Building a Mini 12

First Edition January 2006

Revision 1 September 2006
Appendix C Laminated Rudder

John Hutchings
348 Gunter Stlmt. Rd.
R.R. #3
Trenton ON
K8V 5P6

Table of Contents

Preface

The Mini 12 Class sloop is gaining in popularity due its good performance in both light and heavy winds, and in weedy water.

The Mini12 lends itself to be built by the amateur builder. With a minimum of tools and skill, building one of these boats is relatively simple. There are a few tricky parts that require patience and the correct tools or fixtures. What follows is the method I used to build mine, with refinements I would make and some alternate building techniques suggested by other Mini 12 owners. There may be some errors in this document as it has been written largely from memory, but this is at least a start. I know a couple of guys that I'm sure will correct me on a few things.

I have attempted to keep things as simple and inexpensive as possible. Advanced builders will obviously substitute tools, methods and hardware they feel comfortable with.

The appendices provide a list of tools and materials necessary.

The reader is encouraged to browse this entire document before beginning construction. Obtain clarification on any points you do not understand.

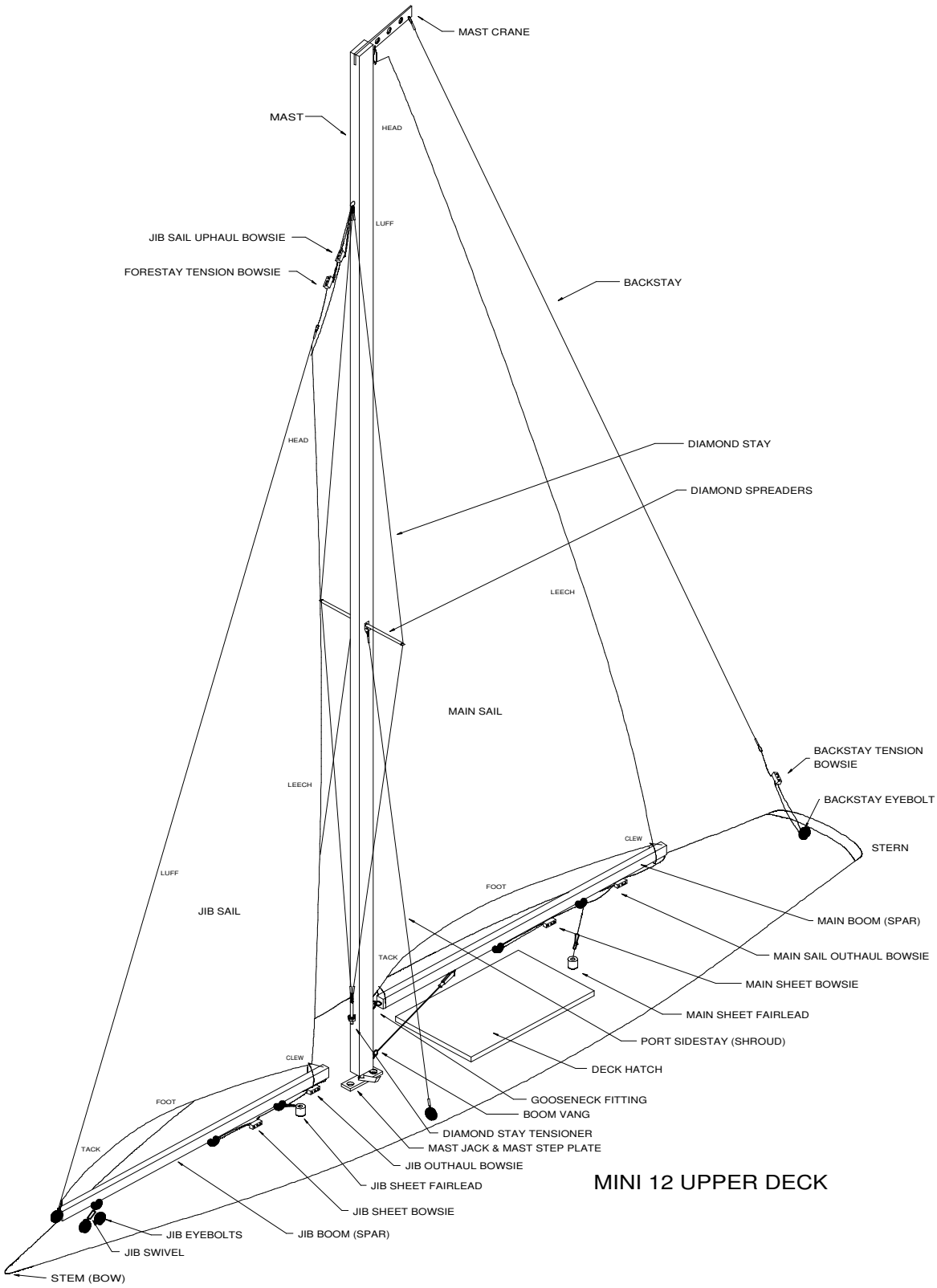
Do not build out of sequence, without fully understanding the consequences. Some jobs can be done while another is gluing etc., but once the deck is on, you no longer have access to certain areas of the hull.

Be careful when drilling into the fiberglass hull as it is somewhat brittle. If it does crack or chip, it can be repaired by filling with epoxy or auto body filler.

My thanks to Chris Wyvill and other members of the Quinte Model Yacht Club for their assistance with this document.

My thanks to Frank Scott for his elegant hull design and many hours of development of this boat, which continues to bring hours of enjoyment to both builders and sailors.

Please let me know if you find any errors or if you have any suggestions toward improving this handbook.



MINI 12 UPPER DECK

1. **Construction Stand**

You need something to hold the hull horizontally on your workbench. I won't go into details here, since Frank Scott supplies a simple design for a building stand in his building plans.
Utility 3/4" plywood or 5/8" pine board is typically used.
I use screws whenever possible as I recycle materials for other projects. Also they are tighter as nails sometime loosen up.
A coping saw or band saw can be used to cut the hull contours.
Staple strips of carpet (hall runner) to line the contours of the uprights to cushion the hull.
Foam or felt strips can be used, stuck in place with a hot glue gun or other adhesive.
It is probable that during construction the stand will acquire drops of glue, paint etc. and you may want a second one to display your finished boat.

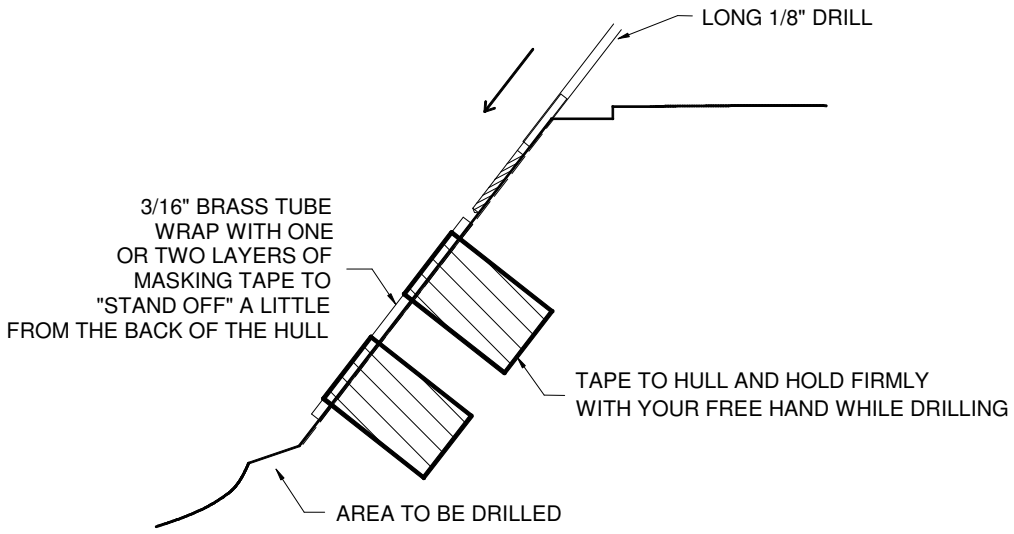
2. **Rudder Tube**

Go slow here. This is a tricky job and care must be taken.

[ ] Place a couple of towels or folded newspapers on your bench and invert the hull so that the keel is facing up. Where the rudder attaches is an angled, concave straight section. You have to bore a hole at the same angle up through the hull where you will fit a brass tube to act as a bearing for the rudder shaft.

[ ] Cut a piece of 7/32" OD Brass tube approximately 3-1/2 inches long, square both ends, and wrap with one or two layers of masking tape, and tape it to the aft edge of the keel where the rudder goes. See Fig. 2-1.

FIG. 2-1
BORING THE RUDDER TUBE HOLE



[ ] Get a 12" length of brass tube 3/16" OD to fit in the tube that has been taped to the keel. CA glue or epoxy a 5/32" drill into 1 end of the 3/16" tube. Now you have a guide and a long drill.

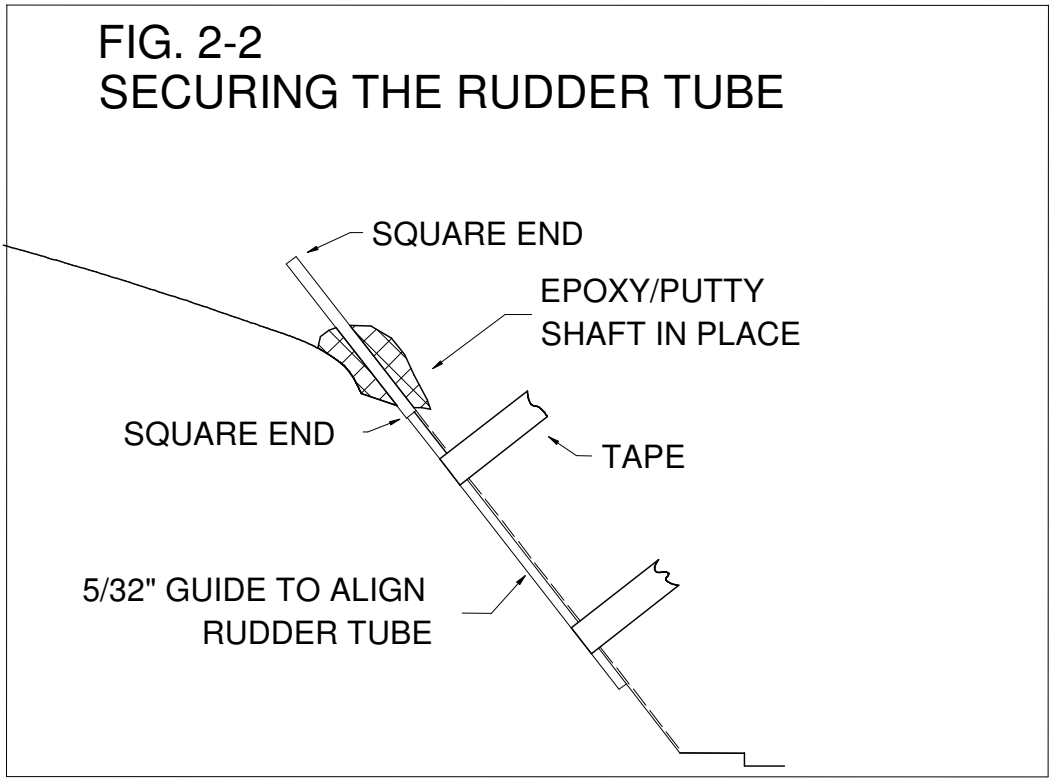
[ ] Slide the long drill into the guide and start the hole BY HAND turning gently. Be careful as the fiberglass is fairly brittle and may chip. Once the hand drilling has established a good cut (1/16" approx.) into the hull a power drill can be attached to the long drill and using LOW speed drill all the way through the hull.

[ ] Turn the hull over and bore down through with a 3/16" drill, taking care to keep the same angle. Note: You want the rudder shaft to stand away from the back of the hull a little so that the rudder turns freely. Make sure the hole is offset enough to achieve this.

[ ] Remove the tape and 7/32" x 3-1/2" guide tube.

[ ] Roughen the inside surface of the hull around the tube with coarse sandpaper.

[ ] Insert a 5/32" locating tube or rod in the 7/32" x 3-1/2" guide tube and position in the hole you have bored with the bottom end of the 7/32" tube just sticking out of the hole. See Fig. 2-2.



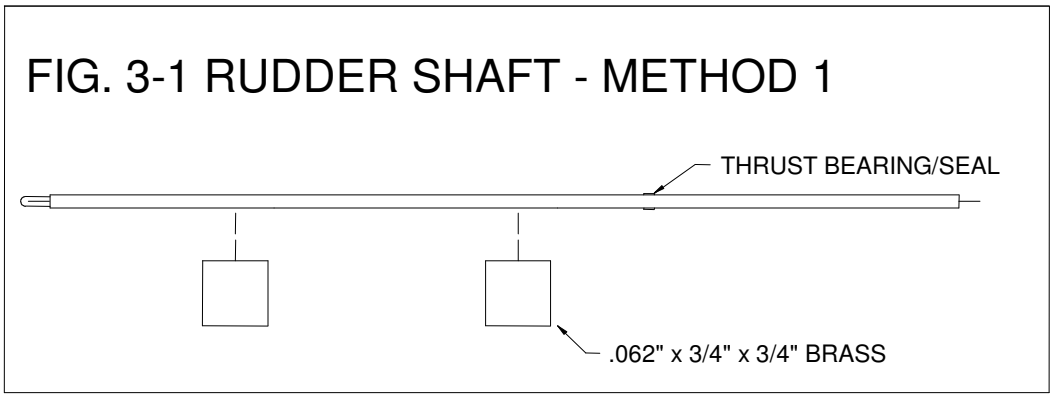
[ ] Tape the 5/32" tube to the hull and epoxy the 3/16" tube in the hull. Use epoxy putty around the tube on the inside of the hull to add strength.

[ ] When epoxy has set, remove the tape and 5/32" locating tube.

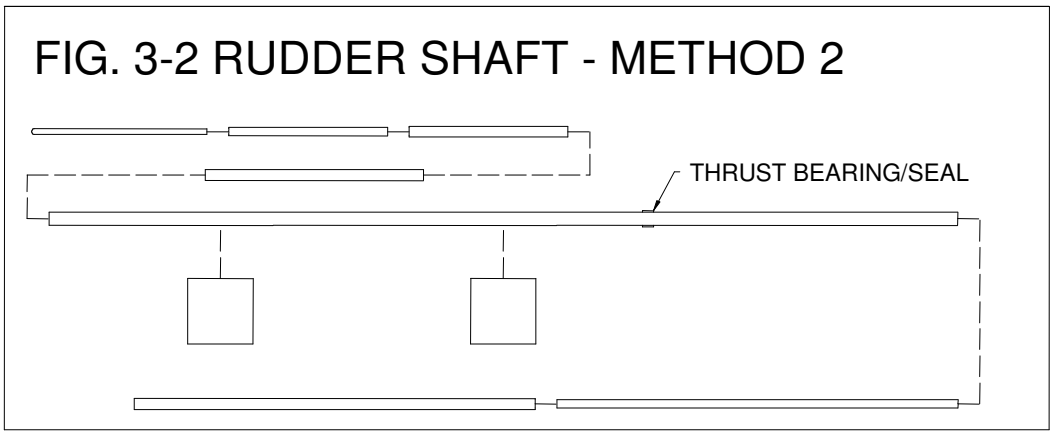
3. **Rudder**

[ ] Make two rudder tangs from 0.062" x 3/4" x 3/4" brass.

Method 1: Simple and cheap, but strength depends on your soldering. See Fig. 3-1.



[ ] Obtain a piece of 5/32" x 12" long brass rod.
[ ] Bore a 1/16" dia. hole in one end about 1/2" deep.
[ ] Obtain a piece of 1/16" brass rod about 5/8" long and round one end.
[ ] See Fig. 3-3. Insert 1/16" rod into hole and solder.
[ ] Lay rudder shaft against drawing and mark positions for tangs.
[ ] Lay the rudder shaft on a brick and position the tangs against it so that they lie in the same plane.
[ ] Silver solder the tangs to the shaft.



Method 2: Not as simple, not as cheap, but I believe stronger. (Parts not included in materials list.) See Fig. 3-2.

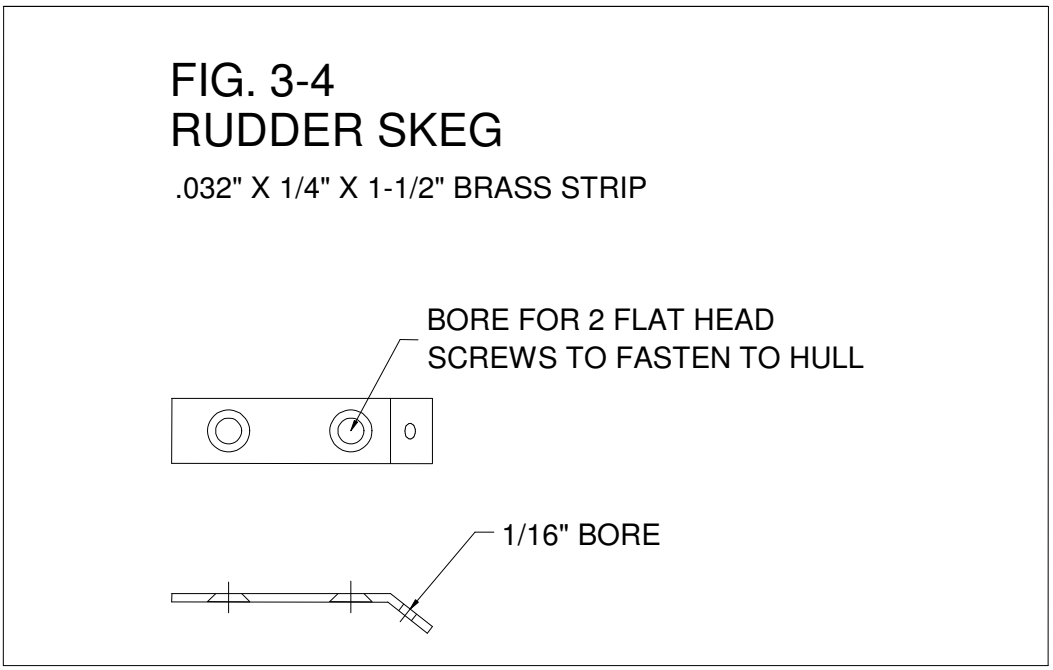
[ ] Get a piece of 5/32" x 12 long brass tube and 1/8" x 12" brass tube.
[ ] Slide the 1/8" tube inside the 5/32" tube.
[ ] Lay the assembly against drawing and mark positions for tangs.
[ ] Cut slots for the tangs through one side of the assembly.
[ ] Dry fit one of the tangs.

[ ] Fill all the interior spaces with smaller rods and tubes.
[ ] See Fig. 3-3. Obtain a piece of 1/16" brass rod to fill the lower interior of the shaft and extend about 3/16" from the lower end.
[ ] Lay the entire assembly on a brick. Pull apart the tube assemblies slightly and flux.
[ ] Silver solder the ends of the shaft and push tubes and rods together while the solder is still molten.
[ ] Silver solder the tangs in place and ensure solder fills all voids.

FIG. 3-3 BOTTOM PIN
REMOVE EXCESS SOLDER

Both Methods:
[ ] Clean all flux from soldered surfaces and file to remove any excess solder. See Fig. 3-3.
[ ] Make a thrust collar from a piece of 3/16" brass tube, about 1/8" long.
[ ] Slide the thrust collar in place.
[ ] Dry fit the rudder shaft in the rudder tube. It should rotate freely but without excessive play.
[ ] Remove the rudder shaft from the rudder tube.
[ ] Cut 2 pieces of 1/8" aircraft ply and 1 piece of 1/16" ply to the shape shown in the control drawing.
[ ] Lay the rudder shaft with tangs on the piece of 1/16" ply and mark the positions of the tangs.
[ ] Cut out the tang area.
[ ] Epoxy the sandwich of 1/8" ply, 1/16" ply and rudder tangs, and 1/8" ply together and clamp until cured.
[ ] Bore small holes through the rudder at the tangs, epoxy and pin with brass nails. Grind flush.
[ ] Streamline the rudder using a hand plane or sander.
[ ] Fill any voids at the joint with the shaft to create a smooth surface. Test fit.
[ ] Sand the rudder smooth and paint.
[ ] Make a skeg to hold the rudder in place. See Fig. 3-4. You can drill a vertical hole and bend the strip, or bore an angled hole in a flat strip.
[ ] Carefully drill the hull for the skeg screws. The pilot hole should be just under the outer diameter of the screws, as the fiberglass hull is easily cracked if the holes are too small.
[ ] Fit the rudder and adjust the thrust collar so that the rudder turns freely but does not move

up and down. Solder the thrust collar in place.

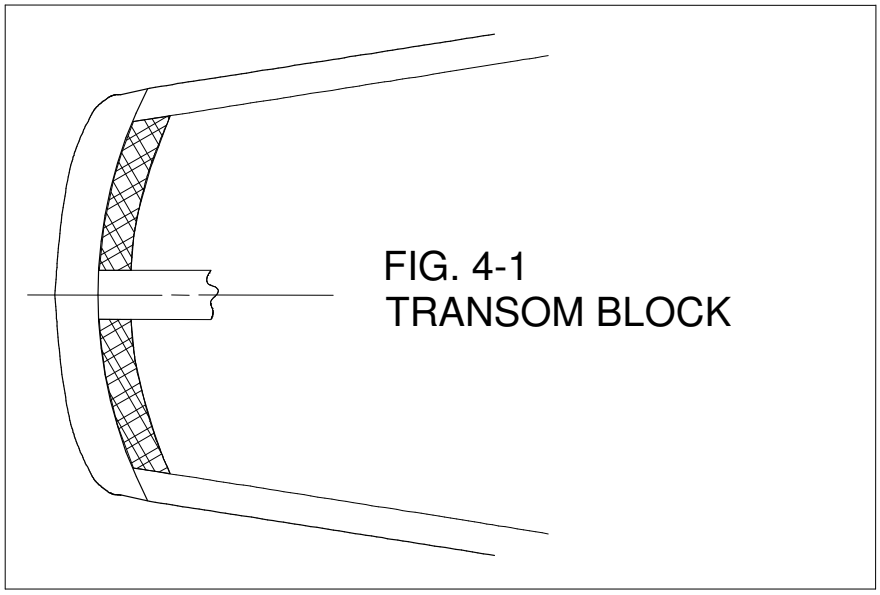


4. **Transom Block**

[ ] Carve a piece of pine with an upper curve to match the upper shape of the deck beams, and lower and back curves to fit snugly inside the transom area. See Fig. 4-1.

[ ] Epoxy in place.

[ ] Mark the center of the transom with a line as shown.



5. **Kingplank**

[ ] Use a piece of 3/16" x 3/4" x 48" pine for a kingplank.

[ ] Cut a tapered notch (scarf joint) in the center of the bow fillet and transom block to center the kingplank. See Fig.5-1.

[ ] Shape the bow end of the kingplank to fit.

[ ] Locate the kingplank in the centre of the transom block.

[ ] Cut a tapered notch in the centre of the transom block.

[ ] Shape the stern end of the kingplank to fit.

[ ] Locate the kingplank in place with tape and mark the position of each deck beam.

Do not glue the kingplank in place at this time.

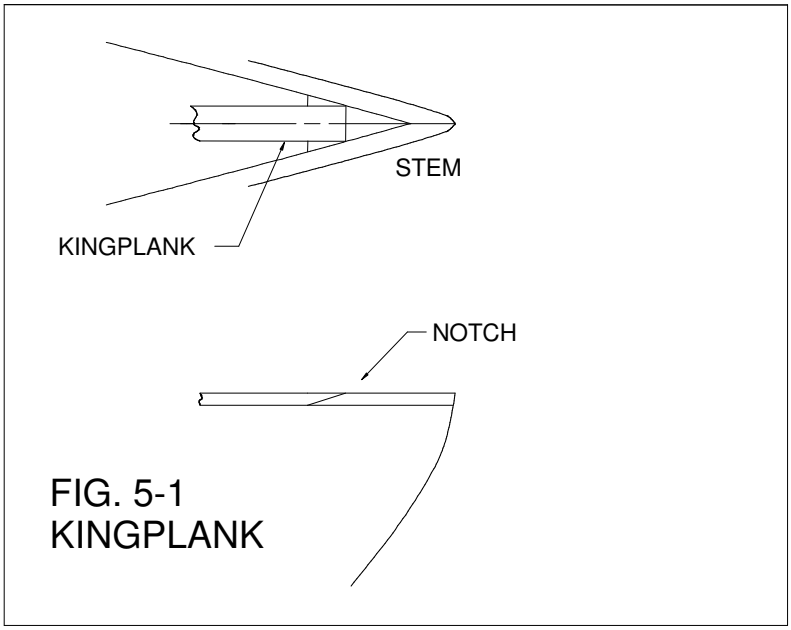


FIG. 5-1
KINGPLANK

6. **Rudder Servo**

Because the rudder shaft is at an angle, if the rudder servo is located on the radio tray, the linkage arm must swing through an arc as the rudder turns. Frank's drawings show using a control arm with a twist in it, and model aircraft ball links are used to connect to the servo arm. Purchase the heavier links - the small ones tend to pop out.

You need an access hatch to the rudder shaft to make adjustments and remove the control arm to remove the rudder. Plan for this hatch when you lay out your deck beams.

I chose to mount my rudder servo aft at the same angle as the rudder shaft with short pull-pull rods and clevises. This is shown in Fig. 6-1 through 6-3. I used a piece of pine to straddle the hull and brace the rudder shaft, as well as provide a base for a short piece of aluminum angle on which the servo is mounted. I can remove the servo through the hatch, if necessary.

Carve the beam for a snug fit with the interior of the hull. Roughen the inside of the hull with sandpaper, lay a small piece of fiberglass cloth against the hull on both sides, and epoxy the beam in place.

If you decide to mount your servo aft as I did, then install it now before proceeding with the deck beams.

FIG. 6-1
STERN RUDDER SERVO

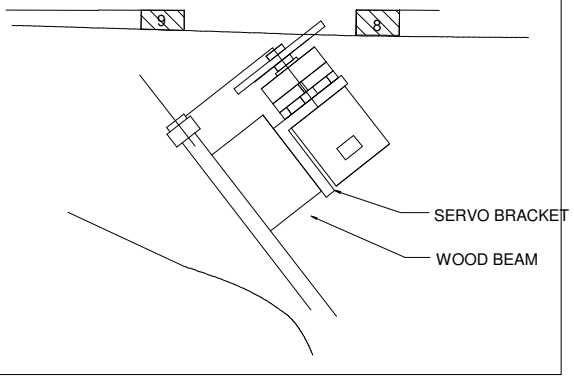


FIG. 6-2
RUDDER SERVO MOUNT

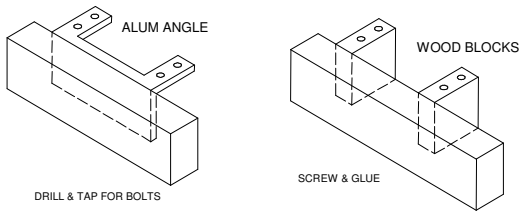
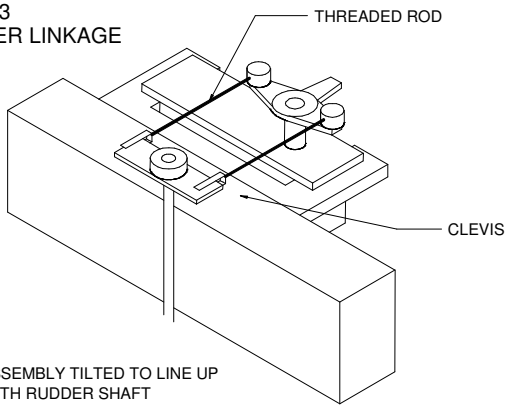


FIG. 6-3
RUDDER LINKAGE

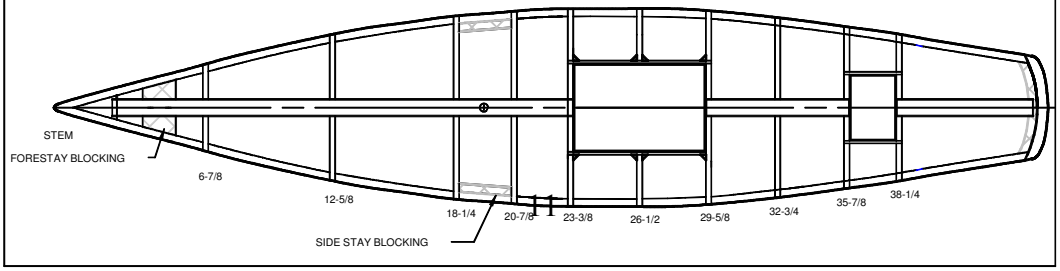


7. **Deck Beams**

[ ] Cut deck beams of 1/8 or 3/16" " thick pine, basswood or plywood, as shown in drawings supplied with the hull. The top radius is the same for all beams. This will result in a cambered deck and horizontal kingplank. Ensure the overall width of the hull is within the control dimensions.

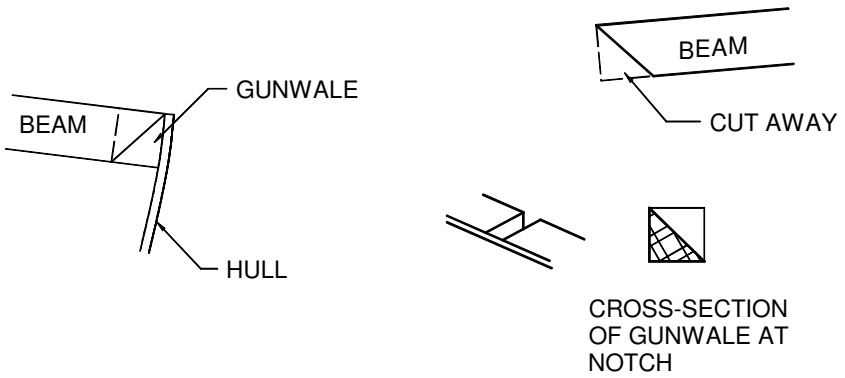
[ ] A typical deck beam layout is shown in Fig. 7-1. You want the resulting deck to be light but strong, especially around the hatch areas. Mark the leading and trailing edges of each beam positions of each beam on the kingplank.

FIG. 7-1
TYPICAL DECK BEAM LOCATIONS



[ ] Using a square, extend the deck beam marks to the gunwales, ensuring they are at right angles to the kingplank.
[ ] Notch the gunwale on each side of the hull for each beam as shown in Fig. 7-2.

FIG. 7-2
NOTCHING GUNWALE



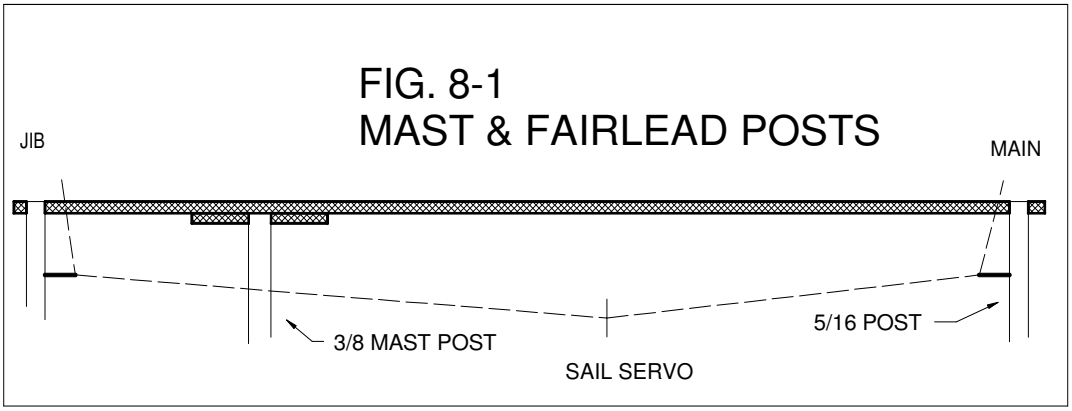
[ ] Remove the kingplank.
[ ] Dry fit each beam to ensure that the beams are not too high to prevent the deck from touching the gunwale, nor too low leaving the deck without support.
[ ] In the hatch areas, notch longitudinal beams to form a hatch opening.
[ ] Lay the kingplank on top of the deck beams, centred, and mark each beam on either side of the kingplank.
[ ] Cut a notch in the top of each beam for the kingplank.
[ ] Dry fit the kingplank. The kingplank should be flush with the tops of the deck beams. Do not cut the kingplank in the hatch areas - this is done later to ensure everything stays square and in line.
[ ] Mark the position of the mast on the kingplank based on the control drawing.
[ ] Remove the kingplank. Cut a piece of wood about 1/8" x 2" x 3/4", bore a 3/8" hole at the centre, and glue it to the underside of the kingplank with the centre directly below the centre of the mast position. (Don't bore the hole through the kingplank - the idea is for it to rest on top of the mast support post.)
[ ] Glue the deck beams in place.
[ ] Glue the kingplank in place.
[ ] Cut the kingplank in the hatch areas.

8. Mast Support and Fairleads

See Figure 8-1

[ ] Cut a piece of 3/8" diameter wooden dowel as a mast support under the kingplank, extending almost to the bottom of the hull. Glue to the underside of the kingplate in the hole previously drilled and align vertically. (The base will be held in place by the ballast - later - but it can be secured with a bit of epoxy putty if you wish.)

[ ] You now have to mark the positions for the fairleads. The jib fairlead is typically at 16-1/4" back from the stem, and the main fairlead at 31", but refer to the control dimensions.



Ensure you are within the control specifications. The main sheet must exit the deck so that it does not get caught on the main hatch as the boom swings and the sheet goes slack.

Also, the length of the sail arm and rotation angle of the sail servo should be considered. The servo rotates through an arc, and if the inside end of the sheet were tied to the end of the arm, it would let out the sheet to the sail boom by this length. When the sheet is anchored to the side of the hull and passed through a grommet in the end of the sail arm, the sheet movement is doubled. Then, depending on where the sheet is attached to the boom, the boom swings. The objective is to have the main boom be at about 5 or 10 degrees off the centre line of the hull when close-hauled, and at about 80 degrees when fully out. The servo has only so much power. The closer the boom attachment is to the mast, the less power is transmitted to the boom. As the attachment point is moved away from the mast, the power is increased, but you need more sheet movement to achieve the same degree of swing.

The main boom must not be allowed to swing forward and hit the side stays, as this may result in a broken mast.

9. Jib Sheet Post

There is debate about whether this post and the main sheet post are really needed. They serve only to stiffen the deck a little and provide an anchor point for a screw eye to allow the sheet to pass vertically through the deck. If your fairlead has a tapered inlet aperture, the sheet may feed at an angle without excessive friction and the post may be unnecessary.

See Fig. 8-1.

[ ] Bore a 5/16" hole through the kingplank, 1/2" forward of the position of the jib fairlead.

[ ] Cut and fit a piece of 5/16" dowel so that it passes into the kingplank and extends down

to the bottom of the hull.

[ ] Install and epoxy a 5/16" eye screw in this dowel, extending aft and oriented horizontally, about 1" under the bottom of the kingplank. (The sheet will extend from the anchor through the sail winch arm forward through this eye and upward through the fairlead and on to the jib boom.)

[ ] Epoxy the post in position with the screw eye facing **aft**.

10. Main Sheet Post

See Fig. 8-1.

[ ] Bore a 5/16" hole through the kingplank, 1/2" aft of the position of the main fairlead.

[ ] Cut and fit a piece of 5/16" dowel so that it passes into the kingplank and extends down to the bottom of the hull.

[ ] Install and epoxy a 5/16" eye screw in this dowel, extending forward and oriented horizontally, about 1" under the bottom of the kingplank.

[ ] Epoxy the post in position with the screw eye facing **forward**.

11. Forestay Blocking

[ ] Epoxy a piece of 1/8" plywood beneath the kingplank extending from gunwale to gunwale in the area of the jib eye bolt attachment. This will resist the pulling forces from the forestay. See Fig. 7-1.

12. Side Stay Blocking

[ ] Epoxy pieces of 3/8" pine or ply between the deck beams and against the gunwale on each side. See Fig. 7-1.

13. Initial Ballast

Some ballast is now needed which also secures the bases of the mast and sheet lead posts. The objective is to build a boat of minimum legal weight, since it is easy to add more weight for balancing etc., but it is very difficult to remove weight once the deck is on.

At time of writing, both cast lead and lead shot can be used, but must be bonded to the hull. This is most easily accomplished by using epoxy.

Casting a lead ballast is not recommended as it is hazardous. Lead shot, available at a local gun shop, is much easier to use as you have plenty of time to move the shot/epoxy mixture as required to get the correct balance.

Some builders have used wheel weights from their local garage, which is also acceptable.

A water bath (bathtub?) is recommended to prevent the heat given off by the epoxy curing process from distorting the hull. You will also need a small bubble level.

You want to distribute the weight along the hull, but keep the weight away from the ends. If all the weight is in the middle, the boat will rock with the waves. If spread too much, it will be more resistant to turning.

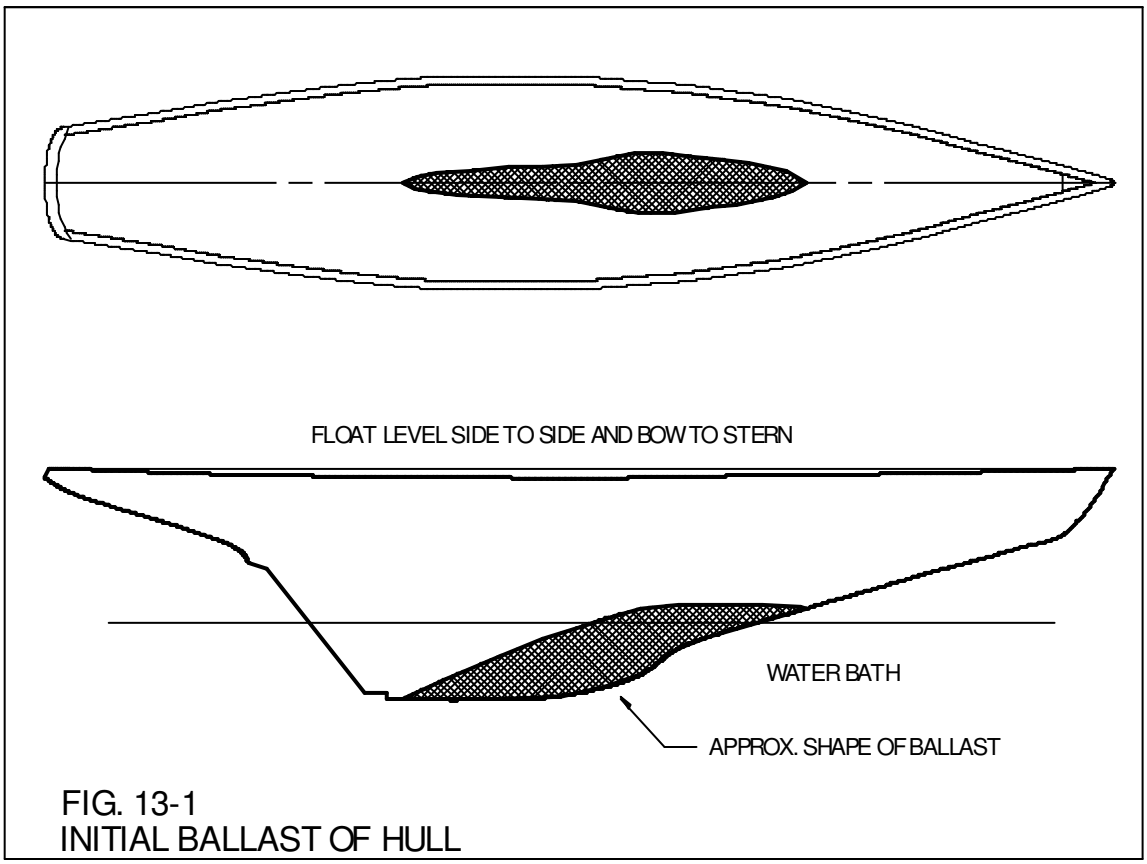


FIG. 13-1
INITIAL BALLAST OF HULL

This is my recommended method for lead shot:

[ ] Weigh 7 pounds of shot.

[ ] Mix sufficient volume of epoxy to bind this mass of shot together. (I used a slow curing epoxy and mixed additional batches as necessary, until all the shot was wetted.)

[ ] With the hull in the construction stand, pour in the ballast mixture approximately as shown in Fig. 13-1.

[ ] Place the hull in the water bath and shift the ballast (with a paint stick) until the boat floats with the kingplank level.

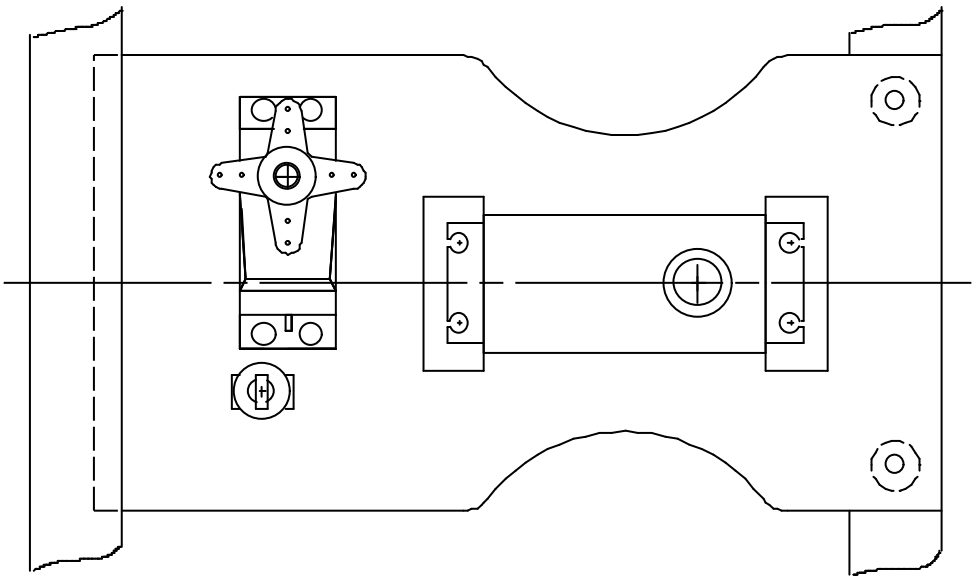
[ ] Ensure some ballast surrounds the base of the mast support and the two sheet posts.

[ ] Allow the epoxy to set overnight with the hull in the water bath.

14. Radio Tray

At this point you need to design a flat piece of 1/8" plywood with the various components to control the boat. An example is provided when you purchased the hull including the rudder servo. Chris Wyvill suggests rotating the rudder servo a quarter turn for better sheet clearance, as shown in Fig. 14-1.

FIG. 14-1
RUDDER SERVO TURNED



An example of the ball linkage from the rudder servo to the tiller arm is shown in Fig. 14-2.

FIG. 14-2
RUDDER BALL LINKS

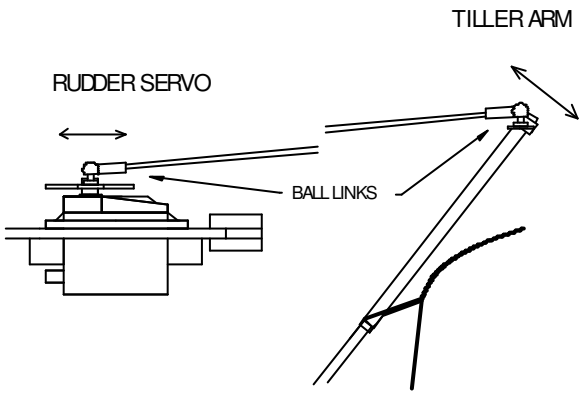
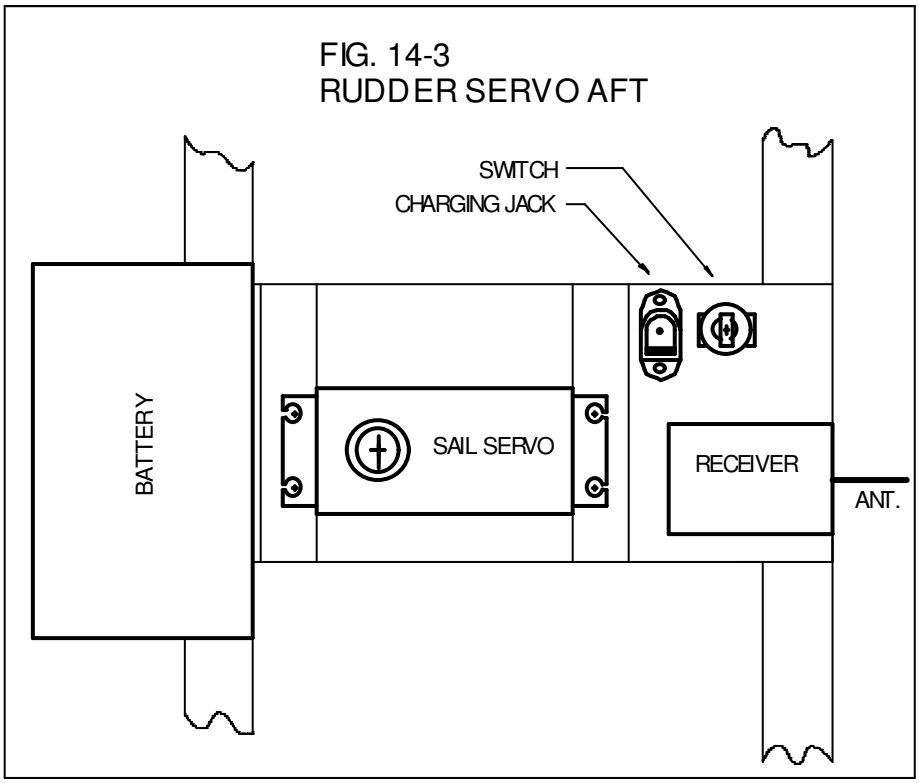


Fig. 14-3 is an example when the rudder servo is mounted aft.



You will need a battery pack, an on-off switch, 2 channel surface radio receiver, sail winch servo and rudder servo.

Try to keep the weight as low as possible and centred side-to-side in the hull. It is also worth considering the use of connectors for the battery pack, so that you can swap a fresh battery pack during regattas. Some provide for a waterproof switch on the deck so that the hatch need not be removed except for charging or changing batteries, but I like to check for water periodically, so I put my switch inside.

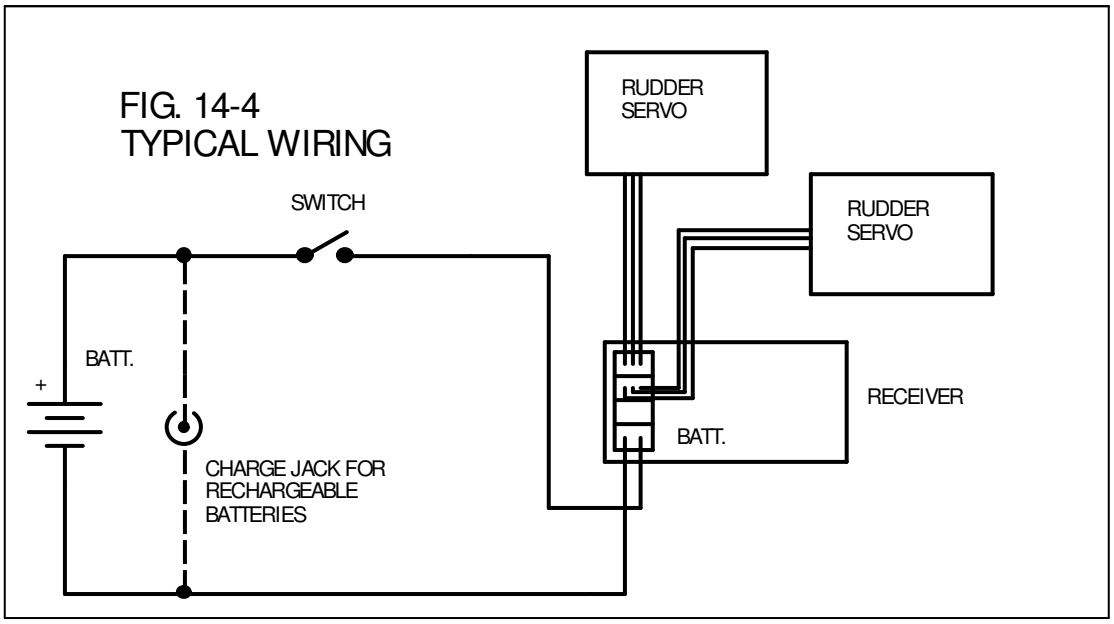
Also the receiver antenna needs to be vertical for best reception. If placed at the front of the tray then it can be fed up through the deck and taped or hooked with an elastic to the mast. Some place the receiver at the back and attach the antenna to the backstay (make sure it's insulated!). Wherever you place it, be sure that in the event your mast falls off, it does not yank the antenna out of the receiver.

You want your sail arm as long as possible so the sail servo needs to be high in the hull for it to clear the sides.

Fasten the tray to a couple of cross-beams mounted in the hull. It must be removable as a unit through the hatch for access to the bilge area. Some have the tray slide in to a simple slot and secure to the forward beam with a single screw.

Also, allow for the fact that your sheets will be above the tray and must not be allowed to snag on anything.

A typical wiring diagram is shown in Fig. 14-4.



Radio receivers normally come with a 4 x AA cell battery holder. Use Alkaline batteries (and replace every 3 hours of sailing) or rechargeable Nickel Metal Hydride of 1500 mah rating or higher (recharge before every race). Some receivers have BEC (Battery Eliminator Circuit). This is essentially a voltage regulator which allows the battery to be as high as 7.2 or 8.4 Volts, which is dropped to 5 Volts for the receiver and servos. If you have this feature, then you can use a 5 or 6 cell battery which will provide more endurance.

If you are using rechargeable batteries, then you need to unplug the battery for charging to a matching connector, or install a charging jack of some form. I use coaxial DC power jacks and plugs from Radio Shack as they are non-shorting and readily available. Batteries can then be interchanged between my boats and I have a single charger for all.

[ ] Cut and fit two pieces of 3/4" square pine to act as cross beams within the hull.
[ ] Roughen the inside of the hull with sandpaper where the beams will attach.
[ ] Epoxy a piece of 2" x 2" fiberglass cloth where the beams will attach, and then epoxy the beams on top of the fiberglass. This adds strength. Allow to set.
[ ] Mount the radio tray to the rails with wood screws.

15. Sheet Anchors

A Futaba S3801 sail servo with an arm has adequate power for the Mini12. Hitec also make a sail servo, but I have not had the pleasure of using one yet. Some members use drum winches, but also as yet I have no experience with them.

The length of sheet pulled in or let out by the servo is determined by the arc the arm travels and the distance from the centre of the servo. Normally the inner end of the sheet is

"anchored" to the inside of the hull and then passed through the end of the sail arm and back to the fairlead eye, through the fairlead and on to the boom. If arranged correctly, the sheet movement is then double the arc of the arm. Some trial and error is necessary to find the best position for the anchor blocks. They need to be somewhat accessible in order to string the sheets and replace sheets when they break. See Fig. 15-1.

FIG. 15-1
SHEET LINES

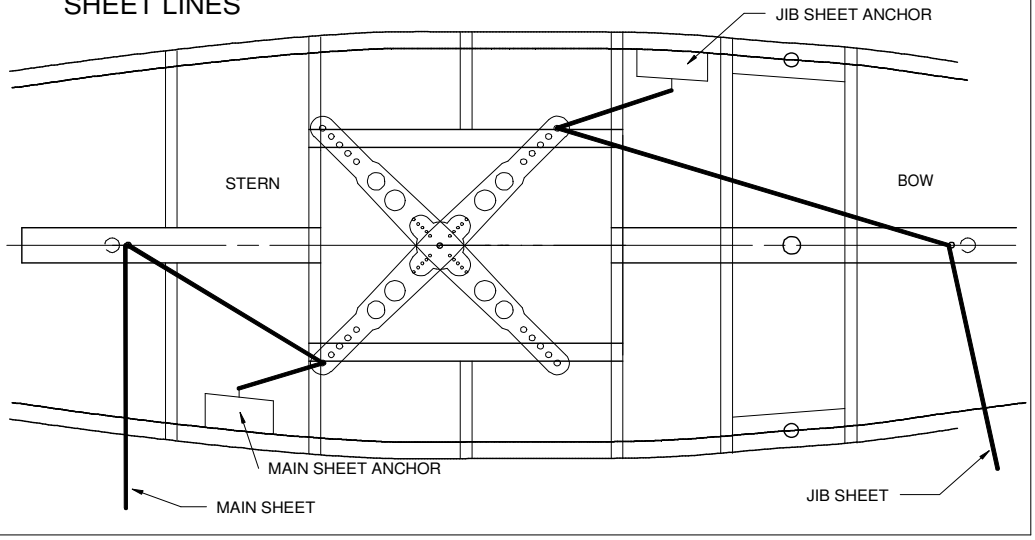
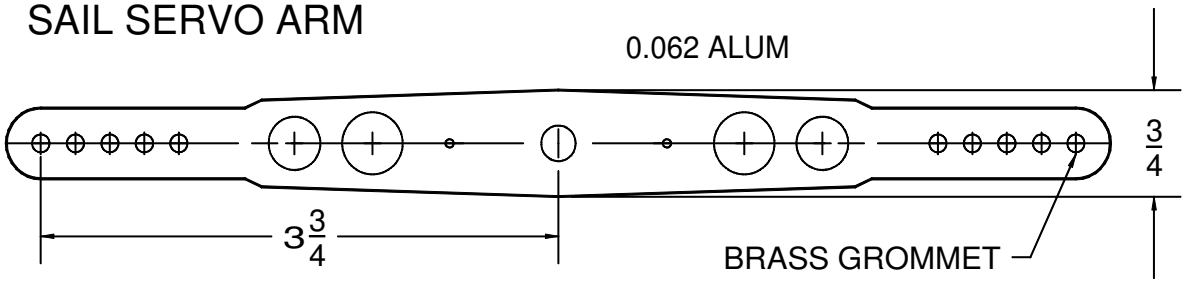


FIG. 15-2
SAIL SERVO ARM



[ ] Make a pair of anchor blocks from 3/4" x 3/4" x 1-1/4" pine.
[ ] Install a 5/16" dia. eye screw in each block.
[ ] Roughen the surface of the hull in the position where the anchor blocks will be mounted.
[ ] Epoxy a 2" square of fiberglass cloth between the anchor blocks and the hull and clamp until the epoxy has set. (Or tilt the hull and place a small weight on the anchor block).

A single-sided control arm is normally supplied with the Futaba servo. I use a double-sided arm made from 1/16" aluminum as shown in Fig. 15-2. For grommets, I use the small brass
ends of broken guitar strings - file off one side and press/glue in place. The small plastic control arm which comes with the servo is installed, and the aluminum arm bolted to the plastic arm.

16. Forestay, Backstay and Side Stay Bolts

The forces on the forestay and backstay are not excessive and many sailors just use eye screws and screw and epoxy them in place after the deck is on.

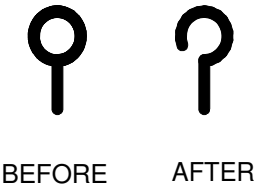
Bolts and nuts are stronger, but it is very difficult to reach this area to add the nut once the deck is on. I mounted the bolt and nut at this time, then added a 1/32" ply deck with slots cut for the eye to pass through, and then planked on top and around the eye with cherry veneer strips.

If you decide to use ply or plastic for your deck, then provide for the installation of eye bolts before you are trapped in a corner.

If you use eye screws or bolts with a closed circle, saw off part of the ring to make a hook as shown in Fig. 16-1. This allows for quick detachment of the stay lines.

Install these fittings now or after the deck is on, whichever you feel is easier.

FIG. 16-1
STAY DECK HOOKS



17. Deck

Wood or plastic may be used.

The problem with wood is that you need one long, narrow piece so as not to have a joint. This is often difficult to find. 1/32" ply is adequate. It's a good idea to waterproof the underside with urethane or epoxy.

The most popular material used is thin plastic sheet, about 1 or 1.5 mm thick. This can be obtained from your local sign shop, often as a scrap piece. It is very easy to paint.

Something else to consider - in the event your boat takes on water, it will sink. In the bow and stern areas it is a good idea to pack this with closed-cell foam, either blocks of the pink construction foam from your lumber yard, or foam packing material etc. Even a zip-loc bag filled with air has been used. Then if water does get in, it may stay afloat (longer!).

[ ] Lay your deck material in place, mark the intersection with the hull all way round, and cut it a little oversize (1/16" to 1/8"). Tin snips may work better than a saw.

[ ] Dry fit your deck and mark hatch areas - cut out a 1" hole . (Once the deck is installed, you can open up these holes to meet the deck beams). This vent hole is necessary to

prevent an air lock which can cause the deck to lift along the gunwale during curing.

[ ] Roughen up the **underside** of the deck where the glue will be applied to ensure a good bond, and the top surfaces of the gunwales.

[ ] Ensure the deck beams do not cause any high spots - you want a tight fit to the gunwales.

[ ] Mask off the outside of the hull just under the gunwales to protect it from excess glue.

[ ] Apply a liberal coating of slow cure epoxy to the entire gunwale.

[ ] Lay on the deck and hold it in place with strips of vinyl electrician's tape around the bottom of the hull. Don't skimp on the tape - use lots.

[ ] When cured, trim the deck to meet the hull with a plane, rasp or file and clean up any excess glue around the gunwale. Open up the hatch areas and vacuum the interior.

18. Rubbing Strake

[ ] Glue a strip of 1/16" x 1/8" pine, basswood, oak etc. completely around the joint between the deck and gunwale. This helps keep the deck from separating from the hull, and also provides some protection for the hull when docking etc.

19. Main and Rudder Hatches

You can build up a 1/16" ply box for deck risers and a matching hatch cover with water seal, but this is very tedious to do. Most sailors are now just using a rectangular piece of plastic laid over the hatch and sealed around the edges with good quality electrician's tape. Black and white tape is available at Canadian Tire for under $5.

It is critical that your hatches not allow water to enter the boat. The Mini 12 is a wet boat as it has little freeboard and a leaky hatch will spell disaster.

Some sailors actually use a piece of sticky-back vinyl shelving material and replace when it loses its stick.

Notch in pieces of 3/16" x 3/8" pine to the deck beams to make sides for the hatch areas.

20. Stay Fittings

Now that the deck is on, go back and mark the positions of the forestay, jib fairlead, mast centre, side stay and backstay fittings (if you have not already installed them).

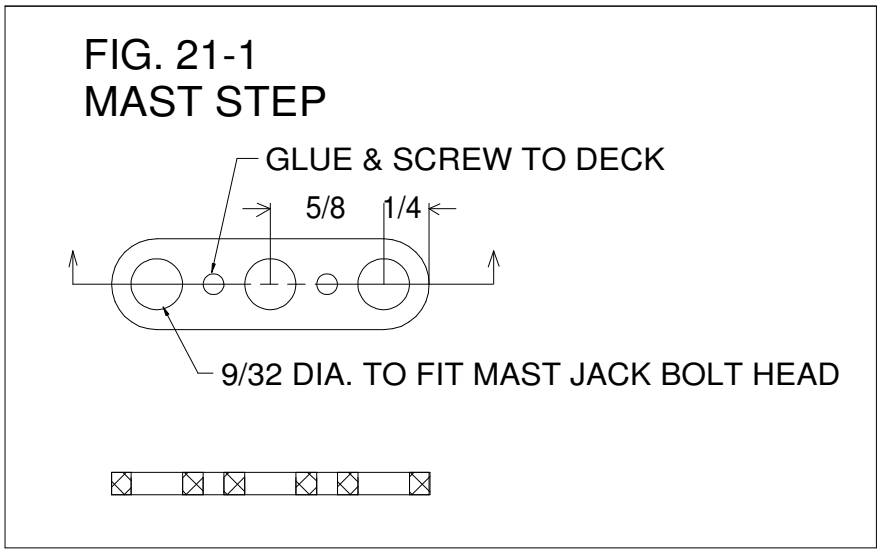
[ ] Epoxy the forestay eye screw in position.

[ ] Epoxy the backstay eye screw in position. It is better to install it on the deck at the stern rather than on the transom itself. Often the bow of a another boat has caught on the eye if it sticks out on the transom, causing both boats to get hung-up.

[ ] Eye bolts with nuts should be used for the side stays. Drill mounting holes in the deck and reach in through the main hatch to secure the nuts. A drop of epoxy or Loc-Tite is useful on the nuts.

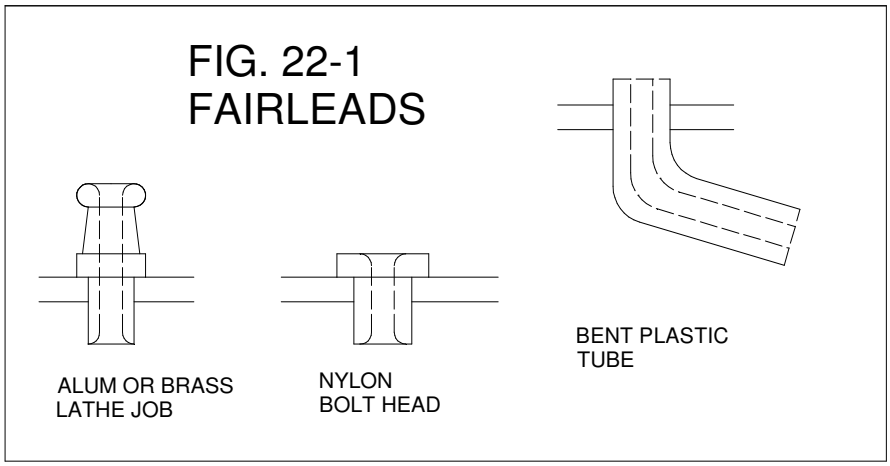
21. Mast Step

A 1/8" x 1/2" x 1-3/4" plastic or wooden plate with 3 holes is required for the base of the mast to sit on. See Fig. 21-1.



22. Fairleads

The fairleads direct the sheet lines through the deck to the booms. You may purchase commercial ones from a hobby store, but many sailors make their own. All that is necessary is that the sheet line follow a smooth curve with no sharp edges which might tend to cut the line, and the hole should be as small as possible so as not allow any significant amount of water to enter the boat. See Fig. 22-1 for some examples of home-made fairleads.



At this stage the hull is pretty much complete, aside from setting up the servos which is done when the sails are in place.

The hull may be painted at this time, as well as the deck, if you wish.

Make sure you give the hull a light sanding to achieve a dull, even finish. The clean it with acetone or a mild soap solution and ensure it is dust-free and throughly dry. Warm, dry weather is the best for spray painting, and do it outside. I used Trem-Clad Red Oxide Primer and Krylon spray paints, although some have had good luck without the primer. Numerous very light coats. Go slow. You'll look at it for a long time.

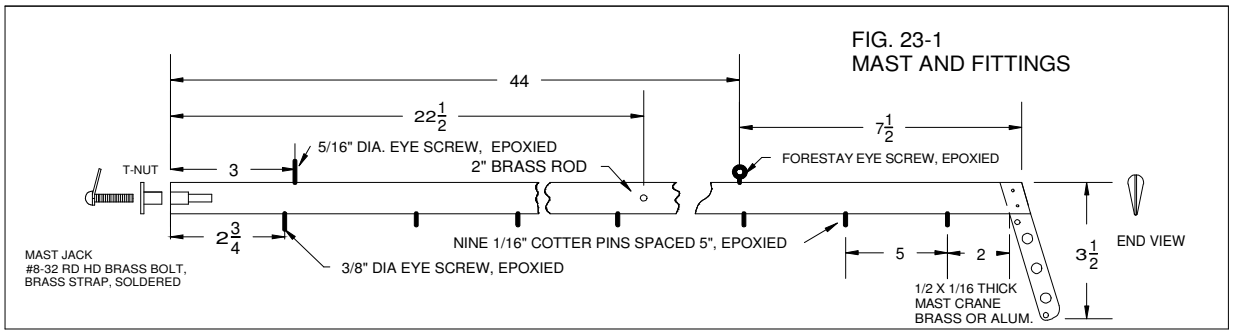
For my planked deck, I used Minwax Helmsman Spar Urethane applied with a foam brush. Use many light coats and do not press down on the brush as it introduces air bubbles.

23. Mast

A single piece of straight-grained pine is adequate for a mast. See Fig. 23-1. Some have split the mast down the middle, rotated the pieces to alter the grain direction, and laminated them together with wood glue, for possibly more strength.

[ ] Get a piece of 1/2" x 3/4" pine, about 54" long, and square both ends.
[ ] Carefully plane lengthwise to achieve an approximate air foil shape with a flat on the trailing edge. Sand smooth.
[ ] Choose one end to be the base of the mast. Drill a 3/16" hole about 1" deep in the thickest section of the base.
[ ] Carefully open the very end of this hole to accept an 8-32 T-nut.
[ ] Grind or file away the excess flanged area of the T-nut to match the mast profile.
[ ] Roughen the T-Nut and epoxy in place. Do not allow glue to get in the threads.
[ ] Make a brass strip about 5/16" x 1" x .032" thick.
[ ] Drill a 3/16" hole in one end of the strip to accept the head of a 8-32 x 1" round head brass bolt.
[ ] Solder the strip to the head of the bolt to make the mast jack.
[ ] The mast jack should screw in to the T-nut and turn relatively freely, but should not be loose.
[ ] Measure 3" up from the bottom end and pre-drill for a 5/16" steel eye screw (horizontal orientation) on the leading edge of the mast. Epoxy in place. This will be the base of the diamond stay.
[ ] Measure 22-1/2" up from the bottom and drill a 1/8" hole through the side of the mast. Insert a piece of 1/8" x 2" brass rod, extending the same on both sides of the mast.
[ ] Measure 44" up from the bottom and pre-drill for a 5/16" steel eye screw (vertical orientation) on the leading edge of the mast. Epoxy in place. This will be the forestay attachment.
[ ] Measure 51-1/2" up from the bottom and mark the leading edge of the mast. This will be the top of the mast at the leading edge once the mast crane is installed.
[ ] Make a mast crane from 1/2" x 1/16" thick aluminum or brass strip as per drawing, about 3-1/2" long overall.
The mast crane is normally installed trailing back at a slight upward angle.
[ ] Lay the mast crane against the mast, mark and cut of the excess length of the mast.
[ ] Cut a vertical slot in the top of the mast for the mast crane.

[ ] Epoxy the mast crane in position.
[ ] Drill through the side of the mast and the mast crane and install/epoxy a couple of brass pins to secure the mast crane. Grind the pins flush on both sides.
[ ] From the base of the mast crane intersection with the trailing edge of the mast, measure down 2" and place a mark on the trailing edge.
[ ] From this point, measure and mark eight 5" intervals to the bottom of the mast.
[ ] Drill the trailing edge of the mast about 5/16" deep for 9 small brass cotter pins. Do not install the cotter pins at this time.



The gooseneck fitting attaches the main sail boom to the mast. It must allow the boom to swing from side to side and up and down without binding. Many sailors prefer a commercial gooseneck/boom vang fitting. An elegant fitting is shown in the building drawings supplied with the hull. I use a simple eye screw and cotter pin arrangement (as used on the Soling) and have had no reason to change. Skip to the next section if you choose not use the eye screw/cotter pin gooseneck.

[ ] Obtain a 3/8" dia. steel eye screw and a steel cotter pin about 2" long with a shank about 1/8" dia. Shorten the cotter pin to a length of 1". Grind or file the inner edges of the "eye" so that they are more rounded. Open up the eye screw with pliers and connect the cotter pin and test it for binding. The cotter pin should slide freely from side to side and up and down without binding. Then close the eye screw.
[ ] Pre-drill for the eye screw up 3" from the mast base and epoxy in place in the trailing edge of the mast (with the cotter pin dangling behind - the main boom will be attached later).

24. Jib Boom

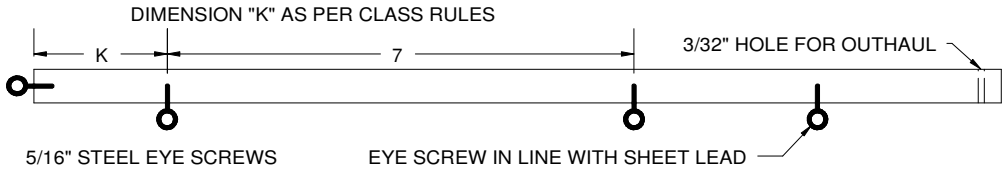
See Fig. 24-1.

[ ] Obtain a piece of pine 5/16" x 1/2" x 14-1/2" long. Square the ends. Sand the sharp edges off along its length.
[ ] Attach steel eye screws to the end and at distance "K" from the class rules. Attach another eye screw about 7" further back.

Another eye screw will be installed when the sheet is attached.

[ ] Drill a 3/32" hole vertically through the boom about 1/4" in from the other end.

FIG. 24-1
JIB BOOM



25. Main Boom

See Fig. 25-1.

[ ] Obtain a piece of pine 5/16" x 1/2" x 15-1/2" long. Square the ends. Sand the sharp edges off along its length.

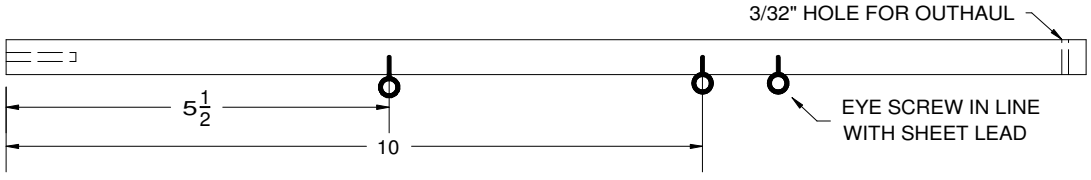
[ ] Bore a hole in the front end about 1" deep to accept the gooseneck cotter pin.

[ ] Attach steel eye screws on the underside at 5-1/2" and 10".
Another eye screw will be installed when the sheet is attached.

[ ] Drill a 3/32" hole vertically through the boom about 1/4" in from the other end.
The mast and booms are now ready to be coated with epoxy or urethane or painted.

[ ] Epoxy the cotter pin from the gooseneck into the main boom. Let it stick out a little and ensure that it swivels freely on the eye screw.

FIG. 25-1
MAIN BOOM



26. Diamond Stay and Side Stays

Refer to the pictorial drawing showing the upper deck rigging.

[ ] Make two spreader tubes from 5/32" x 2" brass tubing. See Fig. 26-1.

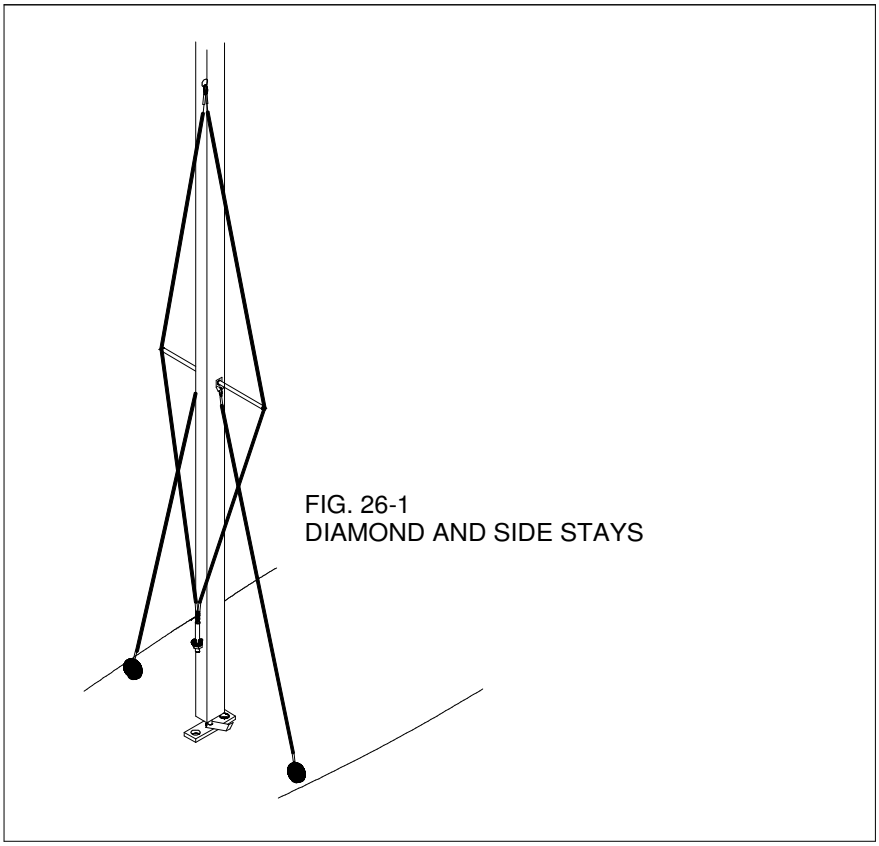


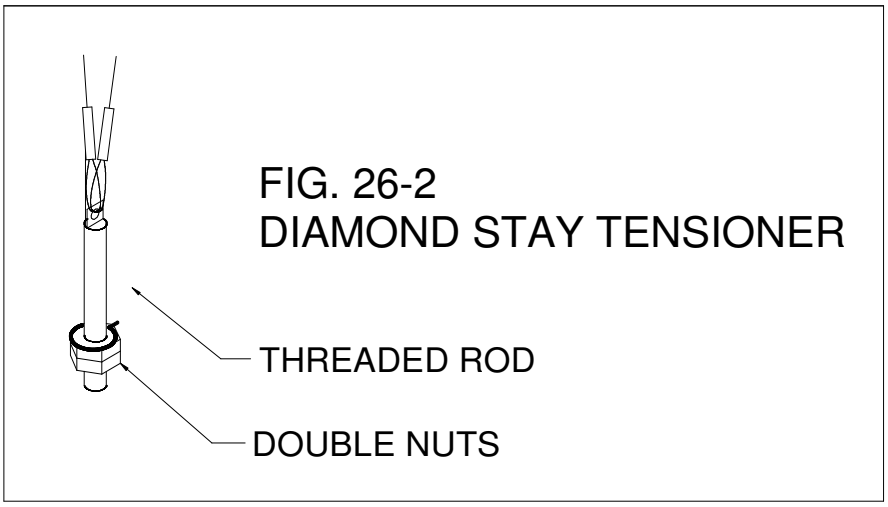
FIG. 26-1
DIAMOND AND SIDE STAYS

[ ] Flatten one end of each tube and drill a small hole through the flattened end. These are the diamond spreader tubes.

[ ] There are a couple of ways to attach the side stays to the mast. You can make two pieces of brass about 5/16" wide by 5/8" long by .010" thick to slide on the spreader rod, being trapped by the spreader tubes. Alternately, you can just use an eye screw on the leading edge of the mast, just above the spreader tube. You have to get the length of each side stay the same, regardless of the method used. I prefer to use lugs because small washers can be used to correct any length variations from side to side.

[ ] Drill a 1/8" hole in one end of each lug, and a small hole though the other end.

[ ] Make a diamond stay tensioner from threaded rod and double nuts as shown in Fig. 26-2. You can't get at a bolt head with a screwdriver, so use nuts.

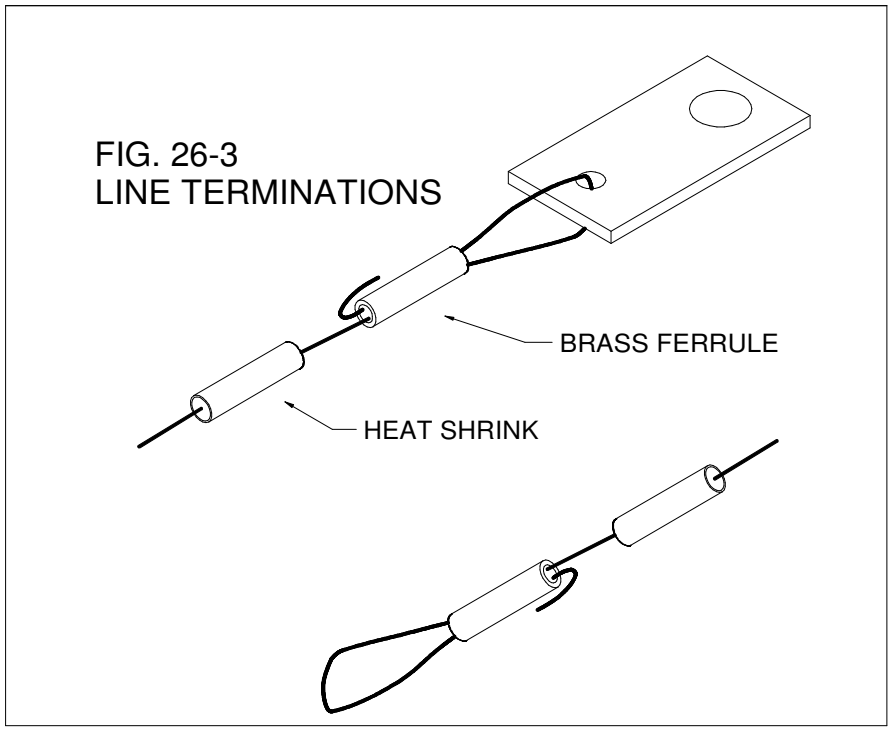


Use fishing line or other light string to initially rig the mast and stays.

[ ] Place the hull and stand on the floor with the deck horizontally level.
[ ] Install the mast jack in the base of the mast and turn it all the way in to the mast base.
[ ] Tie a string around a ceiling joist etc. and suspend the mast vertically above the hull with the mast jack in the centre hole of the mast step.
[ ] Run a line from the forestay eyebolt on the bow to the forestay attachment on the upper mast.
[ ] Run a line from the mast crane back to the backstay eyebolt on the deck.
[ ] Tie each side stay attachment lug to a short piece of line and install the lugs on either side of the diamond spreader rod. Clamp or tape in place for now. Tie each line at its respective side stay.
[ ] Tighten all lines so that there is no slack.

The use of the string lines aids in getting the actual steel rigging line the right lengths. Be very careful handling the steel wire as it has a tendency to poke your fingers and draw blood.

See Fig. 26-3.



[ ] Remove the side stay lines.

[ ] Obtain two lengths of stranded stainless steel wire about 3" longer than the side stay lines, of tensile strength 30 pounds or higher. I used fishing leader line or downrigger . RC aircraft control line also works.

[ ] Make up the side stays. I use the smallest size of brass tubing that will still allow two thickness of the wire to pass through it. Crimp this “ferrule”carefully in 3 spots with wire cutters - don’t cut through! A dull pair of cutters works well. Bend over any protruding ends. A piece of heat shrink tubing to cover the sharp end also is a good idea.

Test each crimp joint, if possible, to ensure it will take a pull of at least 5 pounds. You can secure one end of the line and use a fish scale to pull on the loop.

[ ] Slide the side stay lugs on the spreader rod on either side of the mast. Hold in place with a clamp or tape.

[ ] At the lower ends of each side stay, slide on a piece of heat shrink tubing followed by a ferrule. Bend the end into a loop around the deck eye, and pass it back through the ferrule. Crimp and bend the protruding end back along the ferrule. Slide the heat shrink tubing over the assembly and shrink in place.

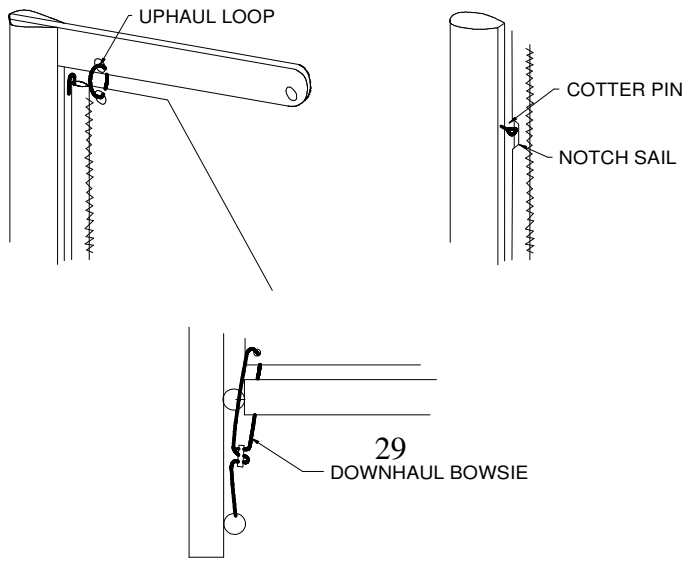
[ ] Extend the mast jack. If the lengths are the same, the mast should be vertical and not lean to one side. If it does lean, you may have to make up a small spacer from washers or tubing and install between the lug and the mast of the slack side on the spreader rod. You should be able to tension the side stays snug but not like a musical instrument.

[ ] Install the diamond spreader tubes on either side of the mast.
[ ] Take a length of about 92" of 0.018 diameter stainless solid steel wire (as sold in hobby shops for the Soling sail boat, or control line for model aircraft).
[ ] Slide one end of the 92" solid wire through the port spreader, through a ferrule, through the forestay eye screw, and back through the ferrule. Draw the wire through until both sides are of equal length. Slide the ferrule up to the forestay eye screw and crimp.
[ ] Pass the starboard stay through the starboard spreader. Both ends should now be hanging near the tensioning eye screw.
[ ] Place the tensioning bolt in the eye screw.
[ ] Pass each stay through a piece of heat shrink, a ferrule, through the tensioning bolt, and back up through its respective ferrule. The diamond lines should be tight. Crimp. Bend over the projecting end, slide on the heat shrink tubing and shrink.
[ ] Tension the diamond. The mast should remain straight if the lengths are the same on each side. If the mast bends either way, loosen the tensioner, slide off the spreader on the slack side and put a washer or other spacer between the spreader tube and the lug until both sides are equal. The diamond lines should be tight, but not like a musical instrument.
[ ] Take a length of about 50" of braided stainless wire (same as used for side stays) and pass it through a piece of heat shrink, through a ferrule, through the aft hole of the mast crane. Form a loop and pass it back through the ferrule. Crimp and shrink.
[ ] Take the other end, pass it through heat shrink, a ferrule, form a loop, back through the ferrule. Crimp and shrink.
[ ] Slacken the mast jack, slip the side stays from their deck eyes, and remove all string lines.
[ ] Lay the mast on a flat table.

27. Sails

See Fig 27-1.

FIG. 27-1
MAIN SAIL



[ ] Slide a piece of 0.018" solid stainless wire down through the leading hem of the sail extending about 1/2" from the top and bottom of the sail. Be patient - this is a very difficult job to do. Bend these ends over tight to the sail.

[ ] Lay the sail against the trailing edge of the mast. Tie a line through the top sail grommet to the mast crane. This is the uphaul loop.

[ ] Mark the sail at the holes drilled previously for the cotter pins.

[ ] Slit the hem about 1/4" on either side of the marks. Pass a cotter pin over the exposed wire at each slit. Run a soldering iron around the cut edge to seal the dacron.

[ ] Epoxy each pin into the mast.

[ ] Using line, make a bowsie downhaul tensioner around the boom and attach to the boom vang eye screw.

[ ] Take a short piece of stainless wire and a ferrule and make a loop through the aft lower sail grommet and around the end of the boom.

[ ] Make up a tensioning bowsie from the lower aft sail grommet down through the hole in the end of boom and back to the eye screw.

[ ] Rig the hull again. Keeping the mast vertical, make up a backstay tension bowsie for the steel backstay line.

See Fig. 27-2 for the jib sail.

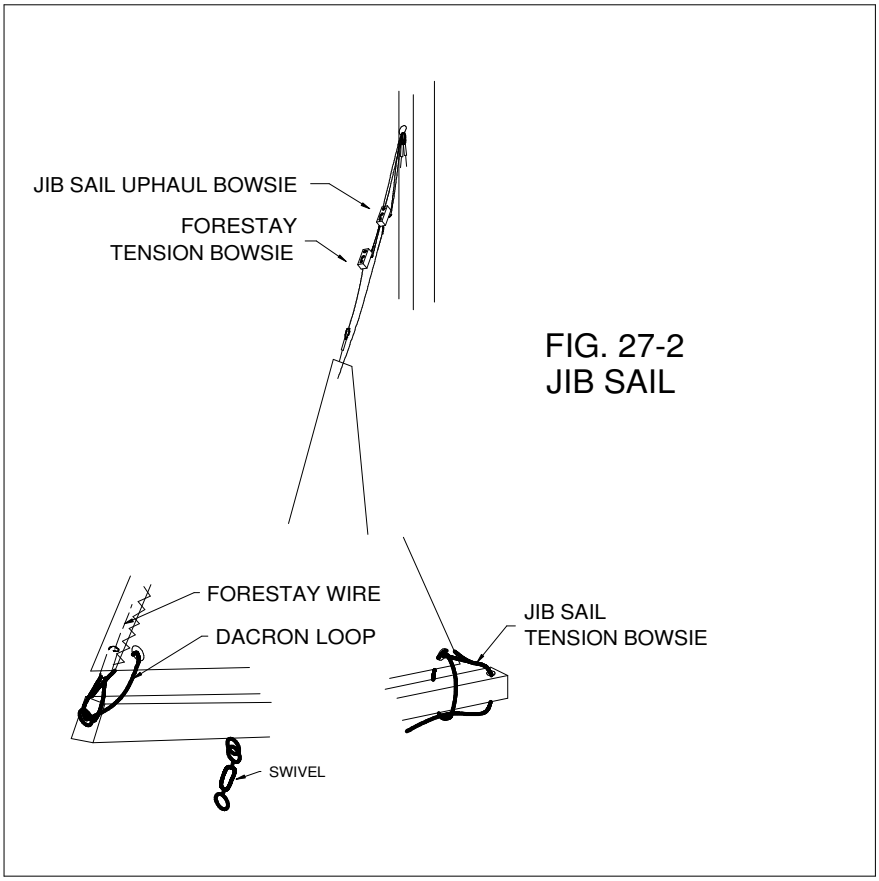


FIG. 27-2
JIB SAIL

[ ] Open the forward underside eye screw of the jib boom with pliers and install a swivel. Close the eye again, and slip the other end of the swivel over the deck forestay eye screw.
[ ] Take a length of stranded stainless wire about 41" long and pass it through a ferrule and make a loop at one end. Pass it back through the ferrule. Bend over the end and crimp.
[ ] Pass the other end of this line through the leading hem of the jib sail, down through the eye screw on the front of the jib boom, and make a crimped loop.
[ ] Make a tension bowsie from the upper loop up to the forestay eye on the mast. These are used in several places on the rig, and are shown in Fig. 27-3.
[ ] Pass a line through the front bottom sail grommet through the eye of the end of the boom to secure the sail.
[ ] Take a short piece of stainless wire and a ferrule and make a loop through the aft lower jib sail grommet and around the end of the boom.
[ ] Make up a tension bowsie from the lower aft sail grommet down through the hole in the boom and back to the eye screw.
[ ] Make up a tension bowsie from the upper sail grommet to the forestay eye on the mast.

At this point you should be able to remove all the temporary lines and make adjustments so that the mast is vertical with light tension on all rigging.

28. Boom Vang

Commercial boom vangs are available, often in combination with the gooseneck fitting. They aren't cheap, but are pretty, and closely resemble the sketches received with your hull.

You may want to reinforce it with a couple of small cable ties around the mast. Fig. 28-1 shows what I use.

[ ] Epoxy a 5/16" eye screw near the base of the mast.
[ ] Cut a piece of 5/32" brass tubing about 7/8" long and flatten one end.
[ ] Drill a hole through the flattened end to accept the clevis pin.
[ ] Measure back about 4-1/4" from the front end of the main boom and drill a 5/32" hole down through the boom.
[ ] Make up a boom vang assembly from threaded rod, aircraft and fishing tackle fittings. When completed, you should be able to adjust the aft end of the boom up and down about an inch. It's a good idea to make a band of thin plastic or brass to wrap around the mast base with a projection and hole for the boom vang attachment. It strengthens the mast base. Keep the pivot of the gooseneck and the lower boom vang pivot in a vertical line or else the boom vang will not work properly.

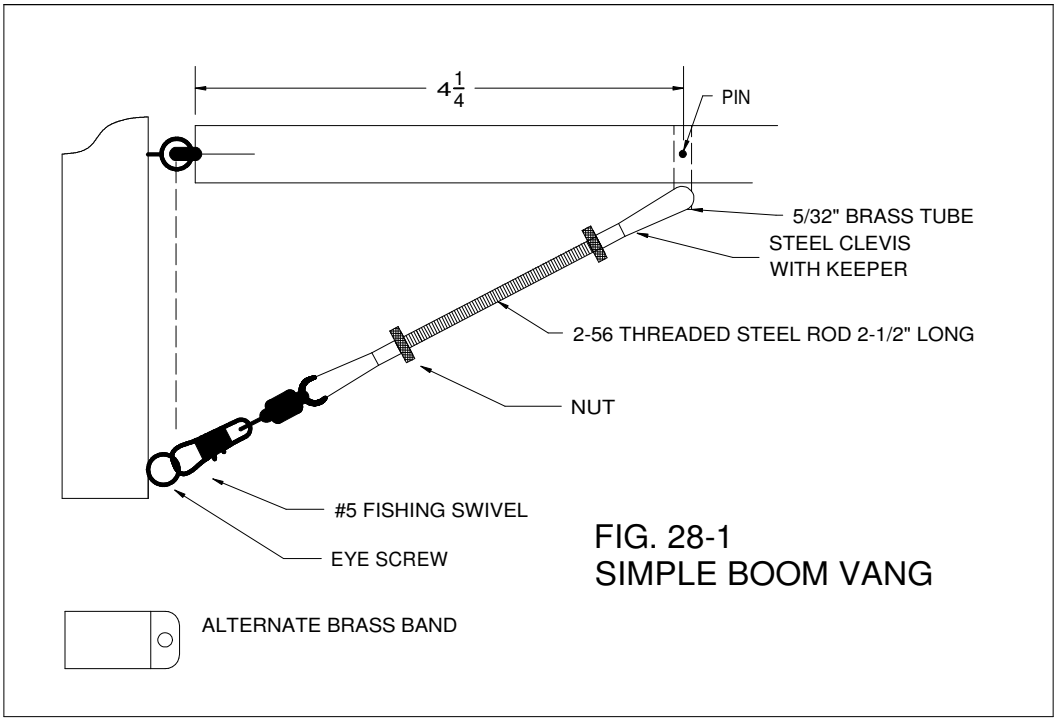


FIG. 28-1
SIMPLE BOOM VANG

29. Radio Tests

(Assuming your batteries are fully charged).

[ ] Bore a small hole through the deck beside the mast and thread the radio antenna up and attach to the mast. I tied an elastic to the end of the antenna and attach it to a sewing needle bent into a hook on the mast. Easy to detach and if dismasted, will break the elastic.

[ ] Cut a slit in a ping pong ball and slip in on the end of your antenna. Prevents being sued for poking someone's eye out.

[ ] Centre both control sticks. Centre the trim sliders.

[ ] Switch on the transmitter with the antenna not extended. (Should work fine up to about 10 feet.)

[ ] Switch on the receiver.

The sail and rudder servos should become active and find their neutral positions. Switch off receiver and transmitter.

[ ] Remove the screw on top of each servo holding the control arm in place. Without twisting the shaft, remove the arms from the splined shafts.

[ ] The rudder should be in line with the keel. Adjust your linkage as necessary.

[ ] Try moving the rudder stick from right to left. The rudder should swing freely, without binding, equally on both sides, about 30 degrees.

[ ] Install the sail arm on the sail servo across the beam of the hull. Move the stick forward and back to ensure it clears everything else.

For sheet line, I use Dyneema abrasion-resistant line, which has about a 90 pound tensile strength and very high abrasion resistance. I've been told that 50 lb. Gorilla fish line is also good.

[ ] Tie off a button (take one from your sleeve) at one end of a sheet line. Pass it through the main sheet anchor, through the sail arm grommet, back to the main fairlead and up through the deck. Leave about a 24" piece dangling off the side of the hull.

[ ] Tie off another button (now you can roll up your sleeves!) and do the same for the jib sheet, leaving a length out through the deck.

[ ] You now need to determine the optimum point to attach your sheet lines to the booms. Switch on (transmitter first) and move the sail stick back and forth. The main boom should be close-hauled to just a little off the center of the boat, but not pulling down on the mast. At full out, it should not allow the sail to touch the side stays, EVER. This involves a bit of trial and error since you can get more sheet movement by moving further out on the sail arm, and moving the attachment point toward the mast on the (main) boom.

The jib boom should be close-hauled just over the gunwale, and should not swing out any more than the main does.

It is probable that however you set it up, after sailing a few times you will make adjustments. The main thing is make sure your sheet lines run freely and do not tangle on any internal equipment. The sheets will go slack during a turn and a wind shift and its amazing where they can get caught.
Also, never turn your servo arms by hand - they have a mechanical stop in them and it is easy to strip the gears. Make sure the servos run smoothly and are not straining. They'll do enough of this in a good wind.

Once you decide on the spots on both booms that seem workable, install an eye screw on the underside of the boom.

[ ] Make up a couple of bowsie adjusters with the loop passing through the forward eye screw, and the single line passing back through the eye you just installed. See Fig. 29-1.

[ ] With the sail stick fully back, and trim back, the sheet should be cut above the deck and tie off to a snap hook. The hook makes for easy attachment of the rig and also keeps the sheet from slipping back through the fairlead.

[ ] Take the single line from the bowsie made earlier and tie a loop around the snap hook. These bowsies are not used to tension the sheets, they are used to adjust the offset of the booms.

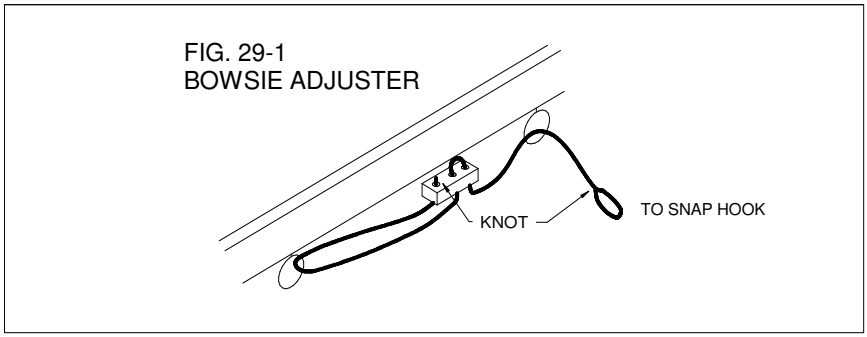


FIG. 29-1
BOWSIE ADJUSTER

30. Bow Bumper

A bow bumper of stic**k-**on or screw-on foam rubber or similar material is recommended. The bow of the Mini 12 is very sharp and WILL punch a hole in another boat under the right circumstances. It also is magnetic around docks and always seems to hit hard. I find it also saves the boat during transport from my shop, down the hall and into the truck.

It's sad to see a beautiful paint job and the front end of a boat looking like hell. Use a removable bumper, and take it off when you want to show off your boat. You can't even see it when you're sailing anyway.

A bumper shows your consideration for the time effort others have spent building their boats.

Lastly, there is that old rule that if you break my boat, you buy me another!

Please, use a bumper.

31. Final Ballast

We're nearly done.

[ ] Weigh your boat, fully rigged, no wind. I did mine at the corner store on their meat scales. Subtract its weight from 16 pounds. That's what you have to add.

[ ] Float the boat, fully rigged, hatches on, no wind. Place a small level on the forward part of the deck.
Make up a zip-loc bag with this weight of shot and move it along the deck until your boat is perfectly level. Note the location for the added ballast with a couple of pieces of masking tape. Hopefully it's level from side to side.

[ ] Remove the rig completely. Remove the radio tray enough out of your way that you can get at the ballast below. Use plastic sheet to cover your deck etc. and catch spills.

[ ] Carefully spread some epoxy on top of the existing ballast in the correct location, and add the correcting weight mixed sparingly with epoxy. Let it cure.

[ ] Install the radio tray.

[ ] Install the rig.

32. Initial Trimming

Set your boat down on land and switch on. Antenna extended. Walk away and make sure things are still working properly even at 50 or 75 yards. If not, it's much easier to retrieve the boat!

Make sure you have a rescue vessel in case something goes wrong on the water. This boat can sail forever on its own.

Every sailor has their own secrets. Try raking the top of the mast about 1" back of the base with light tension on forestay and backstay, a little more on the side stays.

Gentle winds. Try sailing.

The boat should sail straight with your hands off the sticks. If it doesn't, make sure your rudder is not offset to one side, then adjust the top of your mast forward or back.

Don't sail too far away - until you gain some confidence with your radio and your boat.

Lastly, let a good sailor try out your boat. He can tell you more in a minute of how to adjust your boat than by your reading a dozen books.

And sail as often as you can. The wind is free.

Appendix A

Tool Requirements

Safety glasses
1/4" electric drill and bits
Hand saw
Coping saw
Dremel type tool and bits, cut-off wheels (for tubing)
Course & fine sandpaper
Hand plane
Hammer
Needle files
X-Acto knife
Wire cutters
Needle nose pliers
Tweezers
Small bubble level
Methyl Hydrate (epoxy solvent)
Scales - or beg use from a local store
Soldering torch
30 Watt soldering iron

Useful
Dollar Store turkey baster for adding epoxy to shot ballast
Dollar Store soup spoon or ladle
Dollar Store plastic shot glasses/food containers for mixing epoxy
Hot glue gun - for tacking things temporarily
Square
1/8" paintbrushes (throw-away)
Metal tin snips

Appendix B

List of Materials

	Qty	Material	Application	Source
[ ]	6	1/2" brass pin or rod	mast crane, rudder tangs	Hobby Shop
[ ]	9	small brass cotter pins	mast	
[ ]	1	1/16" x 1" brass rod	rudder pin	
[ ]	2	1/8" x 2" brass rod	diamond stay	
[ ]		small brass tubing	ferrules, size depends on wire	
[ ]	1	1/8" x 3/16" brass tube	thrust collar	
[ ]	3	5/32" x 12" brass tube	rudder shaft drill, rudder shaft	
[ ]	1	7/32" x 3" brass tube	rudder shaft jig and shaft	
[ ]	1	5/32" plated brass collar	tiller arm	
		Brass Strip		
[ ]	2	.010" x 5/16" x 5/8"	side stay lugs	
[ ]	1	.032" x 1/4" x 1-1/2"	rudder skeg	
[ ]	1	.032" x 5/16" x 1"	mast jack	
[ ]	1	.032" x 3/8" x 2"	tiller arm	
[ ]	2	.062" x 3/4" x 3/4"	rudder tangs	
		Plywood		
[ ]	1	1/16" x 5" x 6"	rudder	
[ ]	1	1/8" x 4" x 10"	radio tray	
[ ]	2	1/8" x 5" x 6"	rudder	
[ ]	1	1/8" x 1" x 2"	forestay blocking	
[ ]	1	2-56 x 12" thr. steel rod	boom vang, rudder linkage	
[ ]	2	2-56 nuts	mast boom vang	
[ ]	2	steel clevis	tiller arm	
[ ]	2	steel clevis with keepers	mast boom vang	
[ ]	20 ft.	.018" SS solid wire	diamond stay, main sail hem	
[ ]	1	1/16" x 1/2" x 3-1/2" alum.	mast crane	
[ ]	2	fairleads mast	boom vang	
[ ]	8	large bowsies	line tensioning, sheet offsets	
[ ]	6	2" x 2" fiberglass cloth	beam/hull joints	
[ ]	9 fl oz	“5 minute” epoxy	general gluing	
[ ]	12 fl oz	“finishing” epoxy	ballast, waterproofing	
[ ]	30 ft.	Dyneema cord	sheets, outhauls etc.	
[ ]	1	2 channel 75 Mhz surface radio (choose an unused frequency)		
[ ]	1	sail servo		

	Qty	Material	Application	Source
		Pine (or basswood)		
[ ]	2	1/16" x 1/8" x 60"	rubbing strake	Lumber Yard
[ ]	1	1/8" x 3/4" x 2"	mast support	
[ ]	12	3/16" x 1" x 9"	deck beams	
[ ]	1	3/16" x 3/4" x 48"	kingplank	
[ ]	1	5/16" x 1/2" x 15-1/2"	main boom	
[ ]	1	5/16" x 1/2" x 14-1/2"	jib boom	
[ ]	2	3/8" x 1/2" x 3"	side stay blocking	
[ ]	1	1/2" x 1-1/4" x 8"	rudder servo beam	
[ ]	2	1/2" x 1-1/4" x 1"	rudder servo mount	
[ ]	1	1/2" x 3/4" x 54"	mast	
[ ]	2	1/2" x 3/4" x 6"	building stand	
[ ]	2	3/4" x 3/4" x 9"	radio tray beams	
[ ]	1	3/4" x 1" x 5"	transom block	
[ ]	2	3/4" x 3/4" x 1-1/4"	sheet anchor blocks	
[ ]	1	3/8" x 10" dowel	mast support	
[ ]	2	5/16" x 10" dowel	fairlead guides	
[ ]	1	3/4" x 6" x 14" plywood	building stand	
[ ]	2	3/4" x 6" x 7" plywood	building stand	
[ ]	1	8-32 x 1-1/2" brass bolt	diamond stay tensioner	Hardware Store
[ ]	2	8-32 brass nuts	diamond stay tensioner	
[ ]	1	8-32 x 1" rd. head br. bolt	mast jack	
		Brass or Steel wood screws		
[ ]	4	#8 x 1-1/2"	building stand	
[ ]	4	#4 x 5/8"	rudder servo	
[ ]	4	#4 x 1/2"	sail servo	
[ ]	2	#6 x 1-1/4"	rudder servo mounts	
[ ]	1	1/8" x 2" steel cotter pin	gooseneck	
[ ]	1	3/8" steel eye screw	gooseneck	
[ ]	2	5/16" steel eye bolts	side stay fittings	
[ ]	14	5/16" steel eye screw	various	
[ ]	1	8-32 T-Nut	mast jack	
[ ]	50 gm	epoxy putty		
		Plastic		
[ ]	1	1mm x 12" x 48"	deck	Sign Shop
[ ]	1	1mm x 12" x 12"	hatches	
[ ]	1	1/8" x 1/2" x 1-3/4"	mast step	

	Qty	Material	Application	Source
[ ]	1	fishing swivel	jib boom	Canadian Tire
[ ]	3	fishing tackle snap hook	boom vang, sheet line ends	
[ ]	20 ft.	30 lb. SS stranded wire	stays	
[ ]	1 roll	quality electrical tape	construction, hatch seal	
[ ]	1 roll	1" masking tape		
[ ]		silver bearing solder	brass soldering	
[ ]	1 ft.	velcro	receiver & battery	Wall-Mart
[ ]	8	AA alkaline batteries	transmitter battery	
[ ]	4	AA alkaline batteries	receiver battery	
[ ]	10 lbs	lead shot, 8, 9, or 10 ballast		Gun Shop
[ ]		electrical solder	electrical wiring	Radio Shack
[ ]	1 ft.	heat shrink tubing	ferrules	
[ ]	1	SPST switch	(may be incl. with radio)	
[ ]	2	1-1/2" x 20" foam strips	building stand	
[ ]	1	sewing pin	antenna pin	
[ ]	1	elastic band	antenna	
[ ]	1	shirt buttons	sheet anchors	
[ ]	CA glue or clear nail polish		seal knots	
[ ]	1	ping pong ball	transmitter antenna	
[ ]	1	bow bumper	bow	

Addendum: Sept. 29, 2010

The solder I used is not really silver solder. It's lead-free silver bearing solder used for plumbing work, readily available at Home Hardware or Canadian Tire. 98% tin, 2% silver.

Some of the brass tubing sizes may be incorrect. I started rewriting this 4 years ago but never finished as there was no demand. Please let me know what works for you.

Appendix C
Alternate Rudder Construction