust the forestay and shrouds accordingly
- Tension the rigging........the Mirror isn't a high-tension boat........the shrouds should be firm, not slack

Mainsheet system

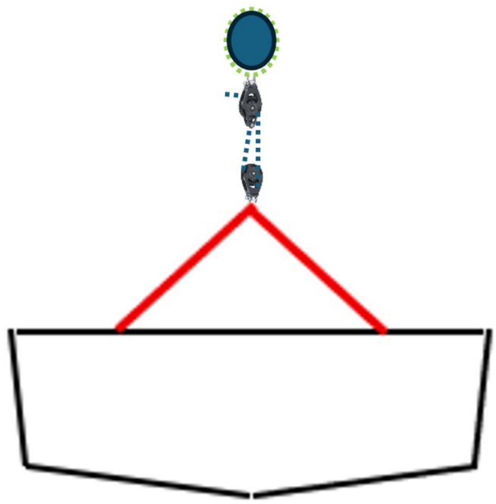
A bridle or split tail (swallow tail) with central block is commonly used and is detailed below.

The **mainsheet** for this system requires 8 metres of 8mm diameter line with 8 or 16 plait matt polyester cover.

The **bridle** (3mm or 4mm dyneema/spectra or kevlar with polyester cover) is tied to 2 stainless **deck eyes** fixed to the aft transom 450mm - 500mm apart. The length of the bridle should bring the block on the bridle close to but not touching the block at the end of the boom.

Deck eye

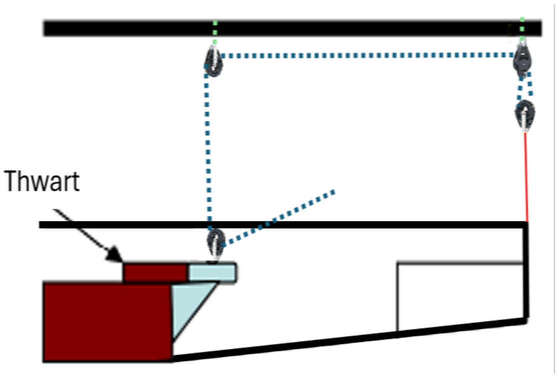
It then passes around a single block attached to the **bridle** (red line in the illustration).



The mainsheet starts from the **becket of a block** attached near the end of the boom.

It then passes back around the **single block** near the end of the main boom, through a **boom sleeve** or **constraining loop** on the main boom, and then around a **single block** near the centre of the boom.

It then descends vertically to a **ratchet block** mounted on the aft end of the centre of the thwart. Positioning the ratchet block on an **aft extension of the thwart** creates more space for the crew to cross the boat between the mainsheet and the kicking strap.



Mainsheet fittings on the boom

- The aft and central blocks are attached to the boom by loops of 2mm cord
- Rivet 2 small deck eyes to the top surface of the boom to keep the loops of cord that are attached to the two mainsheet turning blocks in place
- Position the deck eyes to allow the mainsheet to drop vertically from the boom to the main turning block on the thwart and to the bridle at the transom
- The positions on the boom may have to be adjusted when sailing with the mast in the front footstep (cat rig)

- https://www.ukmirrorsailing.com/images/repairs_and_fitting_out/fitting_out/centre_mainsheet_systems/bridle_with_purchase_and_central_block/bridle_with_purchase_and_central_block_centremain_setup.pdf

Boom

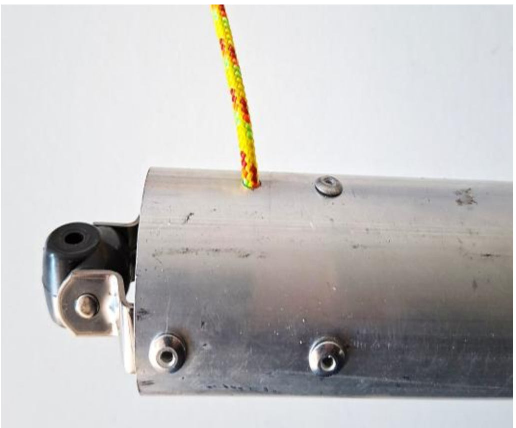
- Overall length of the boom, **excluding** cleats, blocks, or end fittings, is 2235 - 2285mm
- Fit the **gooseneck** to the boom before marking the position of the gooseneck fitting to the mast to ensure that the distance for the heel point of the heel tenon to the top edge of boom measures 669mm ± 10mm

Boom sleeve/constraining loop

- Required by class rules with a centre mainsheet to avoid the sheet getting entangled with and injuring the crew
- It is typically placed about 900mm from the inboard end of the boom
- It may not protrude >50mm from the surface of the boom
- Can also slip a section of a plastic juice bottle around the boom as a sleeve

- **Cunningham downhaul**
  - Adjusts tension on luff (leading edge) of mainsail, also while sailing
  - Use 3mm or 4mm dyneema / spectra or kevlar with polyester cover.

Lengths vary depending on the exact arrangement
  - Drill a 3 or 4mm hole in the center of the top side of the boom about 30mm from the front end, and thread the cord through the hole and knot the end inside the boom
  - The cord is then threaded through the Cunningham and down the side of the mast to a clam cleat fitted to the mast
  - Alternatively, it can be either threaded through a bullseye fair-lead fixed close to the front end of boom and led back to a clam cleat on the boom; or set up (like the spinnaker halyard) to run vertically to a pulley on the face of the stow-age bulkhead, and then back to a jam cleat fixed to the port side of the daggerboard casing for the skipper to adjust the tension while sailing



Gooseneck and Cunningham downhaul exiting the boom, with knot inside the boom

- **Foot outhaul**
  - Adjusts tension along bottom (foot) of mainsail also while sailing
  - Use 3mm or 4mm dyneema / spec-tra or Kevlar with polyester cover. Lengths vary depending on the exact arrangement.
  - A webbing band around the boom is often preferred to a track-and-slider
  - Drill a 3 or 4mm hole in the center of the top of the boom close to the outer end of the boom, and thread the cord through the hole and knot the end inside the boom
  - Rivet a bullseye fairlead on top of the boom close to its end and thread the outhaul through the bullseye
  - Rivet a clam cleat to the side of the boom about 500mm from the end to make the outhaul accessible for the skipper to adjust the tension while sailing

Kicking strap

- Attach the foot of the kicking strap 3/4 of the distance down the stowage bulk-head with a deck eye. One may opt to fix it to the mast or higher up on the bulkhead to create more room for the crew to cross the boat from side-to-side, though this is at the expense of mechanical advantage
- Use an in-line cleat to cleat the kicking strap

Kicking strap setup

- A loop of cable/webbing/rope wrapped around the boom and attached to the kicking strap assembly is commonly used
- The angle of the lower edge of the kicking strap to the upper edge of the boom shall not be greater than 45° with the boom at 90° to the mast: this will determine the position a small deck eye riveted to the top side of the boom to fix the position of the webbing/rope/cable
- Rivet a small deck eye to the upper surface of the boom about 450mm from the inboard end of the boom to keep the loop of rope/cable in place
- Having the attachment point on the boom further forward creates more space between the kicking strap and the mainsheet for the crew

Jib sheets and fairleads

The jib sheets are 6 metres (3m for each side) of 6mm diameter.

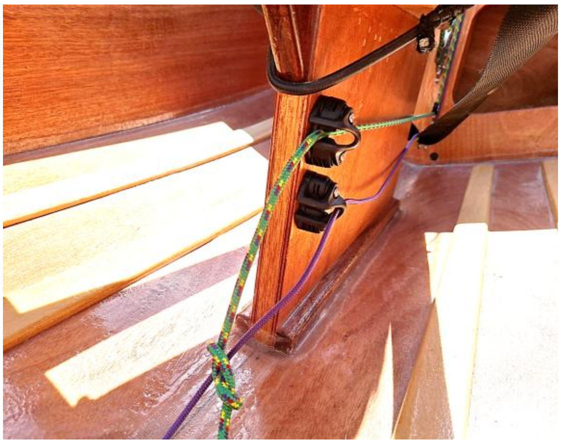
Jib sheet and fairlead setup

Bullseye fairleads with stainless steel insert and **jam cleats** are fitted to the top of the thwart, as far aft and to the side as possible.

Mounting blocks are commonly used and may not be >25mm in height or >150mm in length or breadth and may not overhang the aft edge of the thwart.

Spinnaker halyard and retriever line

After exiting from the slot in the mast, the **spinnaker halyard** runs vertically to a pulley on the face of the stowage bulkhead. It then runs back to a jam cleat fixed to the starboard side of the daggerboard casing.



Spinnaker halyard (purple) and rope (green) to pull flying spinnaker pole forwards

Spinnaker sheets and fittings

- Length: **12 metres** gives ample slack to run from the spinnaker clew, through the turning blocks, and back to the cleats
- Diameter:
    - 3 mm Dyneema is stronger, lighter, and low stretch — ideal for racing

- 4 mm Polyester is slightly heavier, but still entirely adequate for casual use
- Each sheet loops around a **block** attached to the inner aspect of the inner gunwale located 300 - 450mm from the aft transom

- It then passes forwards and through a **block** tied to the aft shroud anchor plate
- A **jamb cleat** is fitted close to the edge of the side tank deck for the crew to cleat the spinnaker sheet
- One may also opt for a continuous sheet with turning blocks near the shrouds: https://www.ukmirrorsailing.com/index.php?option=com_content&view=article&id=762&Itemid=388

- **Reaching hooks**
    - Hold the guy (windward section of spinnaker sheet going to clew of spinnaker where pole is) in position
    - Fit the hooks or clam cleats with their **closed sides inboard**
    - Fix to the gunwale about 300mm forward of the aft shrouds
    - Note: No point of these fittings may be outboard of a vertical line touching the closest point on the outside surface of the outer gunwale to the point on the fitting

Clam cleat with open side

Yacht coat hanger repurposed as reaching hook

Spinnaker chute and sock

A [spinnaker chute](#) to launch and retrieve the spinnaker has become standard on Mirror dinghies. The following video is a good illustration of [hoisting a spinnaker using a chute](#). However, it is not essential to have a chute, especially for the social sailor, and the spinnaker can be stowed in the left stowage compartment or in a spinnaker bag https://www.cautionwater.com/article.aspx?articleid=79 .

Below is a Chute made using black garden irrigation pipe covered with fibreglass tape, and resin mixed with chopped glass strand to mould the chute to the profile of the inner gunwale. It was rigidly fixed to the hull with self-tapping screws and silicone sealant. The sock was custom made by a local sailmaker.

Retriever line

The helm pulls down the spinnaker through the chute into the sock with the retriever line. If the retriever line is continuous with the halyard, then the halyard runs from the back of the thwart, over the top of the toe traps to a block fixed at the end of the spinnaker sock. The location of this block depends on where the sock ends. With a long sock the block might be placed on the thwart support (illustration below); with a short sock running along the side deck, the block might need to be fixed to the topside.

Block placed on thwart support next to bungee is that attached to end of sock

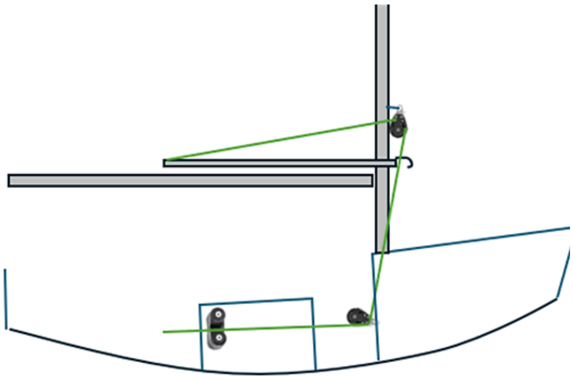
To keep all the spinnaker inside a short sock like above, one needs to run the **retriever line though a plastic ring** before attaching it to the retriever patch on the spinnaker. The ring has a length of elastic fixed to it, about the same length as the sock. The other end is fixed near the mouth of the chute. When one pulls the spinnaker down, the elastic stretches and the retriever patch and ring come back well past the end of the sock, pulling the head, tack and clew of the spinnaker into the chute. On releasing the retriever line, the elastic pulls the middle of the spinnaker back into the sock.

Spinnaker pole (Flyaway pole system)

- The **length** of spinnaker pole **including end fittings** shall not be more than 1524mm
- A **spinnaker pole jaw** with a spring-loaded pin is fitted at one end with the jaw facing upwards.
- Attach a 2mm cord to the spring-loaded pin release mechanism and lead it along the length of the spinnaker pole and secure to the pole at to the opposite end

Spinnaker pole jaw and 2mm cord, and small ***deck*** *eye to secure the up- and downhauls*

- **A flyaway pole system is detailed below**
  - https://www.ukmirrorsailing.com/index.php?option=com_content&view=article&id=758&Itemid=389
  - https://www.ukmirrorsailing.com/index.php?option=com_content&view=article&id=784:flyaway-pole-additional-information&catid=280:fitting-out&Itemid=390
  - The flyaway system stows the pole along the boom when not in use
  - When needed, the **pole is pulled forwards by a rope** attached to the aft end of the pole that leads to a block attached to a deck eye on the mast. The rope then runs alongside the mast to a turning block on the stowage bulkhead, and back to a cleat on the side of the centreboard case next to the block for the spinnaker halyard. When the spinnaker is dropped, an elastic cord returns the pole to its position along the boom

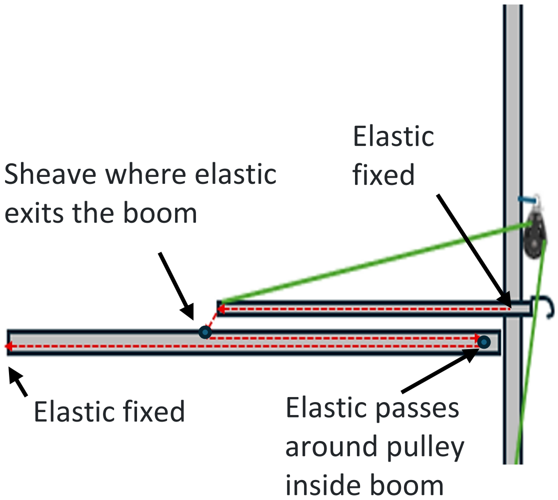


Rope system to pull pole forwards

- A conventional **spinnaker pole mast bracket** is not required for a Mirror…a large deck eye will do and is riveted to the mast about 330mm above the gooseneck fitting rotated slightly to the right of the midline

Deck eye on front of mast with pulley

- **Elastic cord to return the pole** to the side of the boom (Broken red line in figure below)
    - Use 5mm elastic
    - Make it about 4m in length so that there is good flexibility and less resistance when pulling the pole forwards…..with an aluminium boom, the elastic is fixed at the outward end of the boom, then courses along the length of the inside of the boom to turn around a pulley just behind the gooseneck fitting, and then back along the boom to exit at a sheave placed on top of the boom and then threaded into the end of the spinnaker pole to end at the front end of the spinnaker pole



Rope and black elastic exiting back end of spinnaker pole, with elastic entering boom through the sheave

- **Position and insert sheave for flyaway pole elastic (see earlier)**
    - Position the sheave on top of the boom so that when the pole is fully retracted with the end of the pole at the sheave, the front of the pole and the jaw rest on the right side of

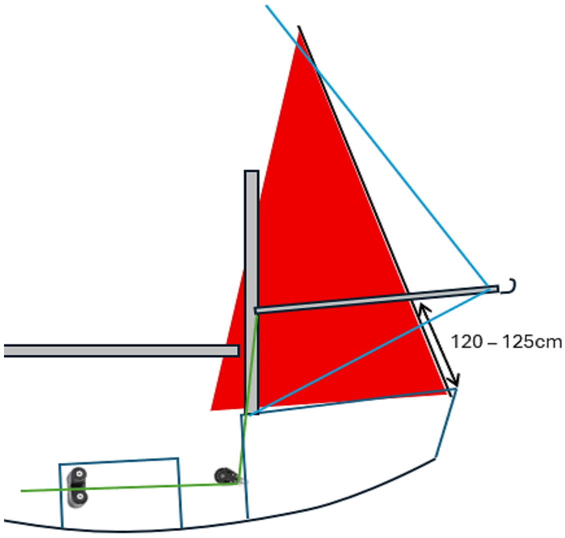
the mast without protruding beyond the mast where it will catch the jib when tacking
   - Check the position of the sheave with your own spars
   - With a standard length pole the sheave fitting is about 1420mm from the inboard end of the boom (excluding gooseneck)
   - **Attach a pulley inside the front end of boom** behind the gooseneck fitting for the elastic cord to pass around

Pully with elastic cord that is then attached inside the front end of the boom

   - **Fix the end of the elastic cord at the back end of boom** by threading the elastic through a 5mm hole in the side of boom or through the end cap and knotting the end

Elastic cord knotted at end of boom with excess cord fed back into the boom

- **Spinnaker pole topping lift/uphaul and downhaul**
   - The up- and downhauls are set so that the distance along the luff of the jib is 120 – 125cms as shown in the diagram below
   - The up- and downhauls are tied around the spinnaker pole adjacent to the jaw, and kept in position by a small deck eye riveted to the pole
   - The other end of the topping lift is cleated after it exits the slot in the mast



Topping lift and downhaul (blue lines) set to position the height of the end of the spinnaker pole

   - **Spinnaker pole downhaul**
      - The downhaul is a rope with a knot at its end where it passes through a pully or a cleat at the foot of the mast to prevent the pole lifting too high when the spinnaker is set
      - 4.3m of 3mm dyneema/spectra line with a knot inside the mast to limit how high the pole can rise
      - When the spinnaker pole is not in use and stowed against the boom, the slackened downhaul

rope can be retracted with an elastic attached to its end to keep the downhaul under tension and the end of the pole against the mast. The length of downhaul which needs to be retracted by the elastic is more than the length of the foredeck. With a Bermuda mast the whole downhaul system can be rigged within the mast. The alternative is to [zigzag the elastic across the deck]

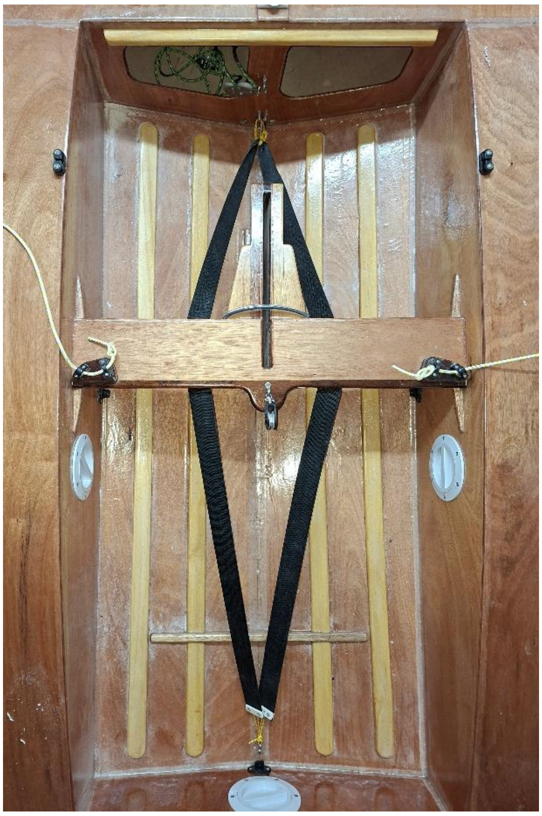
- For social sailing, an option is to lead the downhaul through a clam cleat at the foot of the mast, and to simply manually tension and cleat the downhaul when the spinnaker is not in use

Daggerboard Hold Down Assembly

Thread an elastic cord through a length of plastic tubing, loop the cord around the daggerboard casing, and lash the two ends together with cable ties.

Toe straps

The configuration shown in the picture allows one to release the tension on the straps to create more space in the cockpit for e.g. motoring or fishing.



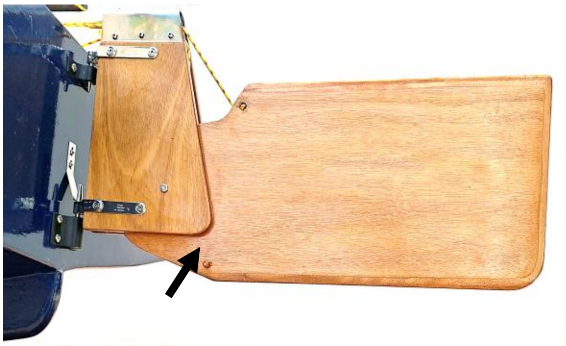
Rudder transom fittings

"Two rudder pivot fittings shall be fitted on the aft transom the bearing surfaces of which shall be not less than 200mm apart. One rudder retaining device shall be fitted"

Fit a **retaining clip** to the transom with self-tapping screws with the lower edge of the clip positioned to rest on the lower rudder gudgeon to hold the rudder assembly in place.

Rudder and Tiller assembly

The rudder below was constructed from the Mirror kit. Note the addition of a wooden dowel (black arrow) protruding from the blade acting as a stopper to avoid the blade rotating forward past vertical.



A 1m x 25mm OD anodised aluminium tube, (same as spinnaker pole) has been used for the **tiller**. It can be fibreglassed **onto the head of the rudder assembly**, or as in this case, mounted in a home-made stainless-steel housing that also allows one to lead the two 4mm control cords across the top of the rudder assembly.

The Mirror plans describe using an elastic to keep the rudder down. The elastic has been substituted by a 4mm **control line** to fix the rudder into the desired position. Rivet two **clam cleats** to the tiller for the rudder control lines.

Tiller extensions come in a range of lengths and materials and can be home made.

Self-bailers

While standard for racing to drain water out of the boat while moving, it is not essential for the social sailor. https://www.ukmirrorsailing.com/index.php?option=com_content&view=article&id=1786&Itemid=1010

Oars and Rowlocks

The recommended length of oars is 1.8 - 1.95m.

Rowlocks are located 635 mm aft of the rear of the aft shroud blocks. Avoid weakening the inner gunwale by gluing a block of wood to the inner aspect of the inner gunwale before rounding it to house the rowlock.

Outboard engine

Below is an example of a wooden spacer that prevents water entering the cockpit when using the motor.

Being of light construction, a 2.5hp engine is recommended. The engine in the picture is 4-stroke and weighs only 13kg making it well suited to the Mirror.

A plywood bracket/spacer below protects the wood and the paintwork of the transom and distributes the thrust of the motor over a wide area. It has been designed to clip over the upper rudder gudgeon so it cannot ride up.

Useful webpages

- International Mirror Class Rules
- Fitting out - Hull
- Spinnaker halyard systems
- Running rigging specification
- Flyaway-pole system
- Spinnaker chutes, socks, bags, nets & rollers
- Mirror dinghy Tuning Guide with Hyde Sails