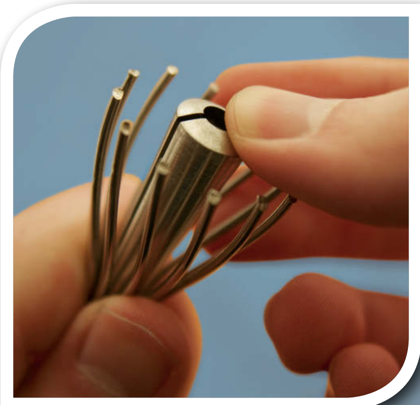
GOOD OLD BOAT

Archive eXtractions

RIGGING



Here's what it takes to keep the mast up and your sailboat seaworthy. This collection of articles features the cordage, cable, and hardware necessary for sailboats.

All articles were published in *Good Old Boat* magazine beginning with our first issue in 1998 through the end of 2015.

GOOD OLD BOAT™

RIGGING

A sailboat is nothing more than a powerboat if it lacks the mast and rigging necessary to carry sails. The lines and cables, the winches and tracks, and the spots where this equipment pierces the deck . . . a sailboat is a complicated vessel indeed. Perhaps that's why we love them so.

There's much to learn about each sailboat's rig; some is specific to that boat, some is generic to most boats. All of it requires that the sailor understand how it works and how to monitor and maintain it. That's why we, at *Good Old Boat*, developed this collection of articles for sailors.

We focus on spars, standing rigging, and running rigging. We write of lifelines and the bow pulpit, stern rails, and stanchions that support them. We didn't forget pilot rails at the mast, mast boots and mast steps, nor blocks and tackles, rope clutches, winches and chainplates. There are vang/preventer systems, rigging terminals, twin backstays, bowsprits and bumpkins, and boom gallows. Also caring for rope, rig inspection and replacement, and so much more.

We hope you'll find just the information you're looking for.

CONTENTS

No fear mast

No trained elephants? Here's an alternative

by Ron Chappell

In a previous article (November 2000), I touched upon the use of a quick and easy way for the lone sailor to raise or lower the mast on the typical small cruiser. Ensuing months brought a number of inquiries clamoring for more details regarding rigging. In truth, ponder as I might, I could never come up with a suitable mast-raising method on my own. However, I have a good friend, Gerry Catha, who is an airline pilot, aircraft builder, and fellow Com-Pac 23 sailor. He grew tired of my whining and worked out the following solution. I am grateful to him for redefining and perfecting the hardware involved and generously passing along the method to be adapted by his fellow sailors.

The instability of the stand-alone gin-pole has long made its use fraught with many of the same safety concerns associated with the use of trained elephants in mast stepping. The greatest fear factor involved in the process has always been the tendency of the mast-gin-pole combination to sway out of control during the lift. I can't tell you the number of "wrecks" I have heard of, or been personally involved in (read, responsible for) over the years, due to a moment's inattention, insecure footing, or errant gust of wind at some critical moment. All of this becomes a thing of the past with Gerry's no-nonsense bridle arrangement.

While systems may differ slightly as far as materials and fittings go, the basic tackle remains the same: a six-foot length of 1½-inch aluminum tubing, two 2-inch stainless steel rings, enough low-stretch ³⁄₁₆-inch yacht braid for the bridle runs, a few stainless steel eyebolts, some snaps and, of course, a boom vang to take the place of the elephants.

Eyebolt installed

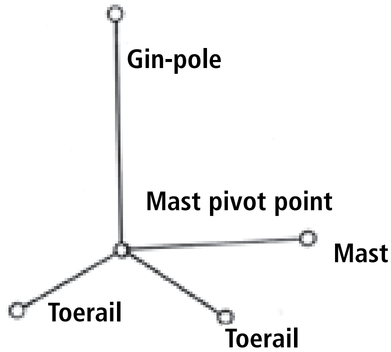
My own gin-pole has a large eyebolt installed in one end, which can be attached by a through-bolt (with a nylon spool cover) into a matching eye at the base of the mast's leading edge and secured by a large wingnut. This is the pivoting point for the gin-pole, which, of course, supplies the leverage. On the upper end of the gin-pole, two smaller, opposing eyebolts provide attachment points for bridles, halyard, and boom vang. Again, I must say that I have already heard of a number of different variations regarding attachments, hardware, and so on, as each individual adapts the idea to his particular boat, budget, and attention span.

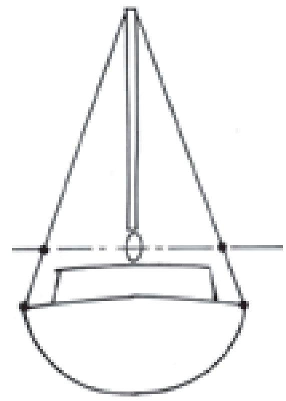
Terrel Chappell used to attract sympathetic onlookers to help with mast raising by appearing to struggle with the problem alone. These days she and Ron can raise the stick without help, and they prefer it that way.

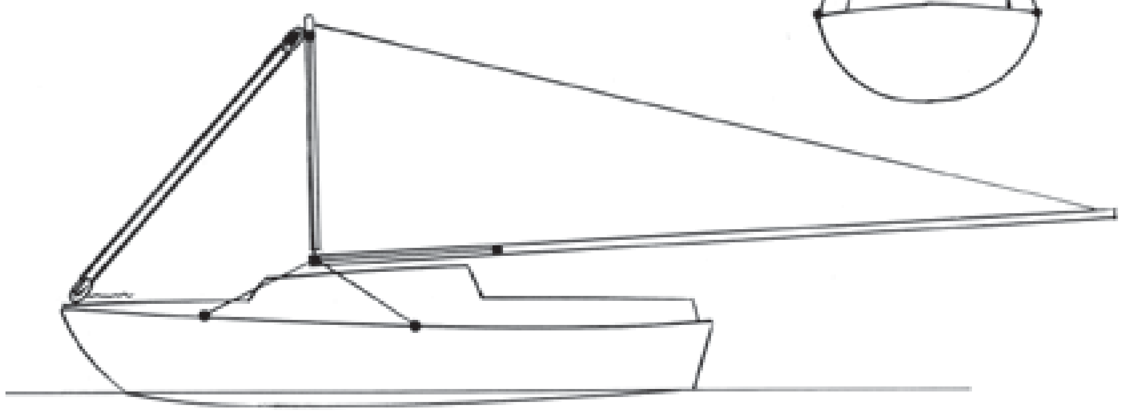
The critical thing to understand about this mast-raising technique is that in order for the mast and gin-pole lines to stay tight and keep the mast and gin-pole centered over the boat, the bridles must have their pivot points located on an imaginary line running through the mast pivot bolt. If the bridle pivot points are located anywhere else, the supporting lines will be too tight and/or too loose at some points during the lift.

There are two bridles. Each bridle consists of four runs of line, one end of each terminating in the same stainless steel ring, which forms the central pivot

stepping







point of that particular bridle. In operation, this ring must be centered directly across from the mast step pivot bolt. The longest of the four lines will go to a point as high as you can reach on the mast (secured to a padeye using a stainless snap). The second longest run attaches to the top of the gin-pole, snapped to an eyebolt. The two bottom runs, your shorter lines, are attached fore and aft to stanchion bases, though a toerail will work as well. It is imperative that the steel ring be centered directly in line with the mast pivot point when all lines are taut. This is accomplished by the location and lengths of the two bottom lines.

Clip the jib halyard to the uppermost eye on the gin-pole and bring it to an approximate 90-degree angle to the mast and tie it off. Next, secure one end of the boom vang (cleat end) to a point as far forward on the deck as possible and the remaining end to the top of the gin-pole opposite the jib halyard.

At your leisure

With all bridle lines taut and the mechanical advantage of the boom vang facilitating the lifting, you can slowly raise the spar at your leisure. Since the mast and gin-pole are equally restrained port and starboard, they will go straight up or down without wandering from side to side. Using the auto-cleat on the boom vang, you can halt the process any time shrouds or lines need straightening or become caught up. This reduces the stress factor tremendously and allows for a calm, orderly evaluation and fix of the problem.

I might note that, due to variations in shroud adjustment and slight hull distortions, you may find the port and starboard bridle will be of slightly different dimensions, making it necessary to devise some sort of visual distinction between the two sides. I spray-painted the ends of the lines on each side, red or green, for instant identification. Stainless steel snaps on the rigging end of these lines make for quick and easy setup. I find that it takes us about 15 minutes to deploy the entire system and only 10 minutes or so to take it down and put it away. Each bridle rolls up into a bundle about the size of a tennis ball for storage. The bridles go into a locker, and the gin-pole attaches to the trailer until next it is needed.

Granted, launch time is extended by a few minutes, but the safety factor gained is immeasurable, especially for sailors who must perform the entire operation by themselves. I have used this method on masts up to 25 feet long and in quite strong side winds with no problem and have found it to be the most expeditious way to raise or lower a mast should trained elephants not be readily available.

Ron and Terrel have retired from ranching. They sail their Com-Pac 23 in the Northwest in the summer and more moderate climates in the winter.

This photo, printed in the November 2000 issue of* Good Old Boat, *drew dozens of requests for more information about Ron's mast-stepping process.

Vang/preventer: a fast, effective safety device

In which the technical editor makes certain confessions and beseeches forgiveness from his wife …

by Jerry Powlas

I was guilty of contempt. Never a good thing, in this case it turned out to be a serious error. I had held a thunderstorm cell in contempt all morning. It was over *there*, and we were over *here*. We had been sailing for hours in strong winds that were probably feeding that cell, but it had been such a joyful ride I couldn't bring myself to quit. We had the 110 up with two reefs in the main and were on a screaming reach. We had been flying like this for hours. Occasionally we would have to tie a foot reef in the jib and put in or shake out another reef in the main. But we were moving. Madeline Island was to windward, and the seas hadn't much fetch. But the wind was getting over the island, and we had plenty of it.

At the bottom of the island we headed up but kept our speed. Eventually we breasted the red nun that marks the shoal, tacked, and fell off on another screaming reach.

Karen is the smarter of the two of us. I don't deny that. She suggested that perhaps the storm cell was moving toward us and we should probably shorten sail. I delayed. Each gust seemed to offer a chance to explore new territory on the knotmeter. It was intoxicating.

Finally Karen said we should at least get our foul weather gear on. She went below first, perhaps to set a good example. Then I went below to dress for the rain that I had to admit was looking more likely. In the middle of my costume change she said, "You've got about a minute." That call was probably accurate to within 10 seconds. I don't know why I don't listen to my wife more carefully.

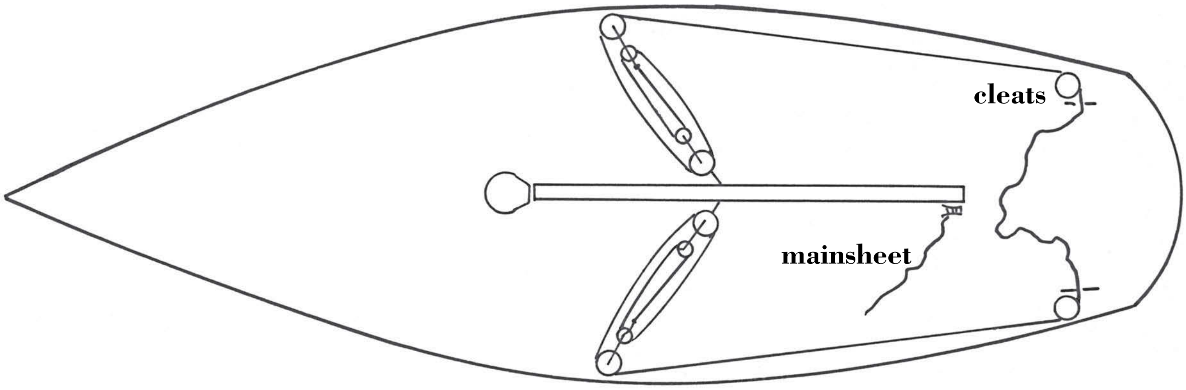
The squall hit. We were deeply reefed but not deeply enough. The wind came from dead astern at maybe 60 knots. I looked out through the companionway and saw that Karen was doing all she could do and doing it exactly right. She was steering dead downwind, not letting *Mystic* jibe or broach. With that course and speed *Mystic* would be a monument in downtown LaPointe on Madeline Island in about five minutes, but I didn't think we would make it that far. *Mystic's* beautiful spoon bow was being pushed down hard by the wind. She was clearly outside the envelope. I popped out of the hatch without bothering to replace the lifejacket I had removed in order to put on my slicker. We always wear our lifejackets, but just when I needed mine the most, there was no time to put it back on.

I crawled to the mast and cast off the main and jib halyards. Fortunately, they didn't tangle or catch; the beautifully simple jib hanks and mainsail lugs did what they were supposed to do, and the press came off our spunky little *Mystic* before she could pitchpole or broach. Bare poles were just right for good speed and control. My arrogance would be forgiven — this time.

Lessons learned

As I look back on it, several factors combined to limit that experience to a good scare and a lesson survived. The person who designed our C&C 30 knew his business; my beautiful wife used great skill in steering without broaching or jibing; the hanks and lugs ran free and fast; and the vang/preventer did exactly what we had intended it to do.

Vang/preventer? We knew of no existing term for this rigging, and we had to call it something. On *Mystic*, the vang/preventer is a pair of 4:1 tackles leading from mid-boom to the port and starboard toerails just abaft the stays. A single control line runs from both tackles aft through fairleads and cam cleats port and starboard of the helm. Because there is only a single line, as the boom swings off, line taken by one tackle is given up by



the other, so very little excess line clutters the cockpit. A flick of the wrist controls the boom.

On *Mystic* the vang/preventer is actually a better vang, a better preventer, and a better traveler than anything else we could have devised. *Mystic* had a traveler when we bought her, but it was a simple affair with no control lines. The idea was to lift the detent pin and move the car stop to the new location. The traveler was about two feet long and resided on a beam between the cockpit seats just in front of the wheel. *(Shown in photo at bottom right.)* It could not be moved under load and was only useful when beating. It was too short to help on a reach.

A message in this

The previous owner kept the original vang in the starboard lazarette made up like a hangman's noose. After using it for awhile, I was convinced he had the right idea. The people at C&C were not about to give up any sail area that could be easily had, so *Mystic's* boom sweeps very close to the deckhouse. This leaves the (conventional) vang at a very poor angle when led between mid-boom and the base of the mast. Fortunately, when the boom is close in for beating, the vang is not necessary; the traveler controls the sail twist. It took some getting used

Viewed from the bow, the photo above right shows the starboard vang released and the port vang trimmed. Photo at right shows the control lines led to the helm station. Notice the double-ended line.

to — unloading the main to move the traveler — but we managed and were glad for the lack of cordage the simple thing offered. The real problem was the vang. We could lead it to the toerail on reaches and runs, but doing so required the crew to scamper about the deckhouse and side decks … sometimes in darkness or heavy weather or both. A jibe demanded tedious choreography and a minimum of two crew. We wanted better.

The night my good friend stuck his head out of the hatch just as an eddy gust from the shore jibed the main, was the last straw. We had been becalmed and so had not set the vang as a preventer to the toerail. It was viewed as a bother in any circumstance and certainly was not deemed necessary when there was no wind. The blow of the boom could have killed him. He recovered and finished the cruise, piloting us skillfully through the Apostle Islands in a late October storm with near-zero visibility. We didn't have radar then or even GPS; we had Steve, the beginning sailor but experienced aviator, and that jibe had nearly eliminated him.

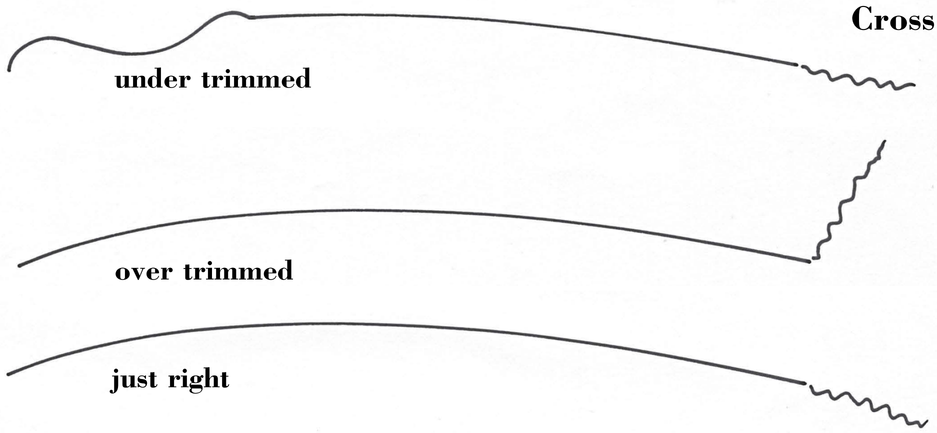
Development of the rig

I wanted a way to set up a preventer in a second — something that did not need to be removed from the toerail in a jibe. Our vang/preventer was the answer. The first version was 3:1 and used horn cleats. It was good, but not good enough. At 4:1, we could get good downward force on the boom no matter what position it was in. The bonus was that the preventer was now a good sail trim control.

The purpose of a traveler and vang is to allow good mainsail leech control. By moving a traveler to windward on a beat in light air, the main can be given the twist necessary for good performance. As

Photo at left above shows the control line and cleat and the caribiner that eases the release and prevents premature recleating. Photo at left shows how a flick of the wrist sets up the vang/preventer.

Cross section of the mainsail



Adjust the mainsheet and vang(s) to make the trailing edge telltails fly straight back.

Other preventer systems

Another preventer that is sometimes suggested is one that leads from the windward jib sheet winch to a turning block on the bow and back to the boom end. Proponents of this arrangement point out that if a boat rolls her boom end into the sea, any vang that leads from mid-boom to the toerail will give the sea too much mechanical advantage so that if the sea moves the boom end either aft or forward it could overstress the boom, mast, and stays. In those specific conditions I think a preventer from the bow would be a better arrangement. It is, however, not a very convenient rig so it might be better to have both a vang/preventer and a preventer led from the bow if one feels the need. Once the preventer from the bow is rigged, the vang could be eased so the rig would be better protected. The vang/preventer provides a lot of safety in all weather conditions, the preventer from the bow only contributes in very heavy weather.

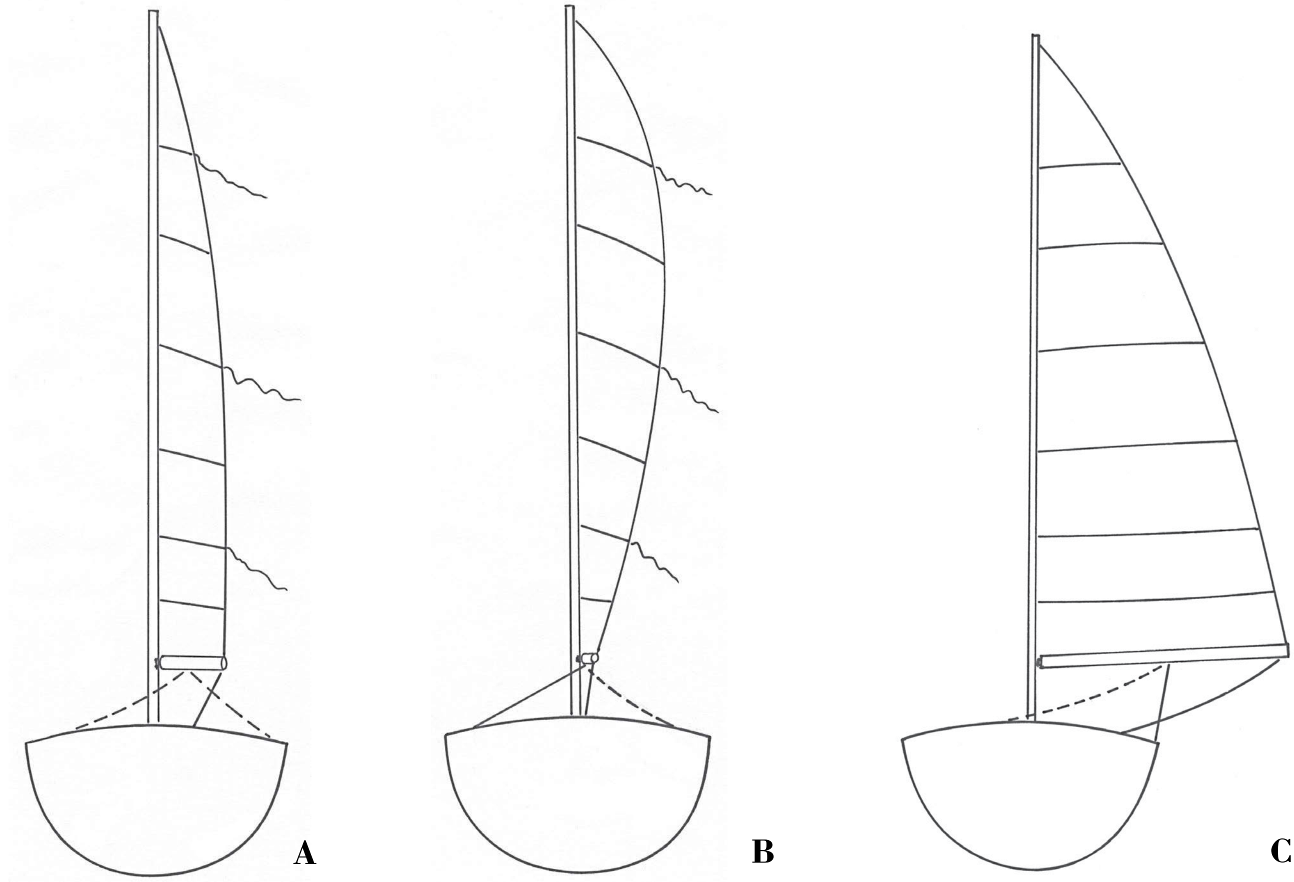
Our boat is a club racer put out to pasture and would be better thought of as a coastal cruiser than a bluewater sailor, but we do routinely cross Lake Superior with her and so might claim that handsome is as handsome does. Each boat will be a different case. We will probably never run a vang off the bow because we view it as awkward to rig, forcing crew to move about the decks rigging, unrigging, and rerigging it. We sail with two normally, and I singlehand often, so we have no one to spare for this work. Our boom is quite low with a full main, but as each reef goes in, the boom end goes up more. With all three reefs in, I have to stand on a seat to reach the end of the boom. If the boom end ever gets to the sea, I'm fairly sure we will have gone past the point of positive stability and will turtle anyway.

We do not intend to use even a reefed main in the kind of conditions where we might risk rolling the boom into the sea. We carry a storm trysail, which is cut to be usable with or without the boom, and we have a sea anchor and 600 feet of rode as well. We actually prefer to sail downwind in heavy weather conditions with just a jib. This is also controversial because our rig has only single lowers, and it is held in some quarters that sailing downwind without a main with this type of rig will cause the mast to oscillate enough to make it fail. Our mast has not failed in such use, but we can't say that other masts will do as well. Once we learned of this problem, we began using a stabilizing line from an extra sail slide raised to about the spreaders and led back to the boom end. A little mainsheet tension on the unused boom makes the mast extremely stiff, and shifts the resonant frequency up too high for there to be a problem. We use a Kevlar line for this, believing that it contributes to the stiffness we want to achieve.

We actually have seven extra slides that reside permanently above the mainsail headboard, riding up and down with it. There is room for these slides on most mainsail/mast arrangements because sails are normally cut to leave a little space at the masthead. We use these slides to attach the storm trysail, thus eliminating the need for an extra track. We use the same slides to set a stabilizing line for sailing downwind and also to stop the mast from pumping in high beam winds when we are in a slip. But these tricks are another story.

Special thanks go to Matt Grant at Sailrite for helping us to develop our storm trysail. It was his idea to put the extra slides in the track above the head of the main. Matt also designed the storm trysail with special hanks that fit the special heavy duty slides.

We have sailed for four years with our vang/preventer. In that time it has gone through three fairly complete revisions. We think it is just about right now. It provides better sail trim than more complicated racing gear and is much safer.



A: Heavy air beat – Mainsheet controls angle of mainsail and twist. Close reach – Mainsheet controls angle. Trim the leeward vang to remove twist; trim the windward vang to add twist.
B: Light and medium air beat – Trim windward vang to bring boom inboard; trim mainsheet to reduce twist.
C: Broad reaching and running – Trim leeward vang to set up preventer, hold boom down, hold boom out in light air, and take out twist.

Vang continued from 44

the breeze picks up, the traveler is let down in stages to leeward which, in combination with increasing mainsheet trim, will give progressively less twist. In a blow just before a reef is put in, the traveler is let down all the way to leeward, and the main will luff a little near the mast and reduce heel. As the wind goes aft, the vang takes over the job of pulling the boom down to control twist. If the boom is mounted high enough, the vang can lead to the base of the mast. But in the best of circumstances, the stresses are high on the vang, boom, and mast because the angles do not favor the task.

With our vang/preventer we have a better traveler than if we had an elaborate track, car, and tackles like a racer. In light air if we want to add twist, we trim the windward vang. The boom lifts just as it would with a fancy traveler. As the air picks up, we ease the windward vang and add some mainsheet trim. When we are a little overpowered, we trim the leeward vang, and the main untwists and luffs a little along the mast. When we bear off, we ease the main and trim the leeward vang a little more to keep the twist from getting excessive. A few telltales on the main make it easy to see what must be done. As we steer farther to leeward, the main is eased and the vang taken up. The preventer goes on automatically in the course of getting good trim, so it is there when we need it.

A jibe is a joy with this rig. There is enough friction from the vang/preventer to keep a flying jibe from being very fast, even if we just let it all go. We don’t do that, of course. We ease the vang and trim the main until it pops over, then we let out the main and set up the new vang — all very easy, fast, and smooth. It is also very safe; no one leaves the cockpit.

On light wind days we used to have trouble keeping the boom out on a run because the weight of the mainsheet was enough to cause it to swing back in. With a vang/preventer we just trim the boom out to where we want it, and it stays there.

The vang/preventer is a good singlehanding rig also. I sailed *Mystic* alone for a couple of weeks last summer in winds up to 35 knots as cold fronts pushed through the Apostle Islands near our home port. The vang/preventer was handy for this, since all the control lines, mainsheet, jib sheets, and both vangs were within easy reach of the helmsperson.

Would we have jibed in that thunderstorm without the vang/preventer? Other boats did. Would I have had the courage to go to the base of the mast knowing that the boom was free to jibe and wipe me off the deck? I think it made a difference.

Next time I’ll listen to Karen.

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Crevice corrosion on the mast (Photos 1 and 2) is obvious as it bubbles up between the layer of paint and the aluminum mast. The first step (Photo 3) is removal of all traces of corrosion first with a scraper, then with a wire brush, and finally with 80- and 120-grit sandpaper. Next, etch the surface with an acid solution (Photo 4) and apply primer (Photo 5). Sand the primer layer with 220-grit sandpaper (Photo 6) and spot-paint with a thinned coat followed by a layer of top coat. Hand-sand with 220-grit paper. The final coat is a thinned layer. First spread the paint horizontally but finish with a vertical stroke to prevent curtains (Photos 7 and 8). The finished mast is Photo 9.

Spiffing up the spars

How to repair corrosion damage on painted aluminum

by Steven Alexander

How does the paint look on the painted aluminum of your boat? Is it bubbling up and breaking through the surface? This is the first visible evidence that the metal beneath the paint is corroded. It is a problem that needs to be dealt with immediately; if left unchecked, the corrosion will eat right through the metal, leading to expensive and time-consuming repairs.

I've repaired this sort of damage several times over many years, experimenting with different materials and procedures on all sorts of aluminum pieces, from masts and steering pedestals to window, hatch, and door frames. What follows is what works for me when it's time to strip, prep, and paint corroded aluminum.

"The key to stopping corrosion from recurring is sealing the metal surface with a proper paint job. And the key to a proper aluminum paint job is the priming."

The first step is to remove the corrosion — all of it. Any corrosion left behind will come bubbling up to the surface later. Use a paint scraper and a wire brush to remove the loose, bubbling paint from the aluminum. Then sand the damaged areas down to shiny bare metal, using an orbital sander fitted with an 80-grit disk. Finish up by hand-sanding with 120-grit paper, feathering the edges of the surrounding paint into the sanded area. Then wash everything thoroughly with running water. If you are working on a thin piece of aluminum — like a window frame — skip the power sander and do the job by hand in order to keep from breaking through the metal.

The next step is to etch the metal surface with an acid solution. Paint doesn't stick well to smooth metal surfaces. Etching roughens up the surface just enough to give the paint something to grab onto. Use a phosphoric acid-etching solution, which is readily available at marine, auto supply, and hardware stores. Follow the dilution directions on the container, applying it to the bare aluminum with


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an acid brush. The etching process is almost immediate; you can wash it off with running water within minutes of application.

Running off in sheets

When you rinse the aluminum, see that the water runs off in even sheets rather than beads of water. Sheeting water is a good indication that the metal surface has been properly etched. If the water beads, repeat the etching process.

The key to stopping corrosion from recurring is sealing the metal surface with a proper paint job. And the key to a proper aluminum paint job is the priming. My favorite aluminum primer is Awl Grip 545, which was developed for use with the manufacturer's linear polyurethane (LP) paint. Although this two-part epoxy primer is expensive, the leftover material doesn't go to waste since it also makes an excellent all-around primer for fiberglass and wood surfaces.

Work with small amounts of the primer, since you'll throw away whatever you don't use. Mix equal parts of base and converter, pass the mixed primer through a paint filter, and apply it over the bare aluminum with a disposable brush, overlapping the feathered edge of the surrounding paint by about ¼ of an inch. Since this primer is thin, keep an acetone-damp rag handy to immediately wipe away drips. The primer will dry hard to the touch within an hour. You can then give it a light sanding with 220-grit paper, rinse it clean, and apply a second coat once it has dried thoroughly. Allow this second coat of primer to dry overnight before repeating the sand/rinse/dry routine.

You can paint over 545 primer with enamels or twin-pack linear polyurethanes; however, I prefer using a marine-grade one-part polyurethane paint as an excellent compromise between these two. One-part polyurethane is more durable than enamel and a lot easier to use than LP. In addition to the paint, you will need a natural-bristle brush, brushing thinner, paint pots, stirring sticks, and filters.


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Spot-paint first

Mix a small amount of paint with 10 percent brushing thinner, pass it through a strainer, and spot-paint over just the primed areas. This will help bring the repaired areas up to the level of the surrounding paint. Let this spot-coat dry overnight before sanding.

The next day you can lay down a top coat of paint. Tape off an area larger than the repair to be repainted. For example, the photos for this article show a mast being repaired and repainted. Although the damaged areas were relatively small, the mast was taped off from the deck to the boom for repainting. When finished, the paint over the repaired areas blended into the paint job over the lower portion of the mast, leaving only a thin line around the mast to indicate that it had been repainted.

"The paint can be applied in any direction; however, the final brush strokes should be vertical to keep the paint from sagging and creating the dreaded 'curtains effect.'"

Hand-sand this entire area with 220-grit paper and wash well with running water. Dry the area with clean cotton rags. Then mix your paint with 10 percent brushing liquid, pass it through a filter, and apply a thin coat of paint with a natural-bristle brush. The paint can be applied in any direction; however, the final brush strokes should be vertical to keep the paint from sagging and creating the dreaded "curtains effect." Let this coat dry overnight and then repaint the entire area one more time the following day.

How well does this type of repair hold up? Well, two years later, the mast shown in these photos looks just fine, thank you. It may take another two years before it needs a new coat of paint.

Standing Rigging: Keepi

The condition and tension of just six wires keep the stick up and the boat sailing well

We all know the rigging on a sailboat is necessary for supporting the mast (if it is not free-standing) and raising, lowering and controlling the sails. The rigging in support of the mast is called standing rigging while the sail halyards (raising and lowering) and sheets (sail control) are called running rigging.

Standing rigging may be made of rope or wire. On ships of the line in Nelson's day, it was all-rope, set up with dead eyes. Running rigging likewise can be wire, rope, or a combination of both. Rope designed specifically for the purpose must be used. Dacron and other flexible low-stretch ropes are required. Nylon has too much stretch.

To help analyze the task of the standing rigging, visualize the boat bisected by two intersecting planes, fore-and-aft and athwart ships.

If we look at an athwartship slice of a boat at the chainplates, it would look like the illustration on the opposite page. Note that the combination of, keel, hull, deck, and rigging wires comprise the support structure for the mast.

When you inspect your boat, follow the load path from the masthead down the capshrouds (upper shrouds) to the chainplates. Continue following the load path from the chainplate into the hull. The chainplate is typically attached to a either a knee or a bulkhead, which is joined to the hull by tabbing. Follow the load path all the way to the keel.

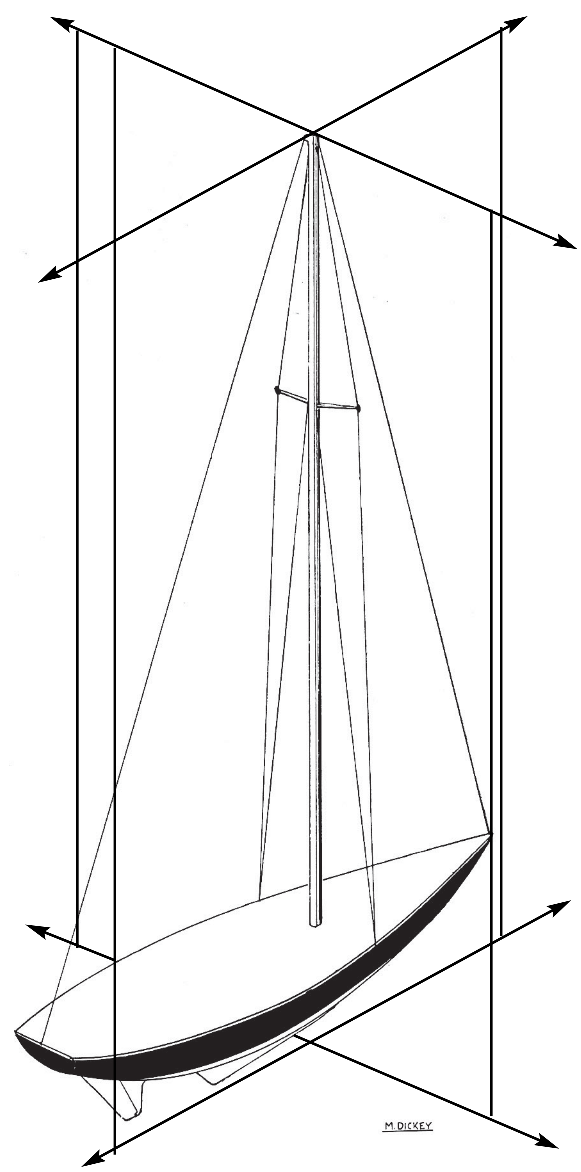
Check for broken strands of wire or cracked fittings, inspect turnbuckles, toggles, rigging pins, and cotter pins. Inspect the hull along the load path just as carefully.

Mast supports are of particular concern because there is a very large compression load at the base of the mast. There are two types of mast supports: keel-supported and deck-supported. A keel-supported mast rests on a fitting that rests directly on top of the keel in a fiberglass boat with internal ballast or on the keel support structure or inside keel for boats with external ballast. Either way, the condition of the connection between the bottom of the mast and the top of the keel is important.

Builders of oceangoing boats may use a steel beam as a mast step or a custom-made stainless steel bracket that transfers the compression force of the mast directly to the keel.

Some keel-supported masts rest on wood or glass beams above the keel. These beams can and do rot, sag, crack, and warp. When we tighten the shrouds and stays which support the mast, we increase the downward force on the mast step. When the boat heels under press of sail the force also increases.

A deck-supported mast sits on the deck and does not penetrate it. Deck-stepped masts are supported by various structural elements within the hull. These can be bulkheads topped with a large wood or metal beam or they can be wood or metal compression posts that support the deck section, which, in turn, supports the mast. They can also be any combination of these. The section of the fiberglass deck on which the mast sits must be a solid structure. It can have solid plywood encapsulated into the deck that will not crack with the compression force, or it could be a solid fiberglass deck in that area. The bulkheads that support the mast must be solidly attached to the



Evaluate and tune the rig fore-and-aft and athwartships.

ng the sparfly pointed up

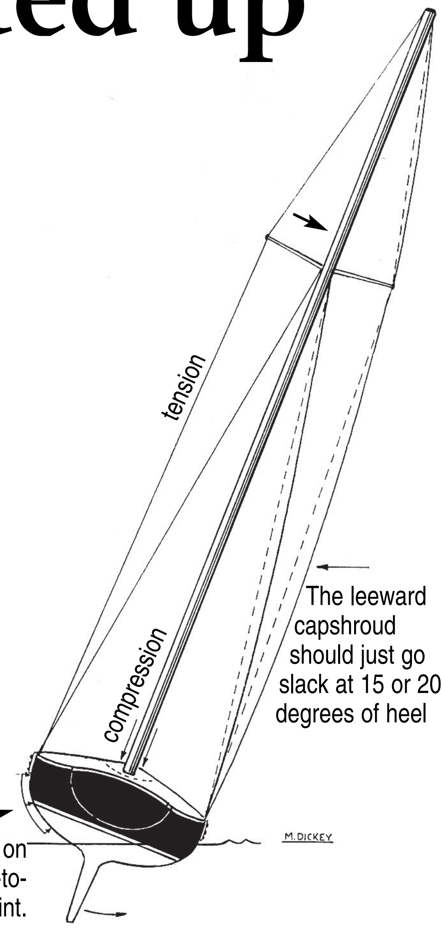
by Bill Sandifer
illustrations by Mike Dickey

sides of the hull and keel to provide the strength required to support the mast beam. If a bulkhead rots along its bottom edge, it can allow the mast step to sag.

If you find it necessary to repeatedly tighten your rigging, you may want to look in the bilge for the cause of the problem. A bulkhead that sags a little will begin to break down each time additional stress is put on it by the tightening of the standing rigging. It fails little by little. Eventually, it will fail enough to become obvious. The mast step will have been pushed down with the deck until it sits in a hollow. The fiberglass covering the deck will crack, water will enter and rot will start. This is the beginning of a big repair project.

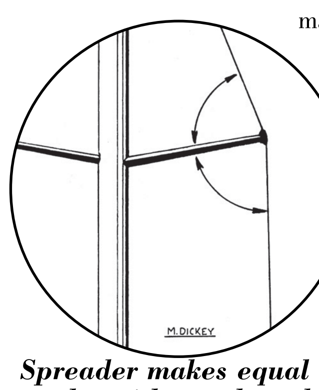
I had this problem with the deck-stepped mast on my Pearson Ariel. By the time I got the boat, it had sunk over 1 1/2 inches from its correct position. This was a boat that was raced hard with the rigging being tightened regularly. When I bought the boat, I had to loosen all the standing rigging and use a 4 x 4 vertical beam and two-ton hydraulic jack to force the mast step back to its correct position so I could sail the boat home. I placed 2 x 4s cut to length vertically from the inside top of the encapsulated keel to the underside of the deck to make sure I did not lose the mast from deck failure. After a complete deck step rebuild, the mast step was again structurally sound, but a lot of work went into the rebuild.

In the fore-and-aft plane of support, the attachment of the standing rigging to the bow and stern is also an area of concern. On racing boats, a backstay adjuster is sometimes used to rake the head of the mast aft and flatten the mainsail. On small boats, this may simply be a quickly adjustable turnbuckle. On medium-sized boats, it can be a turnbuckle controlled by a wheel. On larger boats, a hydraulic cylinder may be used to pull down on the backstay. All these devices are more powerful than the hulls to which they are attached. In a lightweight racing boat, it is possible to distort the hull into a banana shape, fore and aft, by overtightening the backstay. Chainplates have snapped, bolts have been sheared, and wire terminals have been deformed by careless use of these powerful devices.



Now let's talk about the rig. Most modern rigs have at least one set of spreaders. Rig designers resort to spreaders when the angle of the shrouds with the mast is less than about 10 degrees. At these small angles, shrouds have tension loads that are too high, and the mast has a compression load that is also too high. With overlapping headsails, the shroud base must be kept intentionally narrow to allow these sails to be sheeted inboard. Spreaders allow these narrow support bases while keeping the loads on individual wires down. Unfortunately spreaders are another potential point of failure. If a spreader breaks or fails in some way it, too, can bring down the mast.

Some boats have an aluminum mast, wooden boom, and wooden spreaders. Wood is subject to compression failure, crushing, rot, and overstress. Even if our rigs are all-aluminum, the attachment point of the spreader to the mast must be inspected regularly. In many instances, it is an aluminum casting attached to the aluminum mast with stainless steel bolts, a combination inviting electrolysis, corrosion, and failure. My Pearson Ariel had hollow, round sockets on the mast to hold the round tube spreaders. This is not aerodynamic, but it works. The tubes were held in place by a stainless steel cotter pin through the socket. The socket was, in turn, attached to the mast with stainless steel machine screws tapped into the mast wall.



Spreader makes equal angles with capshroud

The outboard ends of the tubes were filled with a wood plug with a vertical groove to hold the upper stay. This wood was subject to cracking and splitting. It had to be inspected annually, re-secured to the tube and fitted at the ends with white rubber boots to protect the sails from chafe.

Even if the underside of wooden spreaders is varnished, the upper side should be painted with white or silver paint to better resist UV. Inspect spreader bases for cracks, and inspect the mast wall under the base for signs of failure. The spreader should **not** be perpendicular to the mast. The upper (cap) shroud should make equal angles with the spreader tip above and below. This allows the load on the spreader to be pure compression.

Wire

There are three basic ways to build, lay, or pre-form wire into standing rigging. Each type suits a particular purpose. The most common type of standing rigging is 1 x 19-strand wire. This is called non-flexible or rigid and is laid up in one strand consisting of 19 pre-formed wires of the same size. This wire provides the least stretch of any stranded wire combined with the highest strength-to-diameter ratio. In newer racing type boats, solid rod rigging is sometimes used in place of wire rigging. Another designation for wire is 7 x 7 cable. This is semi-flexible and is composed of seven strands of seven wires each pre-formed into a single cable. It provides increased flexibility over 1 x 19 with minimum elongation (stretch). Keep in mind that all wire stretches. Even rod rigging stretches. It is only a question of how much under what load.

On smaller boats and on trailersailers where stepping and un-stepping of the mast is frequent, 7 x 7 cable is used, and some stretch in the wire is accepted. The other common designation is 7 x 19 cable. This is the most flexible of the cables and composed of seven strands of 19 wires each. In any boat application it would serve as wire halyards, running backstays, topping lifts, and guys. On large boats, it could be used as wire sheets. 7 x 19 cable is highly resistant to crushing and bending fatigue. Because it may be wound around a winch and through blocks and receives other punishment as well, the wire will generally wear out before corrosion will damage it.

Any of the above cables may be built of stainless steel of various grades or plain or galvanized steel. Galvanizing provides some corrosion protection to plain steel wire. Older boats and restorations or replicas, may use galvanized wire rigging rather than stainless steel for looks. The galvanized wire can be sluiced down with tar and pitch to look black like the rigging of old. Stainless steel would not hold the tar compound. Galvanized wire will last a very long time, if protected from corrosion, and it is much cheaper, too. Plain steel wire, coated with tar, will work as well, but watch your hands on a hot day when the tar comes off on everything. The downside of plain steel is that it is quickly subject to corrosion in those areas where the protective coating comes off.

There are several alloys from which the wire may be drawn. Each has particular characteristics. Not all stainless steel is suitable for making wire, and none is completely "stainless." Water has the ability to corrode stainless steel. Salt water and acid rain can be very corrosive. Stainless steel acquires its protection from corrosion through its interaction with oxygen in the air. If stainless steel is sealed off from the air, it can quickly corrode.

A boat sailed in the Great Lakes might have bright rigging wire for years until it is moved to New England or Florida. Then its rigging will quickly show signs of corrosion. In selecting the type of stainless steel from which to form wire, 302 and 304 are the most common. This is a good compromise between strength, corrosion resistance, and price. For boats that sail in tropical seas or highly corrosive areas, 316 or nitronic stainless steel offers increased corrosion resistance at increased cost. The tensile strength of the 316 is less than that of the 304. It is also harder and more brittle. Generally one size larger wire is needed to compensate for the reduced tensile strength.

Over the years, various wire manufacturers have developed proprietary types of stainless steel in an effort to improve the qualities of stainless steel rigging wire. These are known by "brand names." When shopping for wire, check the specifications. Don't pay for a brand name made from the same material as the basic wire. Type 316 is good for Florida and the tropics while 302/304 is fine for most other areas unless your boat is docked near a source of corrosion such as a power plant with associated stack gasses.

The limited seasonal use of boats kept in northern climates limits the sailing stress placed on standing rigging. However, if the mast is left up during storage, the wire is in the weather and exposed to some cyclic loading from wind 12 months of the year, so it may corrode and fatigue more quickly than you might expect.

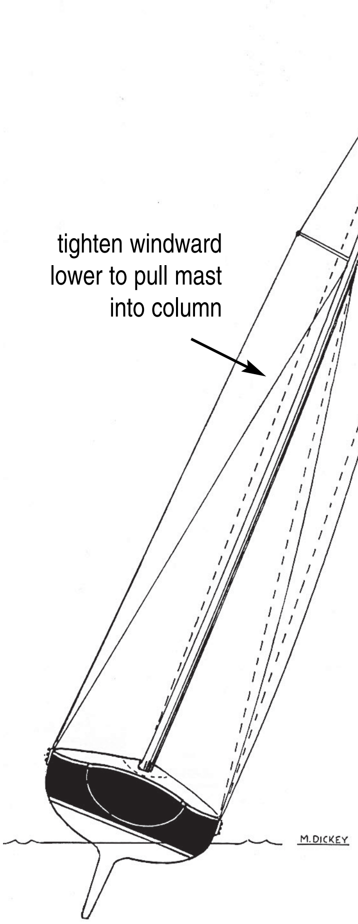
Terminals

Terminals create a mechanical connection between the wire and its attachment, i.e. a chainplate or mast tang. Basic terminal design consists of a fork or an eye. Specialty terminals are made to create studs for turn-buckles, antenna terminals, or other special-use items.

Terminals are designated by the method of attaching the terminal to the wire. Swaged terminals are the most common type found on sailboats. Swaging is the process of squeezing the pipelike barrel of the terminal tightly around the wire. There is no fusion of the terminal to the wire. It is strictly a mechanical grip created by the compression of the terminal barrel over the wire. Swaged terminals have proven themselves in thousands of miles of sailing, but they can fail.

The simplest swaging machine is the roll swager. This machine places the terminal between two dies and compresses the terminal tightly against the wire. Usually two passes of the terminal through the roll swage are used to assure maximum compression. If not done correctly, the terminal can assume a banana shape and have a seamlike line on the long axis of the terminal.

The rotary swage is a better swaging machine. In this machine, the compression of the terminal barrel is accomplished by many light hammer blows to the terminal in a rotary motion as the terminal is passed through the machine. This produces a more uniform swage with little or no distortion of the fitting. A rotary swage may be checked against standard military specifications to assure full compression of the fitting. Both forms of swaging are dependent on the skill of the machine operator for the quality of the swage. My father-in-law's Gulfstar 42 lost its mast from a defective backstay swage. The wire was



never fully inserted into the terminal barrel when the swage was made. Undetectable except through X-ray (not a usual inspection device), the fitting failed when the boat was only a few years old.

Swageless terminals are another alternative. They have proved themselves over time and offer several advantages over the swage terminal. Since they do not require a machine, they are easier to use. They are reusable, inspectable, adjustable in very small increments and easy to work with. The downside of swageless terminals is they cost twice as much as the swage variety. Some swageless terminals and a roll of appropriately sized wire are a good cruising spare to have on board.

There are two types of swageless terminals: mechanical, using a malleable cone to expand the wire within the fitting, and an epoxy type, that uses epoxy to form the bond within the fitting. I have not seen the epoxy type advertised for some time, but the mechanical types are represented by Sta-Loc and Norseman. Products from both companies are available through West Marine, Defender Industries, and other boat supply distributors. If you bought swageless terminals this year and decided to re-rig the boat in 10 years, you could re-use the fittings and only have to pay for new wire and new wedges. These are available from the manufacturer or distributor and are not costly.

A final type of fitting to be discussed is the oval sleeve or Nicropress type. These fittings are not easily used with 1 x 19 wire due to the stiffness of the wire but can be used in an emergency. This fitting creates an eye in the wire which can be used to attach a turnbuckle or other piece of hardware to the wire. The oval fitting will work well with 7 x 7 or 7 x 19 wire and is often used on small boats or for lifelines. If this fitting is used in a critical area, such as rigging, two oval sleeves must be used and carefully compressed around the wire. Be sure to leave a small amount of wire protruding from the end of the second sleeve. This can be wrapped for personal protection, but it needs to stick out a little to assure that both sleeves are in full contact with the wire for their entire length.

Now we have our rig, let's sail. Oops, first we need to tune the rig.

Tuning the rig

Rig tuning is very important. Boats with poorly tuned rigs are slower, don't point as high, make more leeway, and may be difficult to steer. They are also more prone to rig failure. Tuning starts as soon as you step the mast and attach the standing rigging from the mast to the hull. First attach the four primary shrouds, forestay (headstay), backstay, starboard upper, and port upper (capshrouds). Once these are attached and tightened enough to hold the mast vertical, attach the starboard and port lowers, adjusted loosely. If the mast is keel-stepped, do not insert the wedges between the mast and the deck. They come later.

The object of tuning is to support the mast vertically in relation to the athwartship and fore-and-aft waterline of the boat. This means that the mast must not lean port to starboard nor toward the bow or stern. Masts on some racing boats are raked aft, but most good old boats will do well to at least start out with a vertical mast and begin tuning from there.

An easy way to initially position the mast is to establish a plumb line adjacent to the mast which can be used to determine the mast position. Hoist a light line to the top of the mast on the main halyard and tie it off. On the bottom end of this line, tie a weight (a wrench or similar will do), to create a plumb bob. You can submerge the weight in a bucket of water on deck to dampen the motion of the line.

Sight the mast from aft, and compare it to the plumb line. Adjust the port and starboard rigging to bring the mast into vertical alignment with the line. The rigging turnbuckle should be hand tight to start with and then tightened using a wrench to hold the rigging terminal and a screw driver through the turnbuckle to tighten it.

Before you set the mast, open all of the rigging turnbuckles an equal amount and take care to see that the top and bottom screws of the turnbuckles are equidistant from the center of the turnbuckle. If you start with this situation and tighten equally on all turnbuckles as you set the mast, you should have a mast more or less vertical with only the fine adjusting to be done.

Once you adjust the mast into vertical column athwartship, you need to do the same fore-and-aft to assure that you have a vertical mast in both planes. Now, adjust the port and starboard lower shrouds by tightening them to about the same hand-felt tension as the uppers. Check again to make sure the mast has remained vertical. Be sure when you tighten the lowers that you do not pull the middle of the mast out of column. If you have done this, loosen one side and tighten the other to get the column back in line.

At this point, all of the rigging should be basically tight using a wrench and screwdriver, but it is not "tensioned." There are three ways to achieve the desired tension to the rig:

a) use a tension gauge such as the Loos Tension Meter available from various marine distributors;
b) calculate the tension (percentage of breaking strength of the wire; based on empirical measurement);
c) go sailing.

Method C is the most fun and will suit the average sailor. Method B is the hardest and is described in a sidebar. Method A is easy, but you have to buy the tension gauge.

Let's use Method C. The first rule of C is never try to adjust rigging under load. If the starboard upper needs to be tightened, and you're on a starboard tack (wind over the starboard bow), tack so you are on a port tack, take up the now unloaded starboard upper and tack back to gauge the effect you have made. Pick a day with 8 to 12 knots of wind. Find a sheltered shore so you can sail in calm water while still getting full wind. Set full main and your usual headsail or the biggest you would normally carry in the wind range, perhaps a 150 Genoa. Sail on one tack while evaluating the rig. Are the leeward lowers tight or loose? If loose, tighten hand tight without distorting the center of the mast. Is the masthead falling off the leeward? Tack and tighten the offending upper. Only use hand pressure to adjust the rigging. You can tension it more later. Check the masthead. Is it raked fore and aft? Run off or head up to adjust the required shroud. Tack over and do the same thing. Keep sailing and making hand tight adjustments until you can sail on any point and the rigging is tight and the mast is in column.

Now, come into the wind and drop the sails and feel the rigging tension. Is it about equal on all shrouds? It should be. Use your wrench and screwdriver to add tension to the rig by turning each turnbuckle the same amount of turns in a clockwise manner around the boat. Start with one full rotation of each turnbuckle. If it is getting hard to turn the screwdriver to adjust the turnbuckle, you are at about maximum desirable tension. Now, set the wedges between the mast and the deck for a keel-stepped mast. Your rig is ready for the season.

When you get to the point of tensioning the rig with the wrench and screwdriver, you could go to Method A and use a Loos Tension Meter to check the rig in lieu of adding a bit more to each turnbuckle. It's up to you and depends on how you sail. I leave Method B to those more dedicated than I am.

All well and good, you say, but I don't sail hard, and I don't race. Why should I take the time to tune my rig? My short answer is that tuning the rig is about more than how we sail, it is about keeping our mast in the hull and the rigging sound and the tiller easy.

"Tiller?" you say? Yes, the tuning of the rig can assist in minimizing weather helm and bringing joy to the helmsperson. The straighter the mast, the less weather helm you'll have. The ability to correctly tune your sails depends on a stable rig that does not allow the mast to distort out of column from tack to tack. Tuning is fun and can be a source of pride in a job well done and a boat well sailed.

Inspection and upkeep

Our rigs are our motion, our power, our joy, and can be our lifesavers or endanger our lives. We need to regularly care for and inspect the rigging. A careful twice-yearly inspection will pay dividends in catching problems before they become dangerous.

Discoloration is a clue to a problem and is evident before the actual problem surfaces. Rust-like stains in a barber pole stripe on the rigging wire tell us something has failed internally in the wire. Small discoloration around fittings may foretell a fitting failure. Water can enter a fitting and start corrosion. A small crack can travel.

One way to detect small cracks in fittings is to polish the fitting with Never Dull or a similar product. Wash the polish off and apply a mix of penetrating oil with carbon black dye added. Apply the mixture to the fitting, let it stand for 20 minutes or so. Remove excess oil from the surface with alcohol or mineral spirits then dust the fitting with baby powder. The crack will appear as a line in the baby powder. Dye Check Kits are also available from West Marine and others. It may take a couple of hours twice a year, but the peace of mind is worth every minute.

Fatigue failures may be caused by cyclical loading on a fitting. When we sail with the rig incorrectly tuned, the slamming of the sail from side to side cyclically loads the leeward terminals. With enough high load cycles, a crack may form. As the loads are repeated, the crack spreads, and finally the rigging fails. If you see the rig is working or pumping, do something. Re-tune the rig or reduce the press of sail. Applying too much backstay tension to a rig is probably the other common cause of failure.

To maintain your rig, keep it clean. Rinse it regularly with fresh water. Wash it with water-soluble detergent. Never use a cleaner containing chlorine. It is destructive to stainless steel. Use nylon or bronze wool to clean tough spots. Never use steel wool or steel scrubbing pads. Let the rigging breathe. Don't cover the stainless with tape or other oxygen-excluding coverings. Use spreader boots or turnbuckle covers if you must cover some areas.

All rigging has a useful life, but it is very hard to determine what that life is. A rule of thumb for rigging in saltwater service is, "Replace in 10." Ten years is a long time to endure the constant motion and loads on a sailboat. In freshwater service, the period may be extended to 15 years or longer if the rig is rinsed, kept clean, and not subjected to acid rain, smokestack gasses, or the like.

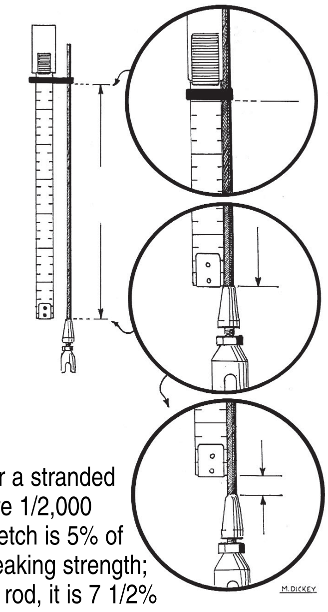
Problems that develop with rigs tend to multiply. Find one, and there is another one around somewhere. Unless you know the specific reason for an isolated failure, the whole rig should be suspect. When you see a light brown barber stripe on the wire, its time to replace, at five years or 15. Respect your rig. It will repay you with years of carefree sailing.

The most important rigging maintenance tool is a good notebook. I also recommend the use of a tension gauge. There is some trial and error involved in the initial tuning of a rig. If your boat sails well, document the way the rig is tuned so you can get back to those adjustments later. This is true for all boats, but particularly true for boats that routinely remove their masts during lay-up.

A plumb bob is most useful if your boat floats exactly on its waterline. Many boats do not, and others are sensitive to crew and gear location. Another handy method of determining that your mast is vertical in the athwartship plane is to use your main halyard to measure to the

Measuring stretch to set tension

by Bill Sandifer



For a stranded wire 1/2,000 stretch is 5% of breaking strength; for rod, it is 7 1/2%

If you don't have a tension gauge, you can set tension by measuring elongation. Be careful: the changes are quite small.

It is possible to determine the tension in shrouds and stays empirically. You can measure the elongation of the wire as a fraction of the initial length and then establish rig tension as a percentage of the breaking load of the wire.

This requires fairly precise measurements. Stranded wire is at about 5 percent of its breaking strength when it has stretched 1/2,000th of its length. Rod wire is at 7.5 percent of its breaking strength when stretched 1/2,000th of its length. After you read this you may decide that a tension gauge is a very reasonable investment. Either way, if you are ever stuck somewhere without one, a copy of this method will help you get your rig tension about right.

The example below is for stranded wire. The elongation for rod wire should be 2/3 of the elongation in the example.

The easiest method is to use a set sample length of the wire, say, six feet. Using the top of the terminal fitting as the baseline and with the rig normally tensioned to hand tightness, measure up six feet from the top of the terminal and carefully mark the wire. You might use a round of tape to make identification of the six-foot mark easy. Now increase the tension on the rig by tightening the turnbuckle. As you tighten the turnbuckle the wire will elongate, and the six-foot mark will move upward as the wire stretches. Take a measurement down from the six-foot mark to the top of the terminal. This distance will now be more than six feet. If the measurement is six feet, plus 1/32 inch (or .036 inches to be exact), the tension in the wire is now 5 percent of the breaking load of the wire. If the measurement is six feet, plus 1/16 inches (.072 inches to be exact), the tension is 10 percent of the breaking load of the wire, and so on. Never exceed 25 percent of the breaking load of the wire. A 7/64 inch increase or (.108 inches to be exact) will put you at 15 percent breaking strength. That should be about right for a masthead rig cap shroud. You may need to go to 20 percent for a fractional rig with swept spreaders. In any case, if you cannot achieve the results you want with 25 percent tension, there is some other problem with the rig. Go back to the beginning of this article and examine the rig support structure to find the problem. If you want to observe the elongation of wire under tension, try this method and see how it comes out. Use care with this method. You should not need anything heftier than a screwdriver and a wrench for this. Fair winds and tuned rigs.

Variations on the theme

deck edge port and starboard. *(See illustration on the next page.)*

You may or may not want your mast vertical. Some boats are designed with a little rake to the mast, and some need some rake to sail properly. There is never any need to rake a mast forward of vertical. What determines if you need some mast rake is weather and lee helm. A normally rigged and sailed boat should not have lee helm. If you have lee helm at any normal point in the sailing envelope, rake your mast a little more. If you have a lot of weather helm under normal conditions, try standing the mast a little straighter. Some boats, particularly those with full keels tend to have a goodly amount of weather helm when sailed at large angles of heel. Making the mast straighter may not cure this characteristic completely.

The easiest way to measure mast rake is to measure the dimension from the masthead to some point on the stern. If your rig is small enough, you can hoist a 50-foot tape measure up with your main halyard. Two-block the halyard and measure to the same point on the stern. You may even want to mark that point to help you remember where it is. The actual dimension is not as important as measuring it the same way every time, and knowing what measurement is needed to make your boat sail well. If you need to measure more than 50 feet, hoist a purpose-made wire with a loop on one end and a mark on the other, and measure the distance from the mark on the wire to the mark on the boat. When the boat sails well, note the setting in your notebook.

It's easier to think of adjusting the rake with the backstay and the tension of both the backstay and forestay by tensioning the forestay. If the rake is correct, go by the forestay tension, and let the backstay tension float to be what it will. It will usually be less than the forestay tension because of the angles the stays make with the mast. Just remember that adjusting either one changes the other.

Continued from Page 11

by Jerry Powlas

Slack rigging is no favor to your boat. Your rigging will work better and last longer if it is fairly tight. Fairly tight is not a quantitative statement however. With a rigging gauge we can be more precise. In fact with a rigging gauge you can pretty well reproduce previous settings without ever leaving your slip. That is why the notebook is so important.

The most important point to understand is that when the sailplan is pretty well loaded and the boat is well heeled, the peak load on a weather capshroud is exactly the same whether the rig was initially tight or loose. The difference is that if the leeward capshroud is slack, under some conditions it will receive high shock cyclic loads as the mast pumps in a heavy sea. This is why it is desirable to set the rig up tight enough so that when sailing in winds that produce 15 to 20 degrees of heel, the leeward shroud is just starting to relax and not flopping around. *(Refer to illustration on Page 7.)*

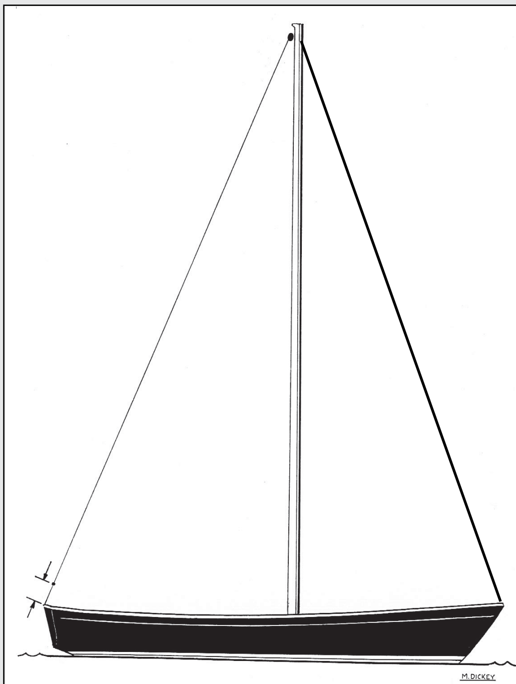
Good instructions and advice will come with your tension gauge. Essentially you gauge your wires to determine the diameter, find the breaking strength of the wires in a table, and initially set them up to 10 to 12 percent of breaking strength. That is for masthead sloops. For fractional rigs with swept aft spreaders, it may be necessary to tighten the cap shrouds to 20 percent to get the forestay tight enough. In no case is it desirable to use more than 25 percent of breaking strength.

Final adjustment still requires sailing the boat (at least the first time) to determine if the capshrouds go slack at the desired loading, which is a breeze that will produce 15 to 20 degrees of heel.

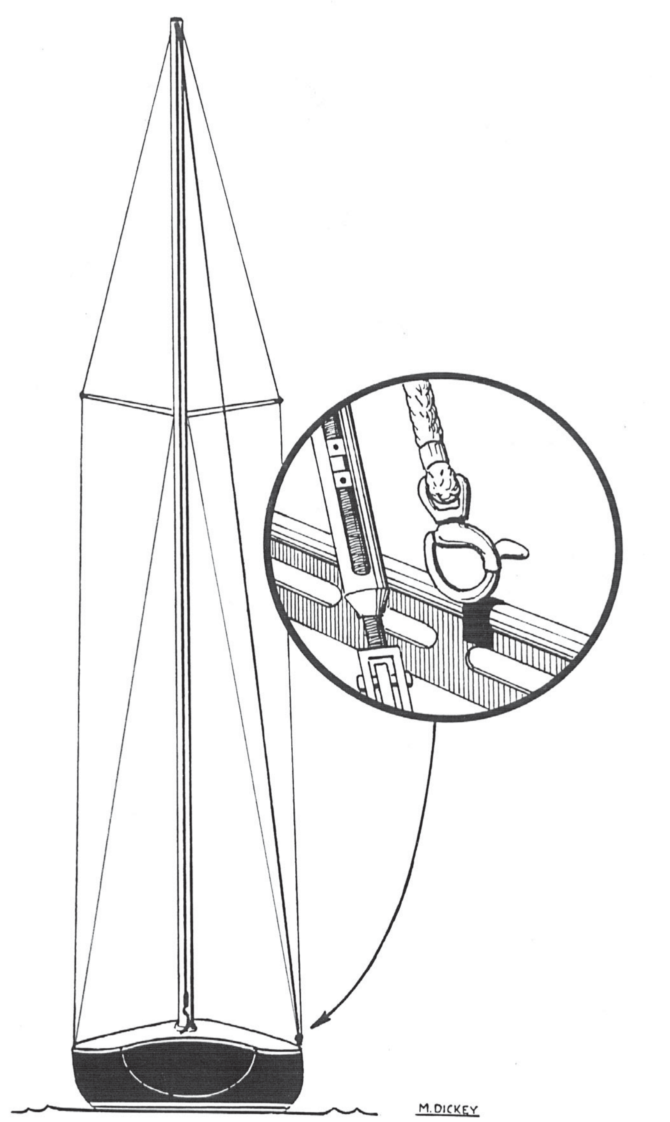
The Loos instructions also say that it may be desirable to set the lowers to less tension than the uppers and that forward lowers should be tighter than aft lowers. Again, it is necessary to sail the boat and adjust the lowers so that the mast is fairly straight when the boat is heeled 15 to 20 degrees. Tightening the windward lower pulls the middle of the mast to windward. No tricks there.

Steve Killing says there are two schools of thought on mast bend. One school says the mast should be kept straight under load, and the other says it will bend no matter what you do, and it is better to let the bend be a very slight and uniform curve to leeward. This second school, to which Steve subscribes, contends that if a keel-stepped mast is kept straight above deck (by proper adjustment of the lowers) it will concentrate the bend below deck.

Last but not least. Be careful, and think it through. The instructions and suggestions in Bill Sandifer's article and in this sidebar are necessarily of a general nature. Your boat may have peculiar characteristics that need to be taken into account. Our 1976 C&C 30 manual, for example has absolute pre-tension limits for backstays specified at 2,000 pounds. This is on a 1/4 inch wire rated at 8,200 pounds breaking strength. With the backstay set that high, the forestay will be higher yet. (I never set it that tight.) If you can find a manual for your boat, it may have good advice that is much more specific than the comments on these pages.



Measure the distance from masthead to a point on the stern. Use this dimension to define and duplicate mast rake.



Straighten mast in the athwardships plane by measuring the main halyard.

Bill's new old boat is a 1976 McInnis-designed Bristol-built Eastward Ho 31.

by Bill Sandifer

Do-it-yourself rigging

When all is said and done, it might be worth hiring a rigger

There was no question about having to re-rig my new-to-me good old boat, an Eastward Ho 31. When I surveyed the boat, I noted the barbershop spiral bands of discoloration on all of the standing rigging and that the bottom eye terminal on the headstay had a severe crack. I wouldn't even have daysailed the boat with that defect.

Once the boat was trucked home to Bay St. Louis, Miss., the first priority was to strip the mast and make up a needs list for the new rigging. The most difficult part of the job was trying to free the port and starboard upper shrouds from the aluminum plates holding them to the spreader ends. The boat, at 23 years old, still had its original rigging. The 6 x 32 stainless steel machine screws were firmly corroded into the aluminum end fittings on the spreader. I unpinned the spreader from the mast sockets and took the sockets, wire and all, to the shop. I succeeded in twisting off the screwheads and freeing the wire, but that left the problem of reassembly. I took the spreaders to a machine shop which drilled out the existing machine screw studs and tapped new fasteners into the old spreader body. They did a great job and cleaned up the surface corrosion in the process.

I had initially contacted a rigging supply firm in Rhode Island in an attempt to buy new spreader end fittings, but I had no luck because the Schaeffer mast is oversized, and the spreader tubes are 1 5/8 inch outside diameter. This company said they carry replacement parts up to 1 1/4 inch only. They suggested sleeving my spreader tubes to fit the smaller endpieces, but I wanted to keep my oversize system intact.

Speaking of oversized, once I was able to assess all of the standing rigging wire, I found the port and starboard upper, headstay, and backstay to be 9/32 inch 1 x 19 304 stainless steel while the port and starboard lower were 1/4 inch 1 x 19 304 stainless steel. This difference would be important when re-rigging. Since the boat's intended use is to be in tropical waters, I wanted to re-rig with 316 stainless steel wire for increased corrosion resistance. This created problems since the 9/32 inch 304 stainless steel wire had, when new, a breaking strength of 10,300 pounds while the 9/32 inch 316 stainless steel wire's breaking strength was only 8,700 pounds. The 316 stainless steel wire would have to be 5/16 inch (having 10,600 pounds breaking strength) to equal the 9/32 inch 304. The 1/4 inch 304 was rated at 8,200 pounds while the 1/4 inch 316 was 6,900 pounds.

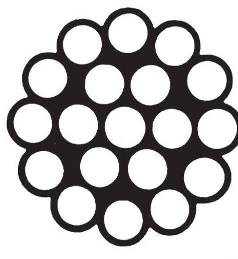
I did not want to reduce the strength of my rig, nor did I want to increase the size of the wire, since this would affect the size of the required terminations and the mating sizes of the masthead fittings, turnbuckles, and tangs. Inspection of the turnbuckles, tangs, and other fittings proved they were solid and in no need of replacement. This was good news, as those are expensive items to buy.

If I had to use 5/16 inch wire, all of my turnbuckles and chain plates, previously fitted with 7/16 inch pins, might have to be replaced or re-drilled to accept the larger pins that go with the larger wire.

Choices, choices

As I discussed in an earlier article (Good Old Boat, *May 1999*), the rigging on a boat is a system. The pieces are carefully orchestrated to work together. Change one size, and everything is affected. It began to look like I had to decide between 304 stainless steel wire for strength or 316 stainless steel wire with less strength but greater corrosion resistance. That was not an easy choice.

Doing further research, I found another type of rigging wire called Dyform. This wire has a different cross-section profile than stranded 1 x 19 stainless steel wire. It is made of 316 stainless steel and has 30 percent greater breaking strength and 25 percent less stretch than conventional wire. Because of its additional strength, a sailor can use a smaller diameter wire, create less windage aloft and have a smoother, aerodynamic shape. Unfortunately, it is also 50 percent more expensive.

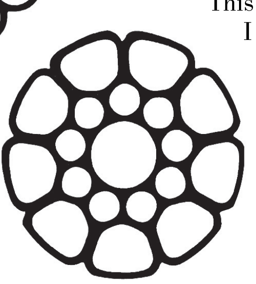


1 x 19 construction

In figuring out my needs for this project, I found the wire to be the least costly of the components needed to re-rig the boat. A 50 percent increased cost in the wire only added $300 to the total cost for the project. Calculated over a 10-year time span, $30 per year was a reasonable cost to pay for the increased strength and corrosion resistance of the Dyform wire.

I spoke with several rigging companies which concurred with my conclusion to use the more expensive Dyform wire. This decision brought its own set of complications. I considered duplicating the old rigging with swaged fittings, but this meant finding a rigging shop to do the swaging. I talked to the rigging shops of two national marine distributors, and they knew of Dyform but had not done much work with it. The Dyform wire has a smoother profile than conventional strand wire, and I worried about the mechanical grip a swaged fitting would be able to make on the hard (316 stainless steel) smooth finish of the wire.

Swageless it is



Dyform 1 x 19

This yellow brick road I was creating seemed to lead me to swageless mechanical rigging terminations such as Norseman or Sta-Loc. In the past, I had installed Sta-Loc and Norseman fittings on boats as large as 46 feet and was impressed with the design concept. On the opposite side of the coin, I had lost a backstay and a mast on a daysailer and on a 42-foot Gulfstar, each time when a swage failed. And a friend lost his mast when an upper swage let go on his Pearson 365.

The negative experiences with swaged fittings, combined with my concern over the suitability of Dyform wire for swaging made swageless fittings the clear choice.

The next choice was between a two-component swageless system and a three-component swageless system. The two-component system uses a cone to spread the wire and the top fitting to form the wire around this cone. *(See Norseman instructions on Page 20.)* The three-component system uses a wedge and a "former" to form the wire strands over the wedge with a screwed-on top fitting. *(See Sta-Lok instructions on Page 21.)* The two systems were comparable in price.

I chose Norseman's two-part system for simplicity (one less part — no former) and on the recommendation of a rigger with whom I had discussed the project.

Next, I attempted to place the order for the wire, terminals, and the biggest manual wire cutter I'll ever see with a marine discount house. All the items were in their 1999 catalog, and I was confident of success. Wrong! The person who took the order acknowledged that they were all catalog items, but were no longer being made. Hmmm.

I called the manufacturer's distributor who assured me they were, in fact, still being made. However, the 9/32 inch terminators with a 7/16 inch pin size (in the catalog) were no longer made. The termination was now 9/32 inch with a 1/2 inch pin size. I called the discount house which received the information with skepticism, but the representative promised to "look into it." Oh yes, the 9/32 inch terminators were indeed available with a 7/16 inch pin size.

I was getting a little nervous at this point, but the price was the best I could find, and the distributor was well known. I placed the order. Delivery was to be in 5 to 10 days.

I asked for a confirmation number for the order, but one "had not been assigned yet." I called back in five days to check and was told that they had "not placed the purchase order with the manufacturer yet, so the order

The project begins. In the photo at left, Bill, in foreground, enlists the talents and muscles of his son-in-law, John Cross, at left, and son, Chip Sandifer, in the middle. Above on facing page, Chip cuts and examines a wire bundle.

would be delayed." My calls to customer service were to a series of voice-mail messages that got me nowhere. I called two days after placing the wire order to buy new rope halyards. That order took 30 days to arrive. And it was only rope, just rope!

Finally, with ever-increasing frustration because I could not even talk to a real person to *cancel* the order, the wire and fittings arrived (35 days from the order date). The wire was correct, but the swageless fork terminals with the 7/16 inch pin size? They were 1/2 inch pin size. This would complicate a lot of things, but I'd waited too long to start over.

Oh, I almost forgot to mention the large (huge) wire cutter I ordered. They sent the largest pop rivet tool I have ever seen. When I called, they took eight hours to authorize the return of the tool. Shipping the correct wire cutter took another week. Finally, all was ready to fabricate my new standing rigging.

As luck would have it, my son and son-in-law arrived for a visit a week after the wire package arrived, so I had plenty of manpower. Even though we all read the instructions twice and had previously installed swageless fittings, we did not do well with the first eye.

The process itself

What the Norseman instructions do not tell you is to unlay left-hand twisted wire counterclockwise. If the wire were to have a right-hand twist, it should be unlayed clockwise. When the wire is unlayed, it should assume a tulip shape. *(See illustrations below.)*

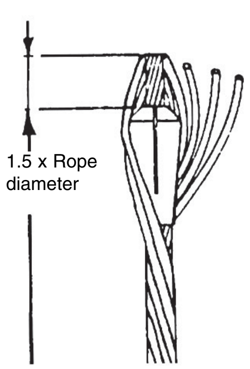
The cone should be positioned below the cut end of the wire a distance equal to one and one half times the diameter of the wire itself. Since I was using 9/32 wire, the cone needed to be 7/16 inch below the end of the wire. When cutting a length of wire, it is possible to cut it at such a point that the curve of the wire will conflict with the cone.

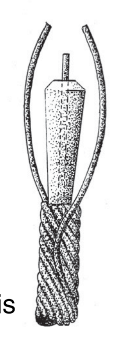
If this occurs, the cone needs to be pushed down into the bowl of the wire and an appropriate amount of wire trimmed from the cut end.

If the cone is too high, the wire will not form over the end of the cone. If the cone is too low, too much wire will close over the cone and the threaded bottom fitting will not be able to be mated with the top portion.

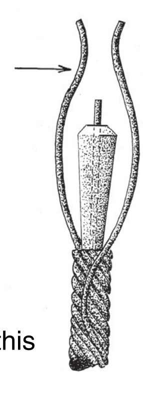
The information the instructions did not give us is to use a little bit of white grease when assembling the fittings so a strand of wire does not get caught between the top and bottom fittings and destroy both fittings. This happened the first time I tried to assemble a terminal on the wire. The way to avoid this is to use white grease and handtighten the top fitting into the bottom fitting. Screw the top down two threads, back off and look inside to see if the wires are forming inward over the cone. If they are, replace the top and tighten a little more, reverse and check. If the wires are not forming over the cone, use a small flat-bladed screw-driver to push the wires inward toward the center. Handtighten the top over the bottom fitting. Do not use wrenches at this point.

If it works, do it several times more, a little at the time, until all wires turn inward toward the center over the cone. Check one more time to be sure they are correctly formed. Then, use two wrenches to tighten the top and bottom together. They should be snug but not overly tight. The instructions advise you to turn only the top fitting if using lefthand laid wire and, if using righthand laid wire, turn only the bottom of the fitting. We followed this advice but still messed up the first fitting. Disassemble the fitting for the last time. Tap the bottom part of the fitting down, away from the cone and wire. Wipe the white grease from the wire and the fittings. Pull the bottom fitting into position over the wire and cone. Fill with 3M 4200 or similar non-acetic-acid marine sealant. Do not use a household bath sealant. They contain acetic acid. If it smells like vinegar, it contains acetic acid, which is harmful to stainless steel.

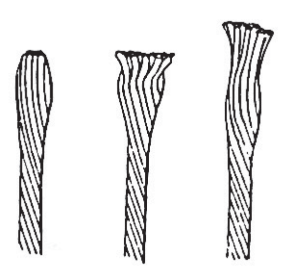




This



Not this



Yes No No

The first of these cuts will work. The second two must be recut.

Assemble the fittings and tighten snugly. Do not overtighten. The sealant should ooze out of the bottom fitting. Wipe it clean, and go on to the next fitting.

Measure twice, cut once

When I was figuring out the amount of wire I needed to buy, I measured the old wires from the centerline of the hole in the eye, or fork, to its corresponding point at the other end of the wire. I did not include the turnbuckles in my calculations. When all eight wire lengths had been added together, I added three feet to be sure I had enough. This added wire was a waste. When you think about it, if you cut a wire short, there is no way to add to it. It will have to be replaced, and the extra three feet will not help. Live and learn.

In measuring the new wire to be cut, I used the old wire as a template and cut it exactly to the length from where the wire bottomed out in the old fitting to the corresponding point at the other end, swage to swage. The extra wire I purchased, from centerline of eye to eye, was also a waste, although it was only a few inches per wire.

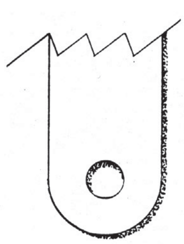
A concern I had when deciding on swageless fittings was their large size as compared to the aircraft fork and eyes used with the original swaged fittings. This should be investigated by anyone planning to re-rig with swageless fittings. Be sure you have room to utilize the larger termination. They were not a problem for me, but could pose a problem if mast tangs are very close to the mast surface without room to allow the larger fittings to be used.

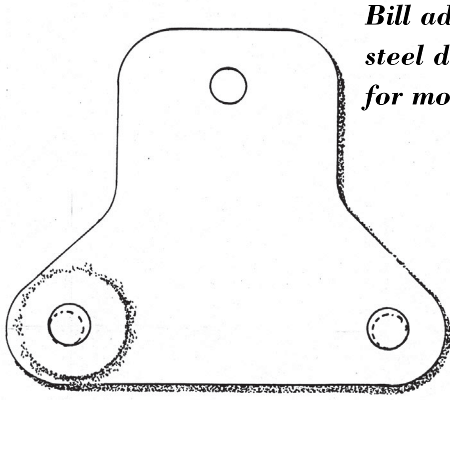
The problem of the 1/2 inch versus 7/16 inch pin for the fork fittings caused some grief as I had to drill out the 7/16 inch holes in the masthead tangs to fit the 1/2 inch pin size. Care must be taken when drilling larger holes to preserve the integrity of the tang. The rule is that the amount of material below the hole must be equal to the diameter of the hole. Thus a 1/2 inch hole needs 1/2 inch of metal between it and the edges of the tang. *(See illustration below.)*

The problem I had was with the tangs for the port and starboard lowers. If I re-drilled the hole to 1/2 inch, I would not have 1/2 inch of metal below and to the sides of the hole. I removed both tangs from the mast and took them to the machine shop where the machinist told me it would be "about impossible" to enlarge the hole up and inboard from the existing location, but he would try.

Using a milling machine, the machinist was able to enlarge the hole to 1/2 inch by taking material away from the edges. Even so, I still had only a 7/16-inch margin outboard and below each hole. I compensated by welding a stainless steel doubling washer to the tang to increase its strength. This is an ABS (American Bureau of Shipping) approved method of compensating for holes or hatches cut into steel plate for large steel construction jobs. I used a thick stainless steel 1/2 inch washer which was perimeter-welded to the tang. The large swageless fitting had room to accommodate the increased thickness.

Prior to re-rigging, my good old boat had 3/8 inch, 7/16 inch, and 1/2 inch rigging pins and 1/4 inch and 9/32 inch wire. Now it has 1/2 inch pins and 9/32 inch Dyform wire throughout. This was definitely an improvement. I think the previous owner owned stock in a silicone factory, because everything was coated in silicone — not bedded — coated. There was no way to determine the condition of the bedding for the mast step or chainplates except to remove all of the silicone and start over. I scraped the silicone from the fittings, cover plates, nuts, and bolts and re-bedded everything in 3M 4200, (similar to 3M 5200 but not a permanent adhesive sealer). A careful inspection of the clean parts showed them to be sound and not leaking. A tribute to silicone, I guess.





A machinist enlarged the hole in the tang to accommodate a larger pin. The new hole is off-center, in order to keep as much margin as possible around the outside of the hole. Bill added a stainless steel doubling washer for more strength.

While you're there

While the mast was horizontal, I pulled all of the old electrical wire out and replaced it with Ancor marine-grade tinned wire. I also rebuilt the foredeck light and bow light assemblies. The original rig had combination wire/rope halyards festooned with fishhooks. You needed gloves to handle them. I'm a firm advocate of all-rope halyards and purchased Sampson XLS 7/16 inch rope for the main and jib halyards. The go-fast crowd will bemoan the weight and windage aloft, but my boat will not feel any difference.

I also added mast steps while I waited for the new rigging since there is one bridge between my home mooring and the sea that we must pass under at less than high tide. With my wife at the helm, I can be at the masthead to make sure we'll clear the span.

Stepping the mast was supposed to be a non-event at the local shipyard, but at the last minute the cherry picker the yard uses to set masts quit, and I had to arrange for a truck crane to do the job. The smallest crane I could find was a 20-ton model. Overkill for a mast, perhaps, but it worked. The rigging fit as desired, and it was time for rig tuning and sailing.

Worth the effort?

I noticed a wide variation in prices between suppliers of identical products. It should be noted that the cost of swaged fittings is one half to two thirds that of swageless fittings, you have to add the labor cost to the swaged fittings. With swageless fittings, you can build your own rig at home with your own "free" labor.

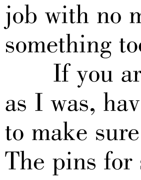
Is it cost-effective to build your own rigging? I think not. It is not very difficult work, but it is time-consuming. If you make just one mistake, it can ruin $50 to $100 worth of wire. The fitting we ruined cost $50 to replace.

In addition, there is the cost of the wire cutter at $140 to $160. If you do not do your own work, you will not need this tool unless you want it for emergencies aboard your boat. I wanted one for my boat anyway, so the cost is not a total write-off.

The cost to have a professional rigging shop do the work seems to be about $400 above the material cost for swageless fittings and about $300 above for swaged fittings. If you subtract the $140 to $160 for the wire cutter, the difference is quite small. For this amount, you get a warranted job with no mistakes. If the shop cuts something too short, they replace it.

If you are upgrading your rigging as I was, have the rigger visit your boat to make sure the new rigging will work. The pins for swaged fittings are much shorter than those for swageless. The fitting diameters may be correct for the wire, but may not fit up to the mast-mounted hardware. There are lots of things to think about before you start the work.

I'm proud of the new rigging I built, and I'm glad I did it. However, it took four times as long as I thought it would, cost almost as much as a professional job, and my fingers are just beginning to heal from the wire punctures which are an inevitable part of the process.



Bill Sandifer is a marine surveyor and small boatbuilder who's been living, eating, and sleeping boats since he first assisted at Pete Layton's Boat Shop building small wooden boats. He's worked for Charlie Morgan (Heritage), Don Arnow (Cigarette), and owned a commercial fiberglass boatbuilding company (Tugboats).

A second opinion

by Steve Lein

When I purchased my good old boat (a 1975 Glander Tavana), I expected to replace the standing rigging in three to five years. The surveyor inspected the lower shrouds and reported them to be in good condition. But he did not scale the mast to inspect the upper shrouds. After trucking the boat from Florida to Minnesota, I inspected the upper fittings before restepping the mast. The forestay protruding from the roller furling showed significant rust. Rerigging moved to the top of the worklist.

Never having worked on large standing rigging before, I checked out the local library's entire selection of rigging books. My boat, the *Yawl of America* is equipped with 1/4-inch wire shrouds with Norseman fittings. Nigel Calder's book, *The Boat Owner's Mechanical and Electrical Manual* (International Marine, 1996), had a detailed description of the Norseman fitting. It appeared to be within my capabilities. I removed the lower shrouds and brought them home to experiment (the boat is 250 miles from my home and shop equipment).

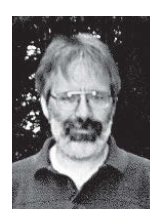
Norseman fittings are reusable except for the inner cone. I decided to totally replace the masthead fittings but to reuse the lower fittings. I ordered 300 feet of 1/4-inch 1 x 19 type 304 stainless steel wire, six complete Norseman fittings and 16 spare cones from Defender. The materials all arrived in just over a week. Unfortunately the Norseman fittings had to be exchanged because I failed to specify the pin diameter. The correct fittings showed up a week later.

Since half the work was to be done at the boat, the next step was to build a portable workbench. I mounted my shop vise on one end of a 3 foot 4 x 6 timber. (This has proved to be so handy that two years later it is still in use.) On the other end of the timber I built a wire cutting jig based on an idea from *Sail* magazine's "Things that Work." This is basically a piece of 2 x 4 with a hole bored through the center that is the same size as the wire. A simple strap clamps the wire in place. A saw cut at a right angle to the wire hole allows my Saws-all to make smooth cuts of the 1/19 wire. Smooth cuts are essential for success with Norseman fittings.

After carefully measuring the lower shrouds for the proper length, I disassembled the old Norseman fittings. With the terminal body held in the vise, I easily unscrewed the eye with a 12-inch crescent wrench. A tap with a two-pound hammer freed the terminal body from the wire. Using the old wire and terminals, I did a practice fitting. If you are careful, the outer strands of the wire will unlay smoothly. The cone is then placed over the inner strands (1 1/2 wire diameters from the end of the wire) and the outer strands are relaid over the cone. The terminal body and eye are then screwed together with 3M 101 sealant around the cone and Locktite on the threads. One of the old Norseman fittings cross-threaded on reassembly and had to be discarded. The key issues seem to be having a clean cut on the end of the wire and accurately placing the cone.

On the next trip up to the boat, I had the mast pulled and proceeded to rebuild the upper shrouds on site. The practice at home paid off, and the rebuild went smoothly. When disassembling the old upper forestay fitting, a single blow from the hammer shattered the wire. (Sometimes it pays to do preventive maintenance.)

I rebuilt the rigging myself for several reasons. First, I enjoy working on my good old boat. If I didn't, I would be better off chartering. I also prefer to be as self-sufficient as possible. I now carry materials on board to make emergency repairs to the standing rigging and have confidence in my ability to do the task. And it is always nice to save a little money. There is always some other task or toy needed on the boat to use up any extra cash. I would definitely do-it-myself again. In fact, I will next year when the mizzen gets the same treatment.



Steve's fascination with sailing began when he spent two years as a teenager building a Glen-L La Gatto sailboat before he had ever experienced the joy of sailing. Next came racing scows and finally his Glander Tavana 33-foot yawl. His latest project is a stitch-and-glue nesting dinghy, Danny Greene's Chameleon.

A note of caution

As we were putting this issue together, we encountered two situations in which Norseman swageless fittings were showing an abnormal amount of corrosion. In one case, this led to headstay failure. We asked Bill to investigate and comment on this:

by Bill Sandifer

The Norseman Gibb company, maker of the Norseman line of swageless terminations, experienced a material problem in 1996. A batch of the barstock from which Norseman manufactures the 1/4-inch and 9/32-inch terminations was mislabeled as 317L stainless steel when it was something else. This resulted in a number of terminations and body parts rusting and cracking.

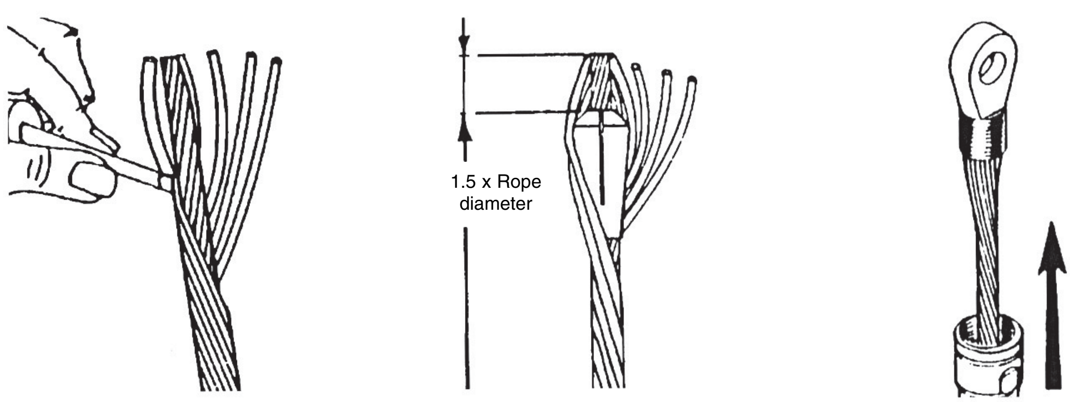
Since that time, the company has become ISO 9002-certified and has improved its quality system. According to Mark Swales, commercial director with Norseman Gibb, "The problem only relates to Norseman bodies sizes 1/4 and 9/32. Long before they crack, the bodies go very dull. If any of your readers spot this problem, they should contact their nearest Norseman agent, who will be aware of the problem, and we will replace all damaged parts."

Norseman Gibb has diligently replaced all defective terminations which have been reported, including the labor and parts required to put the rig to rights. Anyone with Norseman terminations purchased after 1995 should carefully inspect the terminations for signs of rust-colored blush on the outside of the fittings and contact the firm from which they ordered the terminations to obtain replacements.

It is unfortunate that this condition has occurred, but Norseman is responsibly standing fully behind their product with a full material and labor warranty. They are even providing toggles or long studs where required by the repair.

On another note, Norseman also distributes Dyform wire. Recently rolls of this wire have shown pinhead-sized spots of rust discoloration in the wire. This has been caused by tiny pieces of the carbon steel dies adhering to the

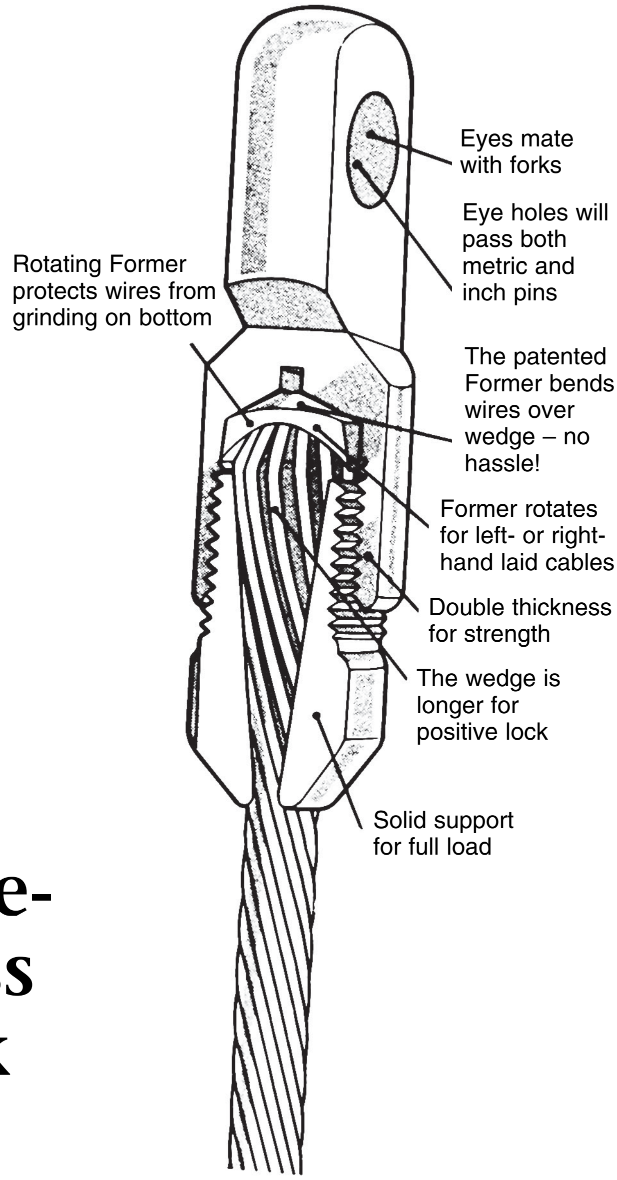
Instructions for two-component swageless fittings from Norseman



May be fitted without the use of special tools. Simply slip the body of the terminal over the full diameter of the cable. Unlay the outer wires and fit the cone over the center core. Re-lay the outer wires. Ease the ends of the wires into the head of the fitting. Draw the body up to the head and screw together. *(Note: One of the unfortunate characteristics of stainless steel threaded components is a slight risk of thread galling or seizing. On certain sizes of Norseman terminals, the male thread has been coated with a special anti-friction compound to eliminate the risk of thread galling or seizing. Care has been taken only to apply this coat to approximately half the threaded length, in order that there is sufficient uncoated steel for the recommended thread locking compound to take hold.)*

wire during the forming process. The spots are independent of the basic wire and do not affect the wire or its strength. Mark Swales says, "All wire, whether conventional or Dyform, does very occasionally suffer from a pickup problem during manufacture . . . it has no impact on the wire itself and does not affect performance. It does, however, spoil the look of a rig. We do not recommend using Naval Jelly or similar rust removers to remove the spots. Instead we recommend rubbing down with Scotchbrite or some similar abrasive medium."

Norseman Gibb is a company trying hard to support its customers with a full warranty when a problem occurs. They are doing their best in a difficult situation.

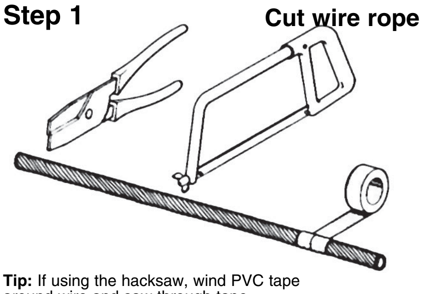


Instructions for three-component swageless fittings from Sta-Lok

Sta-Lok asks, "When ordering, please state clearly if terminals are for use with Dyform wire rope."

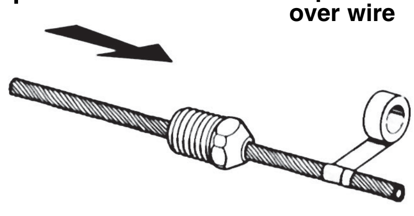
This company's step-by-step instructions are as follows:

Step 1 **Cut wire rope**



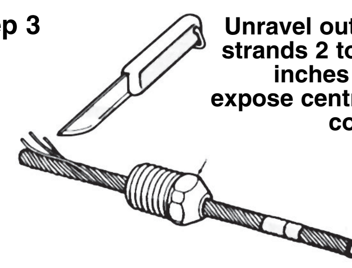
Tip: If using the hacksaw, wind PVC tape around wire and saw through tape

Step 2 **Slide socket component over wire**



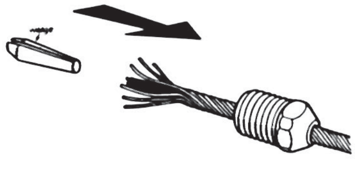
Tip: Wind PVC tape around wire approximately 12 inches from end

Step 3 **Unravel outer strands 2 to 3 inches to expose central core**



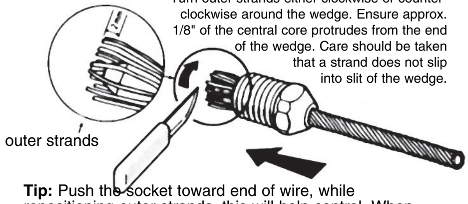
Tip: Use a penknife to prise initial strands out of position

Step 4 **Slide wedge component over central core of rope**



Step 5 **Reposition outer strands**

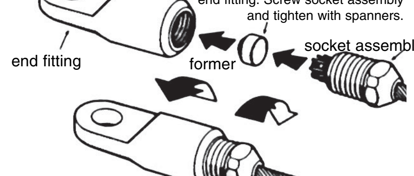
Turn outer strands either clockwise or counter-clockwise around the wedge. Ensure approx. 1/8" of the central core protrudes from the end of the wedge. Care should be taken that a strand does not slip into slit of the wedge.



Tip: Push the socket toward end of wire, while repositioning outer strands, this will help control. When wire strands are in position, push socket firmly, as indicated, to hold wires in position.

Step 6 **Final assembly**

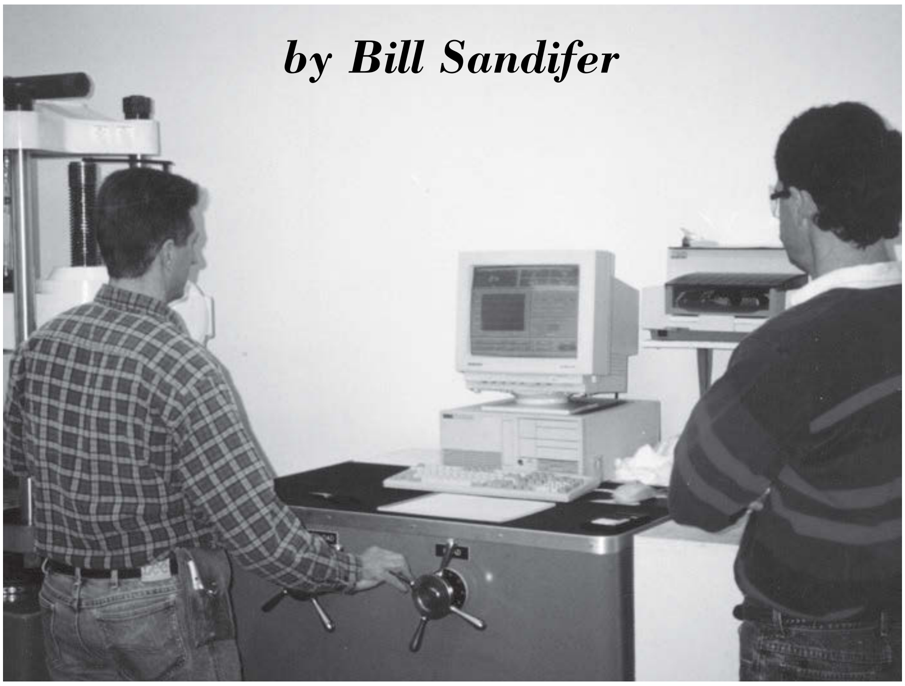
Ensure former component sits in bottom of end fitting. Screw socket assembly and tighten with spanners.



Tip: Undue force is not required to terminate the wire.

New swageless fitting shows

by Bill Sandifer



In my article "Do-It-Yourself Rigging," (*Good Old Boat,* September 1999), I said that after having rerigged my boat I was not sure it had been cost-effective to do it myself. I reasoned that, between the cost of the tools I bought and the cost of the swageless fitting I ruined (by getting a wire pinched between the upper and lower terminal and stripping the threads), I was close to the cost of having the job done by a professional rigger.

That opinion was based, to a large extent, on how time-consuming and difficult it was to assemble the swageless fittings I used.

Recently, I was contacted by *Good Old Boat* and asked to evaluate another fitting manufactured by a Danish company called Blue Wave. I wasn't aware of this fitting when I rerigged my boat. The new fitting promised to be much easier to use. So easy, in fact, that I had reservations about its ability to match the full strength of the wire.

Suncor Stainless is the sole importer of this part and collaborated on its engineering and development. They supplied a sample fitting and a length of 3/16-inch stainless-steel wire. The fitting looked first-class. In fact, it appeared to be the most robust casting of all the swageless fittings on the market. It was easy to install because the wire does not have to be unlaid, there is no cone to be inserted, and there is no bending of the wire over the cone. Total assembly time was under one minute. Very impressive. But was it strong enough?

ABS-approved lab, pictured at top, tests breaking strength of Suncor assembly. Suncor assembly, at far left, breaks at 107 percent of the wire's rated breaking strength. To assemble, simply slide the parts on the wire, leaving 5mm extended beyond the pressure ring. Screw the fitting together and tighten. Then tighten the lock nut. Finished assembly shown at left.

promise

Oil rigs

In a prior life, I was a construction superintendent overseeing the building of North Sea, semi-submersible, giant oil rigs. These are the brutes that work year-round in the harsh weather of one of the world's roughest bodies of water. As part of my responsibilities, I arranged for and witnessed stress-testing of "coupons" of steel cut from plate to be used in high-stress areas of the rigs. The purpose of the tests was to be certain that the material intended for use in the rig actually met the specifications called for on the drawings. I decided to test this new swageless fitting at a lab similar to the ones I used for the steel testing.

To conduct a fair test, I purchased a length of 3/16-inch, 316 stainless-steel, 1x19 rigging wire sufficient for several tests. I could cut the wire into pieces for each sample test. Each section of wire, therefore, would be the same. I also obtained equivalent-sized fittings from two other manufacturers who supply swageless fittings. The variable would be the fittings.

In a test of this type of assembly, it's expected that the wire will be the part that fails. It is also expected that the terminal will not weaken the wire where it's attached to the terminal. The wire used in the test has a breaking strength of 4,000 pounds, so that was the ultimate test goal.

When I arranged for the tests for the oil rigs, the lab had to be approved by the American Bureau of Shipping, as the rigs were U.S. flag vessels and built to a class certification to comply with the ABS rules. I located an ABS-approved lab in Baton Rouge, La., to run the tests.

Overkill

Quality Testing Inc., run by Dale Delaville, has all the required equipment, fully certified, to pull a load of up to 120,000 pounds of force on a sample. A little overkill for my needs, perhaps, but they agreed to do the tests.

One problem we discussed was how to secure the standing part of the wire so we did not pointload one small section of wire. The solution was to build a loop in the wire with two Nicopress compression fittings and a stainless-steel wire clamp backup. A three-inch, heavy-wall piece of pipe was slid through the loop and formed the top secure point of the standing part of the wire.

To secure the fitting to the test stand, we machined a piece of steel plate with a hole in it to receive the pin of the fork from the fitting. I had Charley, a master rigger from Sintes Boat Works, in New Orleans, make up a swage fitting on another section of the same wire so we could test it, along with the other two fittings, as a part of the baseline. Charley has rigged many of the raceboats in the New Orleans area for the past 30 years.

What does all this mean?

by Jerry Powlas

When we asked Bill Sandifer to evaluate the Suncor terminal we half expected him to say, "It's too easy to be true." He could simply have presumed that these things worked as claimed, but he's a cynic. He has had his share of surprises with rigging terminals. So he ran tests.

To provide a proper baseline for the test, he tested the two other swageless terminals he knew of, Norseman and Sta-Lok, as well as a C. Sherman Johnson Co. swaged terminal, with the swaged wire assembly professionally made.

The swaged terminal, as well as the Sta-Lok and the Suncor swageless terminals, passed the initial round of tests by breaking at a load slightly in excess of the wire's rated ultimate breaking strength. The Norseman terminal failed at 69 percent of the wire's rated ultimate breaking strength. When the supplier was contacted concerning this, they offered to supply another terminal and wire assembly made up by their own staff. This terminal and wire assembly also failed the test, breaking at 80 percent of the rated breaking strength of the wire.

There are very narrow limits to what can be inferred from testing only one sample assembly of each terminal (or in the one case, two samples). Many samples of each terminal would need to be tested to make definitive statements about the performance of these parts. At nearly $100 a test sample, we were not inclined to do that, although we hope the manufacturers of these critical parts are so inclined.

Not significant

Respecting these narrow limits, it should be said that the differences in the ultimate breaking strength of these assemblies (the highest load before failure) are not significant in the case of the three assemblies that had ultimate strengths higher than the wire rating. If the terminal functions properly, the test becomes a test of the breaking strength of the wire, not the terminal. This is true even in cases where the wire deforms and pulls out of the terminal without breaking.

In the cases of the two Norseman terminal-and-wire assemblies that failed to reach the breaking strength of the wire, many explanations are possible. Without more evidence (more testing to achieve statistical significance and professional engineering evaluation of the failures), it is not fair to speculate.

One of the appeals of swageless terminals is that they do not require a (very expensive) swaging machine, so they allow the boatowner the opportunity to do this job personally. If spare wire and terminals are carried, it's even possible for the owner to make repairs in remote ports, or in a worst case, at sea.

There are many critical attributes to a swageless rigging terminal. It must be consistently strong, corrosion-resistant, and affordable. If it's to be offered for use by amateurs, it must also be easy to use, so that the likelihood of proper and satisfactory assembly is extremely high. We tested only a few samples, so our opinion must be tentative, but this evaluation certainly suggests that the Suncor terminal is extremely easy to use. Bill considered the Sta-Lok terminal easier to use than the Norseman terminal. In at least some instances, the Norseman terminals may not be able to allow the full strength of the wire to be utilized.

Jerry is Good Old Boat *technical editor.*

Continued from Page 22

The fittings were ready, and the lab was all set. The first fitting to be tested was the "baseline" swage fitting. One of the functions of the test machine is to monitor and record the loads as they are applied to the test specimen. If you look at the first graph (Test 1), you will see that the swage fitting held onto the wire to a peak load of 4,112 pounds before slipping. The wire did not break; it pulled out of the fitting. This was a successful test as the wire breaking strength was rated at 4,000 pounds, and the fitting exceeded that load. The other two fittings were tested to verify the baseline. One test was satisfactory, and one tested well below the breaking strength of the wire. (This terminal brand was retested at a later time with an assembly made up by the supplier. It also failed the second test.)

Held the load

The new Suncor fitting was next in line. The graph (Test 4) for fitting number four shows that the Suncor fitting held the load all the way to 4,278 pounds, 166 pounds higher than the swage fitting. This assembly also successfully passed the test. Not only that, but the outer strands of the wire actually broke, leaving the inner core of the wire attached to the fitting. I do not think the inner core would support too much load, but it did stay together. This was true of one other type of swageless fitting we tested as part of establishing the baseline.

If a picture is worth a thousand words, the accompanying pictures tell a great story of a new fitting on the market that gives good old boaters an easy way to repair or replace the standing rigging on their pride and joy.

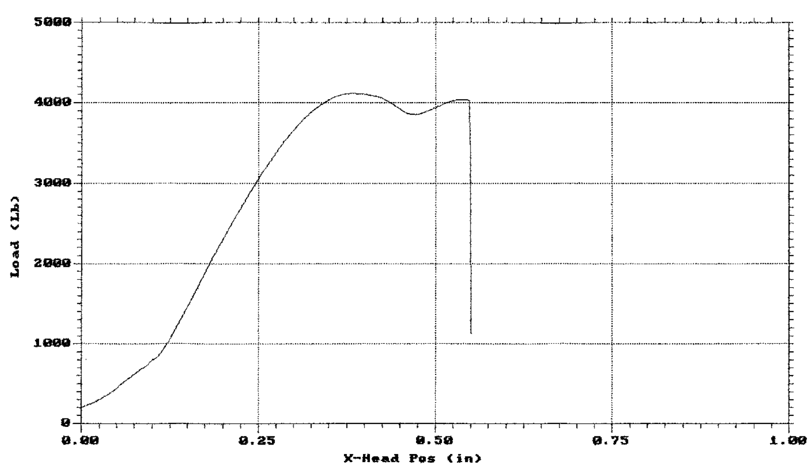
The Suncor fittings have some qualifiers that must be observed. They should be used only with the specific size of wire for which they are made — and they are not made for all sizes of wire. The 9/32-inch Dyform wire on my boat does not have a corresponding fitting from Suncor. The closest is 5/16 inch, so I could not have used these fittings with the wire I chose. It is imperative that the directions be followed carefully as to the length of wire to protrude above the inner wedge and pressure ring. Other than that, the fitting is easy to use and has proven itself under a verified load.

For more information, contact Suncor Stainless, 7 Riverside Drive, Pembroke, MA 02359, 781-829-8899, <http://www.suncorstainless.com>.

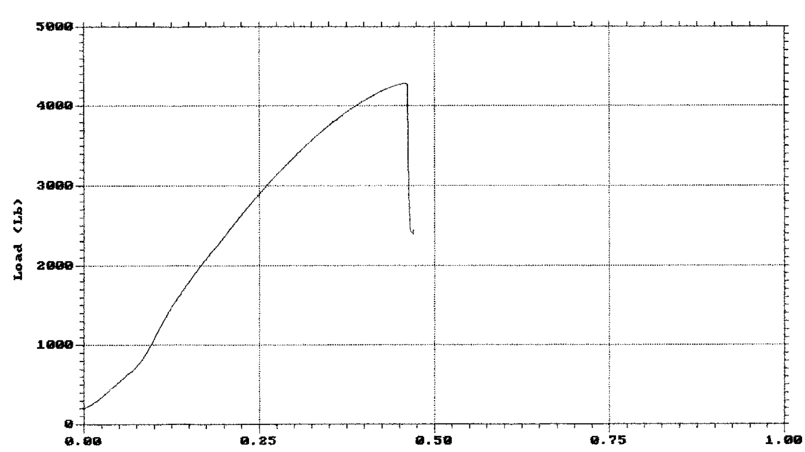
Bill Sandifer is a marine surveyor and small boatbuilder who's been living, eating, and sleeping boats since he first assisted at Pete Layton's Boat Shop building small wooden boats. He's worked for Charlie Morgan (Heritage), Don Arnow (Cigarette), and owned a commercial fiberglass boatbuilding company (Tugboats).

Suncor terminal parts, shown above. Serrated jaws are held together by the O-ring during assembly. Below are stress curves for the swaged fitting which served as the baseline (Test 1) and the Suncor fitting (Test 2). Both passed the test by exceeding the breaking strength of the wire (4,000 pounds).

Test 1



Test 4



Wedging the mast

A small project that brings satisfaction and pride

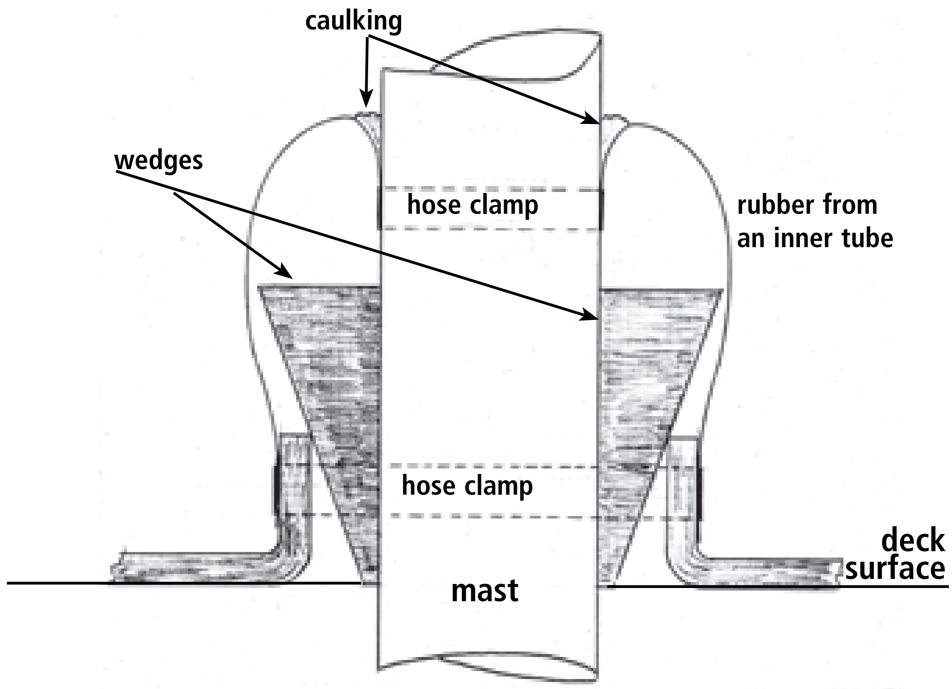
by Norman Ralph

An acquaintance raised the question concerning those little wedges that hold the mast in column on many boats. On a recent sail in blustery conditions, the wedges on his boat worked loose and fell into the cabin. He wanted to know how to prevent this from happening again.

An area of boat maintenance that is often overlooked is where a keel-stepped mast passes through the deck. Perhaps the boatyard takes care of this when the mast is stepped. But don't count on it. In my case, the yard stuck the mast in the boat, attached the shrouds, tightened them sufficiently so the mast would stay in place, and left the rest for me to do when the boat was in the slip.

I was left with tuning the rigging and the more pressing job of wedging the mast. If the mast is not wedged snugly it will "work" or flex under the varying loads on the sails. This flexing can weaken the mast. The common solution is to drive rubber wedges between the mast and the flange (a turned-up edge around the hole where the mast passes through the deck). On my boat this flange is 3 inches high.

A newer technique is to use Spartite. After placing a temporary bottom or floor below deck around the mast in the overhead, Spartite liquid is poured around the mast from above. After this liquid hardens, the temporary bottom is removed, the mast is held in place, and leaks are prevented. The precaution to observe in using Spartite is to be sure that the area between the mast and the deck flange has a slight taper outward toward the top of the mast. If it does not or is tapered the opposite way, it will be difficult or impossible to remove the mast without chiseling the Spartite out, as it adheres tenaciously to the mast. With the proper taper, the Spartite will come out with the mast and can be reused when the mast is re-stepped.



Time-honored

I use the time-honored rubber wedges on our boat. Since I bought our boat as a project boat, it didn't come with wedges. So I went to a store that carried rubber products of all types and purchased a piece of rubber mat from their scrap supply. (Shore hardness 40 to 50 is good.) This material was a foot square and 2 inches thick. With the mast centered in the hole in the cabintop, I had approximately 1¼ to 1½ inches between the mast and the flange around the hole. I marked and cut the rubber, using a band saw, into wedges approximately 2½ inches at one end tapering to ¼ inch at the other end (*see sketch on Page 50*). The wedges were approximately 6 inches long. The piece of rubber yielded 16 wedges, far more than needed for the boat.

I tuned the rig first and then loosely placed four wedges, one on each side of the mast. Then I used a rubber mallet (you could use a piece of wood and a hammer) to drive the wedges in tight. Be sure to drive them evenly, each a little bit at a time, alternating sides. This will ensure that the mast stays straight. After the mast is securely wedged, drive in an additional wedge on each side adjacent to the first ones. More can be installed if desired, although it might be overkill.

To prevent water from leaking below, I went to a tire store and purchased a truck-sized inner tube. A used one will work as well as a new one. In this day

About that rig . . .

- Record rig "tune" before you pull the mast.
- Record location of any shims between the mast and the step.
- Tune the rig fore and aft and side to side before wedging the mast.
- Some kinds of rigs may benefit from wedges fore and aft as well.

Refer to *Illustrated Sail and Rig Tuning* by Ivar Dedekam for details on rig tuning.

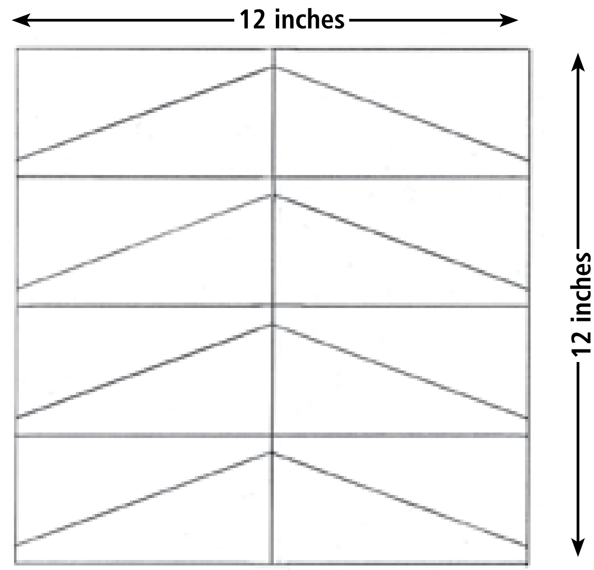
of tubeless tires, inner tubes are harder to find. I cut the inner tube into a piece approximately 12 inches wide and a length equal to the perimeter of the flange on the deck around the mast plus several inches. Using a large stainless-steel hose clamp, I wrapped the rubber from the inner tube around the mast with the bottom of the rubber approximately 8 inches above the deck, I fastened the bottom of the rubber securely with the hose clamp. Then I folded the rubber down over the hose clamp and over the deck flange. I attached a second hose clamp, securing the rubber to the deck flange. If you can't get long enough hose clamps, hook two or more clamps together to get the proper length. Using a tube of silicone caulking and a caulking gun, I liberally caulked the top of the rubber where it folds back over the top hose clamp next to the mast. This will keep water from seeping down the mast past the rubber and hose clamp.

To cover up the unsightly black rubber boot, I took a rectangular piece of Sunbrella to match the canvas on the boat and hemmed it on all four sides *(see sketch below)*. After hemming, the piece was approximately 12 inches by 1½ times the perimeter of the bottom of the rubber boot. I stitched a 3-foot piece of ⅛-inch Dacron line on the outside of each long side of the canvas close to one end. The canvas was then wrapped around the rubber boot, the end without the Dacron line placed first and overlapping itself to ensure complete coverage. Then I wrapped the Dacron line around the cover and tied it with a square knot.

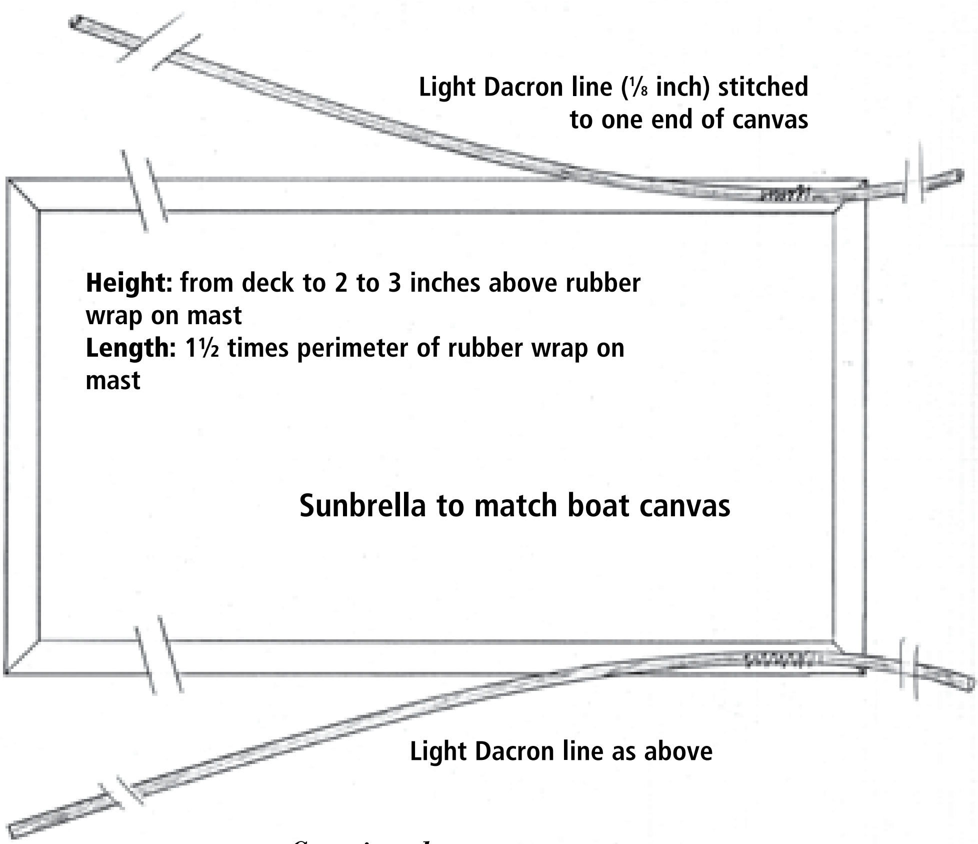
This completely covers the rubber boot and leaves a waterproof, yet attractive, finished look. The silicone sealant is also protected from deterioration from the sun.

When pulling the mast, all that is needed is to remove the canvas cover and the bottom hose clamp. When the mast is pulled, the wedges will come loose and can be collected for reuse.

This is not a high-tech project, but it is one that will give much satisfaction and pride. And that is part of the enjoyment of owning a boat.



Cutting the wedges. Yield: 16 wedges.



Creating the canvas cover

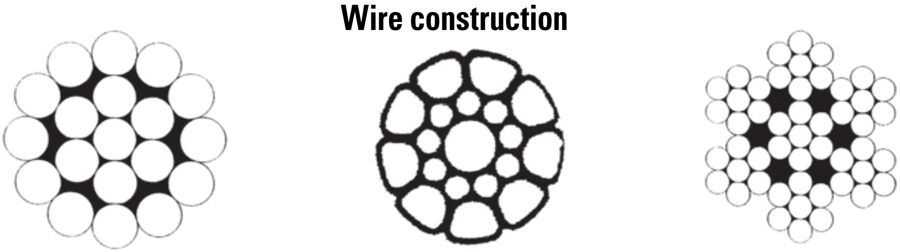
A 1988 trip to the Gulf Coast exposed Norman and his wife, Jeanette, to year-round sailing and sowed the seeds that initiated early retirement and a move to Lake Pontchartrain in Louisiana. Norman is able to rest in peace knowing his boat won't leak (at the mast anyway).

Standing rigging

How changes can affect the strength of a rig

by Ted Brewer

Wire construction



1 x 19 | Dyform 1 x 19 | 7 x 7

In recent weeks I've had several inquiries from boatowners asking for advice on mast rigging. Their questions prompted me to write a few words on the subject. One of the queries was the advisability of switching over to the newer, more corrosion-resistant, type 316 alloy stainless-steel wire. Another dealt with the benefits of increasing the wire diameter from ¼ inch to 5⁄16 inch on a boat that needed new rigging. These questions were easily answered. In both cases, my reply was, "Don't do it." The reasons are simple but perhaps not obvious unless you are a professional rigger or have been involved in design. First, a bit of background on yacht rigging.

A group of wires concentrically laid about a central wire is termed a "strand." The usual number of wires in a strand of yacht rigging is 7 or 19. A single strand, or a group of strands, forms a "wire rope," or "cable." Wire rope is designated by the number of strands, plus the number of wires forming each strand. The three basic types of wire rope (sometimes just called wire) used for standing rigging are shown above. The most commonly used wire rope in a yacht's standing rigging is 1 x 19 construction, which means that it is made of one strand, composed of 19 wires in all, twisted around a central core. This produces a rather stiff and strong wire rope.

Traditional yachts often use 7 x 7 wire, composed of seven strands, each of seven wires, as it can be spliced around deadeyes, blocks, or cast thimbles. It can also be swaged. It is much more flexible than the stiff 1 x 19 wire, so it's often used for running backstays.

Even more flexible than 7 x 7 is 7 x 19 wire, seven strands each of 19 wires, but it is not used for standing rigging. It was long the standard for halyards as its great flexibility allowed it to be run over masthead sheaves. But 7 x 19 tended to develop "meat hooks" (protruding wires) with wear, and these took many a long, painful slice out of a crewman's hand, including mine. Fortunately, wire rope has been largely replaced for halyards by the development of low-stretch synthetic ropes and, as one of its numerous victims, I do not regret 7 x 19's passing.

More metal

Dyform wire rope is available in 1 x 7 construction in 3 mm and 4 mm diameter for dinghies and in 1 x 19 construction in larger diameters for yachts. As is evident in the illustration above, the Dyform wire simply packs more metal into a given diameter due to the unusual shape of the individual wires. This makes it both heavier and stronger for any given diameter or, conversely, slimmer and with less wind resistance for a given strength. It is also considerably more expensive. One company prices 6 mm Dyform at more than three times the cost of ¼-inch type 304 wire. Note that Dyform comes only in metric sizes.

Stainless-steel rigging wire for marine applications has been commonly made of type 304 alloy. This alloy contains 18 percent chromium and 8 percent nickel and is often termed 18-8 alloy. Type 304 has a lower carbon content than the similar type 302 alloy and thus has somewhat greater corrosion-resistance. Type 304 wire is relatively inexpensive, strong, and resists corrosion quite well. However, it does develop rust stains over the years.

Indeed, it is particularly prone to failure in swaged fittings in warmer tropical waters, as it suffers from crevice corrosion. The corrosion starts just inside the neck of the swaging, where the water can seep in. It eventually expands to a point where the swaging starts to split and peel like a banana. Complete failure is the inevitable result and often ends in the loss of the mast, unless the rigging assembly is replaced in time.

The more corrosion-resistant type 316 stainless steel is made by adding 2 percent molybdenum to the other components of the metal. Unfortunately, type 316 is weaker than type 304, as is shown on the breaking strengths chart on Page 18, and cannot be used size-for-size to replace type 304 wire. It is necessary to increase the size, and this is not always feasible for reasons that will be shown. There is also the matter of cost. For example, ¼-inch type 316 will replace 7⁄32-inch type 304 but costs 80 percent more. The need for larger end fittings and other hardware will add to the cost as well. The question you must ask yourself is, "Will it last 80 percent longer?" I have to doubt it.

Cheaper but weaker

Galvanized wire is the least costly wire rope and can prove durable if properly maintained. Galvanized plow-steel wire is considerably weaker than stainless steel, but I have older catalogs showing galvanized aircraft cable in both 1 x 19 and 7 x 7 construction with strengths comparable to that of type 304 stainless. However, aircraft cable may not be readily available today.

> **“Fortunately wire rope has been largely replaced for halyards … and, as one of its numerous victims, I do not regret 7 x 19’s passing.”**

Still, many handsome character yachts are happily sailing around our waters with galvanized 7 x 7 plow-steel rigging, properly sized for the loads, of course.

The secret to giving galvanized wire rope a long life is to soak it in a trough containing boiled linseed oil and then letting it dry before it is set up. After that, slush it down annually with a rag soaked in the oil. I have inspected galvanized 7 x 7 rigging close to 15 years old that was still in good condition as a result of this treatment.

The table below shows strengths of wire rope in the various diameters and materials. The difference in strength between type 304 and 316 alloys is quite substantial so it is, obviously, very dangerous to substitute 316 for 304 of equal diameter. The 7 x 7 wire is weaker still, so traditional rigs need to be given an increase in diameter also. This adds windage, of course, but that is rarely a major concern to the skipper who is in love with the gaff rig.

Since Dyform wire comes only in metric sizes, some compensation in diameter may be necessary. Also Navtec does not recommend the use of Dyform wire with hydraulic backstays due to the reverse lay. The wire tends to unwind with tension, and this has shown to result in undue stretch.

Hayn makes swageless terminals with specific cones to suit the Dyform wire. If swaged terminals are used, they must be purpose-built for metric wire.

The reader is cautioned that swaging Dyform is a controversial practice, and some riggers will refuse to do it. The concern is that there is not sufficient room for the metal to flow. Also, above 10 mm, the strength of the swaged fitting will be less than the wire because the commonly used milspec limits the wall thickness of the swage fitting for other reasons.

Designed for bronze

The illustration on Page 61 shows the measurements of marine-eye terminals as used on so many of our boats from the 1960s into the 1980s, and even today. These terminal dimensions were, in all probability, originally designed for the old bronze, hot-zinc socketed terminals (still a great end fitting if you can find them) and continued on unchanged through the era of the stainless-steel swaging. The terminal sizes shown are also similar to those available in swageless terminals.

Just to confuse you, I noticed in a recent catalog that the swaged marine eye for 5/16-inch wire is now available to fit a ½-inch diameter pin as well as the more usual 5/8-inch pin. I checked it out on my calculator, and the smaller pin is adequate for 5/16-inch diameter 1 x 19 wire, but the yield strength of the pin is too close to the 12,500-pound breaking strength of the wire to suit me. I have to believe the original designers knew what they were doing when they specified the pin sizes, and I do like to see some more meat around parts that are subject to considerable wear and corrosion.

When it comes to turnbuckles, I was surprised to see that one manufacturer makes an open body stainless-steel turnbuckle which, it says, can be used with 3/16- to ¼-inch wire. It has a 3/8-inch pin, and the manufacturer lists the breaking strength of the turnbuckle at 8,000 pounds, which is below the breaking strength of the ¼-inch wire. Also, some stainless-steel, tubular-body turnbuckles are made with odd pin sizes, such as a turnbuckle for ¼-inch wire also fitted with 3/8-inch pins. I certainly would not use them on my boat or recommend them to a client going offshore. It’s definitely a case of “buyer beware.” A close study of the catalogs is necessary.

Pin size problem

Earlier I mentioned a problem in going to a larger-size wire diameter. The problem lies in the pin sizes. For example, the man who wanted to go from ¼-inch wire to 5/16-inch did not realize that the terminal pin size would increase from ½-inch to 5/8-inch. That would mean the chainplates and the mast tangs would have to be reamed out to the larger diameter with a commensurate loss of strength. It might be safe or it might not, depending on how generous the designer was in specifying the original chainplate and tang dimensions.

Of course, today you can buy a 5/16-inch terminal with a ½-inch pin, but I would not go that route. Instead, I suggested that my client increase to 9/32-inch wire that is 25 percent stronger than the original ¼-inch, yet still uses the same ½-inch pin. Similarly, in upgrading from type 304 to type 316 wire, you must increase the wire

Wire rope breaking strengths in pounds

Diameter in decimal inches		1 x 19 ss 304	1 x 19 ss 316	1 x 19 ss Dyform	7 x 7 ss 304	7 x 7 galvanized plow steel
.0625	1/16″	500				330
.0938	3/32″	1,200			920	735
.1250	1/8″	2,100	1,780		1,700	1,300
.1563	5/32″	3,300	2,500		2,400	2,020
.1875	3/16″	4,700	4,000		3,700	2,900
.1969	5 mm			5,294		
.2188	7/32″	6,300	5,350		5,000	3,930
.2362	6 mm			7,828		
.2500	1/4″	8,200	6,900		6,400	5,108
.2756	7 mm			10,826		
.2813	9/32″	10,300	8,700		7,800	
.3125	5/16″	12,500	10,600		9,000	7,933
.3196	8 mm			13,500		
.3750	3/8″	17,500	1,480		12,000	11,340
.4375	7/16″	22,500			15,600	15,340
.5000	1/2″	29,700			21,300	19,930

Note: Wire manufacturers’ catalogues list “galvanized aircraft wire” as having essentially the same strength as stainless-steel 304 of the same diameter and construction.

diameter to obtain the same strength and, again, the problem of incompatible pin sizes crops up. You would have to increase to ¼-inch type 316 wire to get strength equivalent to 7/32-inch type 304; then the pin size of the terminal jumps from 7/16-inch to ½-inch. It is quite probable that the chainplates can be safely drilled out to suit, but there's no way to guarantee it without measuring and calculating carefully.

In some situations, custom-made fittings will solve problems caused by changes in the rigging schedule of a yacht. Rigging Only can supply some custom fittings. If you go this route, you may want to buy extras because replacements will be hard to find.

Even more confusion exists when you get into "aircraft" terminals. These terminals are available in both jaw and eye type, but use a smaller pin than marine eyes. A ¼-inch "aircraft" eye uses only a ⅜-inch pin, instead of a much more robust ½-inch. The fork-style terminal is often used with single-plate mast tangs, instead of the more common double-plate tang, and I would avoid these like the plague on any boat much larger than a daysailer.

Not cost-effective

I do not include rod rigging as I have not used it to any extent on my yacht designs, and I do not find it to be cost-effective for the typical cruising sailboat. Rod does have advantages of excellent corrosion-resistance, lighter weight, and smaller diameter for less windage. Its main disadvantage is that it can fail unexpectedly, as the signs of failure are difficult to detect. If you are a serious cruiser/racer you may find it to be affordable and advantageous for your sport. If so, I would suggest that you contact an experienced rigger for advice and an estimate.

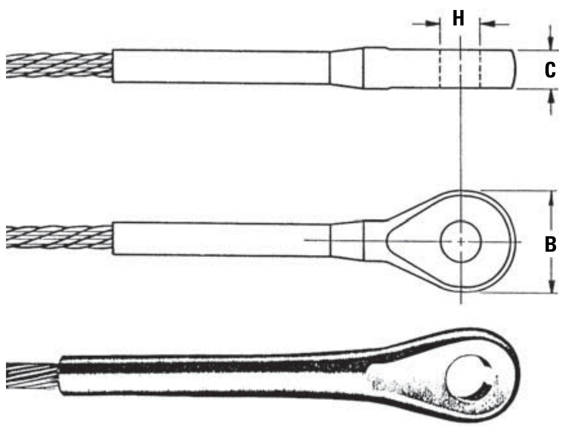
I would add one note. It is obvious that shrouds can slat around considerably when they are on the lee side of the yacht. Most sailors realize that toggles must be fitted to prevent damage to the turnbuckle from the banging around. The other alternative is to use toggle-type turnbuckles. However, few sailors think about the ends of the fore and aft rigging and, here, toggles are recommended at both the top and bottom on all headstays in order to allow for the twist of the catenary under a press of sail.

Finally, regular inspection with a very strong magnifying glass is essential to head off rigging problems. Rust is the first sign of a potential failure in stainless steel. The use of a penetrating dye is particularly helpful in detecting minute cracks in swagings, turnbuckles, and toggles. Careful polishing of the rigging can eliminate the small pits that allow corrosion to get a start.

Remember that like a chain, standing rigging will be as strong as the weakest component in the path of tang, fitting, pin, wire, fitting, pin, chainplate. There is nothing gained by upgrading only one of these "links," and everything is downgraded by making any of these parts weaker.

Rigging terminal dimensions in inches

Wire diameter	B	C	H	Pin size
3/32	.625	.219	.260	1/4″
1/8	.625	.219	.260	1/4″
5/32	.750	.281	.323	5/16″
3/16	.875	.344	.385	3/8″
7/32	1.000	.406	.448	7/16″
1/4	1.125	.469	.515	1/2″
9/32	1.125	.469	.515	1/2″
5/16	1.375	.594	.640	5/8″
3/8	1.375	.594	.640	5/8″
7/16	1.625	.719	.765	3/4″
1/2	1.875	.844	.890	7/8″



Resources

Rigging Only
508-992-0434, <http://www.riggingonly.com>

Hayn Enterprises
800-346-4296, <http://www.hayn.com>

Navtec
203-458-3163, <http://www.navtec.net>

Bowsprits,

Tried and trusted old fittings give character to modern yachts

by Donald Launer

bumpkins, *and*

IF YOU REMEMBER WHEN ALL sailboats had wooden spars, manila lines, galvanized fittings, and cotton sails, chances are you have problems with your waistline, your hairline, and the number of teeth you can call your own. Those of us who fit this category have a special feeling for those sailboats of our youth, but those fond memories don't include the maintenance involved in boats of that period.

When people see our schooner sail by, they see a boat from the turn of the century: a schooner rig with bowsprit, figurehead, bumpkin, belaying pins, wooden blocks, bronze portholes, lazy-jacks, and a graceful sheer. Yet she's only 21 years old, with fiberglass hull, aluminum spars, and modern conveniences throughout — a modern version of a small Down East schooner of the last century. She's one of the breed sailors call "character boats," befitting her skipper. Boats such as this are the "rediscovery" in fiberglass of traditional cruising boats, such as schooners, catboats, Friendship sloops, and other designs from the past.

While the conscious mind is thinking, "She looks dated . . . slow," sneaking into the subconscious are thoughts of coastal trading, Tahiti, and the whole mystique of other times, faraway places, and nostalgia. But traditional beauty doesn't necessarily mean being impractical.

Bowsprits

Take the bowsprit, for example. On our schooner it provides a sailplan longer than the boat's hull. With a lower center of effort there is less heeling, and more sail can be carried. This translates into drive power.

When tied up at a mooring buoy in an area with wind, current, and tide changes, a "bull rope" from the tip of the bowsprit can prevent the hull from striking the mooring buoy. This bull rope consists of an extra line from the ring of the buoy to the tip of the bowsprit, with just enough tension to keep the mooring buoy away from the bow.

Bowsprits traditionally found homes on cruising boats, but then for several decades they were abandoned. In the last few years, a resurgence in the use of bowsprits has occurred in reproductions of old designs as well as in the racing classes that allow them. With a bowsprit, more of the headsail is free from interference by the main, and in fresh winds the center of effort, which is farther forward, reduces weather helm and pressure on the rudder.

In many racing boats, the bowsprit is made retractable, either into the hull or along the deck, and unguyed carbon-fiber bowsprits are now emerging on the scene.

Our solid teak bowsprit provides a perfect platform on which to sit and watch the bow wave or the dolphins. Besides, without a bowsprit where would we put the figurehead?

Figureheads

A millennium before Christ, the Egyptians carved the heads of deities on the bows of their ships, and the Romans, Greeks, and Phoenicians carried on this tradition, dedicating their ships to their gods and goddesses in the hope of ensuring safe voyages. The "dragon ships" of the Vikings were adorned with menacing snarling dragon heads carved from oak which were intended to terrify the raiders' victims and to guard against evil spirits at sea. The power of figureheads was thought to be so great that at one time Iceland insisted that foreign ships remove them before entering her waters.

Captain Bligh reported that the Tahitians were fascinated with the figurehead on the *HMS Bounty* (*see photo on Page 48*). He described it as "a pretty figure of a woman in a riding habit," who was lifting her skirts over the seas with her right hand as she looked ahead of the ship. This painted likeness was the first representation of an Englishwoman the Tahitians had ever seen. Bligh wrote: ".-.-. and they kept gazing at it for hours."

Although a century or two ago figureheads became merely ornamental, many American commercial, and even Naval, ships were still sent to sea with elaborate carvings at their bows. The frigate *Constitution* was launched in 1797 adorned with a bust of Hercules. But Hercules was not up to the foray with the Barbary Coast pirates at Tripoli, where the figurehead was destroyed.

Our schooner, *Delphinus,* is named for the constellation of the dolphin and, therefore, sports a carved teak figurehead of a leaping dolphin beneath her bowsprit (*pictured at left above*). It serves not only as a decorative appendage, but also as a bowsprit brace. It's a great hit both on the water and at dockside. It seems to have a special attraction for children.

As enlightened sailors, we know our figurehead is purely decorative, yet sometimes there's the feeling of a "presence" at our bow, guiding us through foggy and unfamiliar waters.

Belaying pins

Another rare item on sailing vessels nowadays is the belaying pin. The closest most sailors come to them is during visits to the tall ships or when watching a deck fight in an old pirate movie. Who would think of using them on today's craft? They're out of fashion, impractical and archaic … and I love them.

"In the last few years, a resurgence in the use of bowsprits has occurred in reproductions of old designs as well as in the racing classes that allow them."

In the olden days, belaying pins were made of hardwood, usually locust, and sometimes bronze, iron, or brass. They were used to secure and store lines, particularly the running rigging. Securing a line to a belaying pin is the same as to a cleat. The added advantage is the speed and ease with which a line that is belayed, or made fast, can be released. When the pin is pulled, the line falls to the deck in an untangled flaked-out pattern, ready to run freely.

Belaying pins are used to provide increased friction to control a line by taking a single round-turn and one or more "S" turns around the pin. This is to "belay" the line. When a single hitch or slip-hitch is added to the belayed turns, the line is "made fast" (*see diagrams on Page 48*).

The large sailing ships of yesteryear frequently set their belaying pins in holes in the "pin-rail," which was fixed inside the bulwarks or incorporated as part of the bulwark or main rail as in the photo below. Short pin-rails, fastened to the standing rigging are called "pin-racks," and around the mast on deck, rectangular or U-shaped racks, called "fife-rails," are used to make fast and store halyards. A variation of the fife-rail is used on modern sailboats, where the mast pulpit is combined with a small pin-rack. A "spider band" was sometimes fitted around the mast a little above deck level, with holes for the belaying pins. This was sometimes called a "spider hoop" or "spider iron." Stanchion-mounted pin-racks are used for storing coils of line and are both decorative and utilitarian.

For the do-it-yourselfer, belaying pins can be turned out on the most basic of lathes from brass, bronze, or scrap hardwood. But remember, those metal ones don't float! With today's teak prices, it's nice to know that those teak scraps can be turned into beautiful belaying pins for onboard use or home decoration.

Our schooner is rigged in the old Grand Banks manner with no sheet winches. To attain mechanical advantage, multiple-part block and tackle is used for each of the sheets.

belaying pins

Photo courtesy of Arnie Janaro.

At left, the replica of the* HMS Bounty *figurehead stands as a proud lookout on a reproduction of Captain Bligh's* Bounty*, built in 1960 in Nova Scotia. At right, while admiring the figurehead on* Delphinus*, the author's granddaughter, Jenny, becomes a figurehead in her own right.

This presents the problem of long coils of line ending up in the cockpit due to the 4:1 block ratio. This would be a colossal spaghetti pot if it weren't for the pin-racks we've installed, not for belaying as such, but rather as an attractive and practical way of keeping our sheets out from underfoot.

When I built our schooner, I added belaying pins because they "belonged" on a schooner with traditional lines, not because I had ever used them before. Now, I couldn't imagine sailing without them. As well as being useful, they add that needed touch of character. And they're good for dispatching that fish you caught on the lure trailing astern or for fighting off pirates.

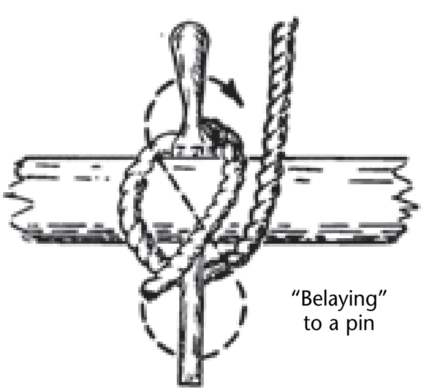
The bumpkin

And, oh yes, the bumpkin (sometimes called boomkin or bumkin). This is a short boom, frequently V-shaped, extending from the stern, to which the backstay or mizzen sheet block is attached. When used for the backstay, along with an associated bumpkin stay, it allows for a longer mainsail boom and frequently eliminates the need for running backstays. It provides a more practical lead angle for the mizzen sheet for a ketch or yawl. On our schooner, the mainsail extends all the way to the stern of the boat, with the bumpkin keeping the permanent backstay well out of the way (*see photo on Page 46*).

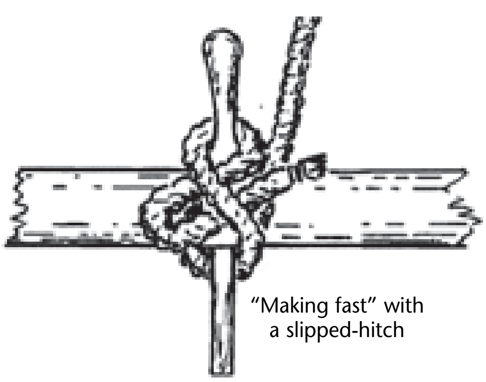
"As enlightened sailors, we know our figurehead is purely decorative, yet sometimes there's the feeling of a 'presence' at our bow, guiding us through foggy and unfamiliar waters."

For years we looked for a retirement boat that would fill our specs until we happened to stumble across our little schooner design from the board of Ted Brewer. It meets our needs completely, and seems appropriate for our vintage years. When we sail by with everything up, people turn to watch or take pictures. With that gray-haired and bearded character at the wheel, they probably think it's an apparition from the past. After all, how often do you see a small schooner with bowsprit, wood blocks, figurehead, belaying pins, and bumpkin?

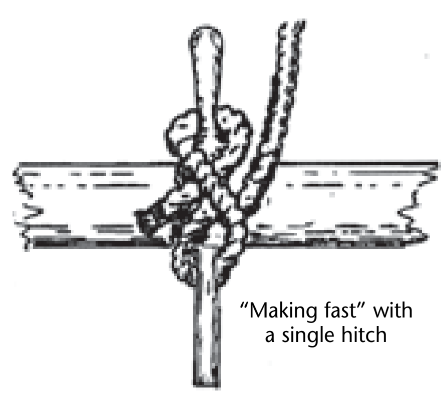
Don is a Good Old Boat *contributing editor. He holds a USCG captain's license and is a frequent contributor to boating magazines. He built his traditionally rigged schooner from a bare hull and keeps it next to his home on a waterway off Barnegat Bay on the New Jersey coast.*



"Belaying" to a pin



"Making fast" with a slipped-hitch



"Making fast" with a single hitch

Crash, *bang,*

BOOM!

When the noise died down, he needed a new boom

by Geoff Cooke

THERE ARE FEW GOOD reasons to replace your boom. If you want to add capability or features, it's easier and more cost-effective to adapt an existing boom than to replace it. There's no shortage of hardware available from the major manufacturers. However, if your boom gets bent or broken you don't have many options.

A few seconds of inattention by the helmsman while I was at the mast preparing to take in a deep reef, ended in a jibe. The mainsheet was in tight, so this wasn't a crash jibe where the boom swings 12 feet from one side to the other. But even a 2-foot jibe with the wind blowing around 20 knots was more than our boom could take.

The previous owner had converted *Meander*, our 1975 Tartan 30, from end-boom to mid-boom sheeting. The cabintop traveler was one of the features that made us choose *Meander* over other boats when we bought her a few years ago. However a shortcut was taken during the conversion when the mainsheet was fastened to three bails that were bolted through holes in the boom. The increased loads from the mid-boom sheeting, along with the weakening caused by holes, led to the end of our boom's useful life.

> "Nobody thought having holes in the boom where the mainsheet and vang attached was a good idea."

So I had a winter boat project and some interesting research to do. I just hoped the bill wouldn't put a big hole in our boating budget.

Any boat more than 20 years old has a number of boom variants: short or long booms; roller, slab, or single-line reefing; end- or mid-boom sheeting. Then there are the modifications made by various owners over the years.

Internet search

I went on the Internet to figure out what sort of boom *Meander* had and what might replace it. I came up with Rig-Rite and their Rig-Rite #6 extrusion. Looking around their site, I also identified the Kenyon E and the Spartan CD-3 as similar extrusions. Many manufacturers of 25- to 33-foot boats have used these booms over the years. Buying a section would cost about $240 plus tax and shipping. All the existing parts would fit so the project would be a quite simple. Rig-Rite offered a number of options for fastening the mainsheet, vang, and preventer, so the boom might be a bit stronger.

I decided that *Meander's* boom needed to be substantially stronger. The jibe that bent it was quite mild. I didn't want to replace the boom twice.

In discussing options for reinforcing the boom with a few machine shops and boatyards, I discovered that welding an aluminum extrusion weakens it substantially. The option of stitching a collar on with pop rivets or machine screws would look horrible and still require cutting holes or

The mid-boom traveler on the cabintop, above, was one of the reasons Geoff Cooke bought his 1975 Tartan 30. What the previous owner (who made the conversion from end-boom to mid-boom sheeting) didn't realize was that a stronger boom should have been installed at the same time. Considering the increased loads it took and the weakening caused by the additional holes drilled in it, the original boom held up remarkably well for many years until one day a mild jibe finished it off.

Geoff laid the two booms (the older damaged Kenyon model and the new Isomat replacement) side by side to measure the locations of fittings. The replacement boom is much beefier than the previous boom which had held up admirably, considering that it wasn't rated for the loads it took once it had been converted from end-boom to mid-boom sheeting. At right, the tie rod on the mast belowdecks helps hold the deck down when vertical loads — such as halyards and shrouds — want to buckle it upward. Once the boom was painted and all previous hardware carefully diagramed, Geoff added reef and outhaul turning blocks, bottom.

slots in the boom to attach the mainsheet and vang. Nobody thought having holes in the boom where the mainsheet and vang attached was a good idea. A boom that didn't require holes to fasten the mainsheet was required, but how strong would it have to be?

To identify the loads on the boom, I used a service offered by Harken. They gave the mainsheet load on a Tartan 30C with end-boom sheeting as 1,400 pounds. Additional research found that mid-boom sheeting increased the load on the mainsheet by 50 percent or more depending on how "mid" the sheeting was. The mainsheet on *Meander* fastens 60 inches aft of the mast on a 132-inch boom. This indicated that a load of 2,800 pounds could be expected. This seemed twice the load the original boom was designed for, so I had been lucky (or cautious) for a few years. Returning to the Rig-Rite website, I looked for booms that were at least *twice* as strong as the original.

Moments of inertia

Strength in beams is stated in moments of inertia, which is basically the strength in the horizontal and vertical axis. The numbers for the old boom were Ixx of 2.70 and Iyy of 1.20. I would be looking for a boom section with numbers like Ixx of 5.00 or more and Iyy of 2.4 or more that didn't require cutting holes to fasten the mainsheet and vang.

The choices narrowed to the Isomat NB-32 and Z-Spar Z-360. Both have a similar hexagonal profile that includes a track into the bottom to hold a very strong-looking bail assembly. The tracks in the top and bottom add substantial stiffness and strength. As an additional check, I again used the Harken site to compare *Meander's* boom loading with that of the various boats that had used these extrusions. It seemed either would provide a comfortable margin of strength (see illustration on Page 17).

This project reminded me of the saying, "Good, fast, cheap: pick two." I could go with the "good, fast" approach and call a rigging company. Quotes from two companies ran between $1,200 and $1,400 plus tax and shipping. Lines for the reefing would be extra. I wonder what it costs to ship a 12-foot boom?

I could go with the "fast, cheap" option like the previous owner, but that's what got the boom bent in the first place. (In all honesty, after many years of sailing.)

What I wanted was a "good, cheap" method that would require some work on my part.

Looking up the boom extrusions proposed by the various rigging shops on the Rig-Rite website, I saw that the proposals were basically doubling the strength of the boom and increasing its weight to 2.5 pounds per foot. This gave me great confidence in the Isomat extrusion, which was substantially stronger and lighter than any proposed boom.

Consignment shops

Wherever there are sailboats there are boating consignment shops. These provide a great opportunity to save money as well as to recycle. I visited a few shops with a tape measure and the information from Rig-Rite in hand. At one I found an Isomat NB-32 boom with the mast-mount casting that could be purchased for $240. It was 30 inches longer than needed and had a variety of outhaul and reefing lines wrapped around it. The gooseneck pin was nowhere to be seen and would have to be figured out later.

So for less than $250 I had a nice strong boom that could be shortened and modfiied to fit *Meander*. I strapped it to the roof and drove home … slowly.

A boom can have attachments for a topping lift, reefing arrangements, an outhaul, lazy-jacks, a vang, a mainsheet, and a preventer. Each has an ideal location. Shifting one even a few inches can be a bad idea. *Meander* had all of these, and I wanted to make sure everything ended up it its proper location on the new boom.

With a felt-tip marker, I outlined and labeled every piece of hardware attached to the old boom. I made a drawing of the boom showing dimensions from either end to each attachment. Then I removed the hardware and screws and laid them out on the workbench.

The cast ends of the Isomat boom had been fastened to the extrusion with pop rivets. With a ⅜-inch bit, I drilled the tops off and the cores out. To avoid weakening the boom, I drilled through the first pop rivet with a very small bit. Then I enlarged the hole using gradually larger bits until the rivet could be pushed through. This last drill bit was used to remove the rest of the rivets.

Pulled lines out

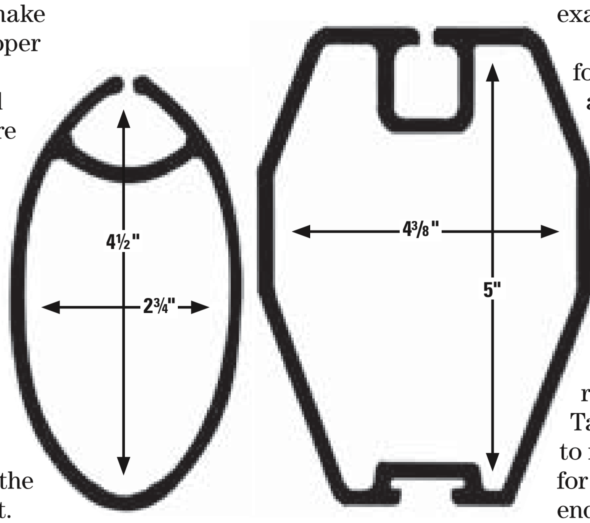
After removing both end castings, I pulled and tugged each line until I knew their purpose. I pulled all the lines out and pulled in a messenger line twice the length of the boom, plus a few feet.

> *"… a shortcut was taken during the conversion … The increased loads from the mid-boom sheeting, and the weakening caused by holes, led to the end of our boom's useful life."*

Peering inside the boom, I could see sharp points from sheet metal screws used to fasten the minor attachments. These points would catch any line inside the boom. I removed the attachments and threw the screws out. I would drill and tap for machine screws to fasten things back together.

To remove the four sheaves from each end casting, I slipped a metal ruler between the sheaves and against the axle and tapped gently with a small hammer. All the parts were checked, cleaned, and tested for ease of operation. Some of the sheaves had nicks in them, but by being careful during reassembly, these nicks were placed against the outer edge of the casting, preventing any future problems.

With all the hardware and lines removed, this was a perfect time to paint the boom. The Isomat was raw aluminum and scruffy looking, while *Meander* had white spars. It would have been nice to get a professional two-part paint job done, but that wasn't in the budget. In my experience a very durable finish for aluminum can be achieved with lowly Tremclad enamel. I've sprayed and brushed this on aluminum in the past, and it lasted for years. I prefer the satin finish as it hides minor imperfections while still giving a little shine. So the boom was scrubbed with a citrus cleaner and sanded with 320-grit paper to remove the top oxide. A few coats of spray paint made it look good as new. The end castings also got a few light coats of black to freshen them up.



The Kenyon E and the Spartan CD-3, shown at left, are similar extrusions. The Tartan's original boom was of this type. Since mid-boom sheeting increases the load on the mainsheet by 50 percent or more, Geoff opted for a stronger replacement extrusion, the Isomat NB-32, shown at right. His research showed that another option was a Z-Spar Z-360.

All-internal lines

Meander's boom was set up for two jiffy reefs with pad-eyes, cheek blocks, and cleats mounted on the outside of the boom. The Isomat had no external reefing attachments; all lines were inside the boom, and there were four sheaves at either end. I was unclear on exactly how this was intended to work.

Returning to my web search, I found a number of reefing methods and discussions on each. I also discussed the methods with members of the Tartan list on SailNet. This is a great resource. One Tartan 31 owner with an Isomat boom copied the reefing page in his manual and emailed it to me for comparison.

The Isomat boom would support any reefing method, except roller reefing. The drawing from the Tartan 31 seemed the best approach to me. With this method, a single line for each reef comes out of the forward end of the boom and is either cleated there or run back to the cockpit. *Meander* is a tall-rig Tartan 30. While this provides very nice performance in light to medium air, she really needs a reef when the wind hits 15 knots and another before 20 knots. With this in mind, I had already decided to rig for a single deep reef for the next season. The ability to take in and shake out a deep reef from the cockpit would be a major improvement as I frequently sail singlehanded.

This was a great opportunity to simplify and improve all facets of mainsail handling. For example, the lazy-jacks never caught the leech of the sail properly, the outhaul was impossible to reach from the cockpit and was rarely used, the preventer used a mainsheet bail that wasn't far enough aft, and the Cunningham arrangement I used had no purchase. I'd fix all these annoyances.

Moved attachments

I moved the aft lazy-jack attachment forward 10 inches and the middle one aft 2 inches. Shortening the boom by 30 inches would free up enough outhaul line to reach the cockpit (30 inches with a 4:1 purchase meant 10 feet of extra line). I'd use the reefing bail for the preventer and mount padeyes on the side of the boom for the leech reefing attachment. The outhaul from the old boom was used as a Cunningham. It looked like replacing the boom was a stroke of genius. Accidental genius, perhaps, but isn't most genius accidental?

All the research and discussion, schemes and dreams, sketches and drawings were done; it was time to shorten the boom. "Shorten" sounds so safe and easy. What it really meant was chopping a few feet off of an expensive piece of hardware. I wanted to be sure it was the right amount.

My original intention was to cut both ends of the extrusion to provide clean ends for fastening the end caps. This would require removing and remounting the outhaul attachment and, as there seemed to be little gain in this, I decided to just cut the aft end.

Because *Meander's* gooseneck fitting and the Isomat fitting were very different, it wasn't possible to simply cut the new extrusion to the same length as the old extrusion. To measure the correct length, I temporarily reassembled both booms and placed them on sawhorses. I measured the length from the mast to the end of the old extrusion and transferred that to the new extrusion.

I marked the placement of each piece of hardware on the new extrusion in pencil. I didn't want to ruin the new paint job. Each measurement was checked several times from both ends of the boom. It wasn't paranoia, merely caution, and totally appropriate.

The used boom was a bargain, but the pin for the gooseneck was missing. A new pin was one of the last additions.

" 'Shorten' sounds so safe and easy. What it really meant was chopping a few feet off of an expensive piece of hardware. I wanted to be sure it was the right amount."

During this process, I discovered the aft end of the Isomat extrusion was cut ¼ inch out of square. This seemed to be intentional, as it allowed the aft casting, with its reefing and outhaul sheaves, to tip forward. Once I had confidence that the situation was understood, I carefully drew a cut line.

Removed the end

By practicing on the end that was going to be removed, I developed a tipping-in technique with the saber saw that worked well. Using a fine-tooth blade, I removed the end of the extrusion and then filed the cut smooth.

Now each piece of hardware was fastened to the new extrusion. 10 x 24 x ⅜-inch machine screws were used for the smaller pieces such as the lazy-jacks and topping lift. Larger items, such as the reefing pads and bails, used ¼ x 20 x ⅜-inch machine screws. I used Tef-Gel anti-seize compound on all fasteners to prevent galvanic corrosion, but Loctite makes a similar product.

When fastening each item, I carefully marked, drilled, and tapped an initial hole. I then fastened each item to the boom and made any additional holes one at a time, inserting and tightening the screws as I went. This made sure that each item was fastened properly the first time. Using two rechargeable drills, one for drilling and the other for tapping, speeded up the whole process. (Note: When you use an electric drill to tap threads in aluminum, use a very low speed.)

Now I pulled each line back inside the extrusion with the messenger line, running the ends of each line through the appropriate sheaves on the end caps. Each line was also marked as to function and destination. I drilled, tapped, and fastened the end caps with ¼ x 20 x ⅜-inch screws, following the earlier process.

The only item left was the gooseneck pin. To find a machine shop able to drill and cut some ⅞-inch bar stock, I did an Internet search for "metal welding Bristol RI." This found Luther's Welding and Fabricating. Luther's had no problem following the picture from Rig-Rite and making it fit the gooseneck casting.

The new boom was finished and ready for fitting in the spring. Mounting would need six drilled and tapped holes in the mast and only take 15 minutes. The new boom would be a substantial improvement in safety and convenience. I could hardly wait.

Of course, this meant a few new projects. I'd have to add turning blocks at the mast base for the reefing line and outhaul, add line organizers and cabintop line stoppers to handle two extra lines to the cockpit, and make backing plates for all the new hardware. I'd even add the cabinroof tie that I'd been planning for the last two years. There's nothing like messing around in boats…or in the winter, messing around in the basement.

For further reading…

Read more about spars and rigging in Richard Henderson's *Understanding Rigs and Rigging* (1991), available at <http://www.goodoldboat.com/bookshelf.html> or by calling 763-420-8923.

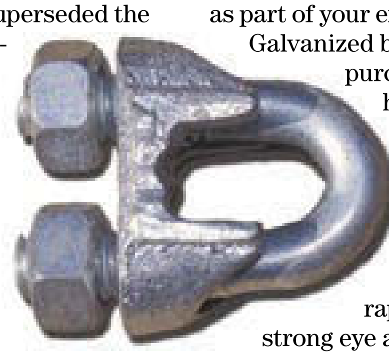
Rigging terminals

What's at the end of your shrouds and stays?

by Don Launer

THE STAINLESS-STEEL STANDING RIGging that supports our masts is critical to our sailing safety, and the terminals at the end of these stainless-steel cables are the vital connection between those cables and the mast's tangs and the hull's chainplates. Although most use a single terminal type, the swaged fitting, there are actually many other types of wire terminals.

In the old sailing ships of yesteryear, standing rigging was made of natural-fiber rope terminating in an eye that was wrapped around a wooden deadeye (see *Good Old Boat*, January 2002). When metallurgy was finally able to produce strong and flexible wire cable, these natural-rope shrouds were replaced by wire rope, but deadeyes still were used for tensioning. Finally, as manufacturing technology advanced further, stainless-steel standing rigging and threaded turnbuckles superseded the ancient ways of supporting masts.



However, there still are some boats whose stainless-steel rigging terminates in an eye. This eye is usually a wire-rope splice around a thimble — a sailor's art that is not common in the repertoire of today's boaters. Once the eye is formed at the end of the shroud, a turnbuckle can then be attached to this eye/thimble combination at the hull end and a shackle at the upper end.

Patent wire clamps

Although a wire splice is the strongest way to create this eye, occasionally you'll find bulldog fittings used. These fittings are U-shaped clamps with a sliding bar that is usually curved to fit the wire-rope diameter.

Though seldom seen as a working system these days, bulldog-fitting clamps are useful for an emergency repair of a broken shroud. When used for this purpose, the U-shaped end should never be used on the standing part of the shroud, since it tends to crush the cable. Even if you never plan to use this method to terminate your standing rigging, it's a good idea to have two or three bulldog clamps and a thimble, sized to your standing rigging, as part of your emergency kit.

Galvanized bulldog clamps can be purchased from your local hardware store for less than a dollar each, and stainless-steel ones are available in marine stores for several dollars each. With these you can rapidly make a relatively strong eye at the end of a broken shroud or connect two broken ends together. This is a much faster fix than trying to use a more permanent fitting, such as a Nicopress, since the oval sleeve of that fitting requires a cleanly cut wire end, which could take time to accomplish, and time is in short supply during an emergency of this nature.

Getting a clean cut on stainless-steel wire rope is a tough job unless you've spent a lot of money for a pair of cable cutters made just for that purpose. One way to achieve a clean cut is with a hacksaw and several new fine-toothed blades. The key to cutting with a hacksaw is to have a portable vise so that you can hold the wire firmly and rotate it as necessary to cut through the strands. A pair of clamping pliers will also work in a pinch. Electrical tape, tightly wound around the wire rope at the point of cutting, is a big help.

A deadeye, above, a bulldog clamp, center, and a swaged fitting, at left.

A wire splice fitting, at left above, is created with spliced wires in the same way that rope strands are spliced together; the splice work is covered with rigging tape here. A double Nicopress terminal, above right. The parts that make up the Hi-MOD swageless terminal offered by Hayn Enterprises, above.

Oval sleeves

Another method of creating an eye in wire rope is the Nicopress (pictured at far right) or Talurit system. This method of terminating the shrouds is still seen occasionally on small boats. An oval metal sleeve is fitted over the short and standing parts of the shroud. This sleeve is then compressed hydraulically or manually, until the relatively soft metal of the sleeve fills in all the voids between the strands of the wire ropes as it compresses them together. To minimize electrolytic action, these sleeves are made of copper or stainless steel when used on stainless-steel rigging.

The manual hand-crimping tool that compresses this sleeve looks like a giant bolt-cutter, but instead of cutting blades, it has indentations in the jaws that fit the sleeve. Although some people call this a swaging tool, it should not be confused with real swaging. Another, simpler tool for this operation is one that compresses the sleeve between two metal bars by wrenching down two machine screws that pull these bars together.

The true swaged terminal, pictured on Page 13, is the type we are most familiar with. This type of fitting has an eye, fork, threaded stud, or insulator on one end, and a sleeve, the exact size of the wire rope, on the other. With the wire rope inserted into the fitting's sleeve, the stainless-steel sleeve is hydraulically squeezed, rolled, or pounded until it forms into the contours of the wire rope. The roller swager, sometimes called a Kearney after one of the manufacturers, compresses the terminal onto the wire by rolling it between two wheels. There are small, portable, roller-swagers with hydraulic hand-pumps as well as larger swagers that use electrically operated hydraulic pumps. Even larger wire sizes require a swaging machine, which is an enormous device that can weigh a ton or more. It hammers the fitting until the sleeve is beaten into the wire. This machine, which costs thousands of dollars, performs the most satisfactory swaging operation.

Not superior

Most wire terminals found on today's sailboats are swaged fittings, but professional rigger Brion Toss suggests that this is not because they are superior solutions — which they are not — but because these end-fittings can be produced in volume at relatively low prices and fastening them to the rigging can be done rapidly by anyone with the right equipment, whether highly skilled or not. This last point may be the reason for the high number of banana-shaped sleeves on the swaged fittings that Brion encounters on his clients' boats (see *Good Old Boat*, January 2003).

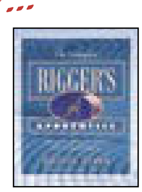
There's yet another type of swaged terminal fitting. It looks just like a normal swaged fitting but the sleeve that is squeezed onto the wire is a soft alloy, so a manual crimping tool can be used. This kind of fitting, which is often used on lifelines, is designated as a hand-crimp fitting. This hand-crimp soft-alloy-type of swaged fitting should not be used in high-load applications, such as standing rigging, due to its lesser strength (and I have strong reservations about using it for lifelines, also). When a hand-crimping tool is used on this type of fitting, it is usually crimped in three places, leaving three indentations in the sleeve. When a swaging machine is used on this type of fitting, the sleeve is smooth.

The final terminal fitting is a swageless terminal. Although a bit more expensive than the swaged terminal, this fitting is a do-it-yourself terminal that can be connected to the wire rope by a boatowner using nothing more than two wrenches. The fitting is machined from stainless steel and is stronger than any of the other rigging terminals. Because of its strength, reliability, and ease of replacement, it is often preferred by world voyagers.

Swageless fittings are reusable (except for the inner cone) and, as with swaged fittings, are available with an eye, fork, threaded stud, or insulator. There are several manufacturers of this type of terminal: Norseman, Sta-Lok, Suncor Quick Attach, and Hayn's Hi-MOD (pictured at left), among others. Swageless fittings are an excellent choice when it comes time to replace the old standing rigging on your boat. It's a job you can do yourself, one that will create a stronger mast-supporting system than when the boat was new. Installation instructions, with diagrams, come with each fitting.

There are also terminal fittings for rod-rigging, but as this type of standing rigging is uncommon on our sort of boats, we needn't venture into that specialized territory.

For further reading...



For a complete and well-illustrated discussion of many aspects of rigging, see *The Complete Rigger's Apprentice* (1997) by Brion Toss, available at <http://www.goodoldboat.com/bookshelf.html> or by calling 763-420-8923.

The mizzenmast comes ashore, above. Pulling the masts, below, at Opua Wharf, Bay of Islands, New Zealand.

All shipshape aloft

A 20-year-old 47-footer gets new rigging and spruced-up masts

by Michael Batham

THERE COMES A TIME IN THE life of every vessel when it needs more than routine annual maintenance. Our 47-foot steel ketch, *Sea Quest*, now nearing her 20th birthday, had been our home for 11 years as we cruised the Western Pacific. To prepare for our next long voyage, my wife, Tere, and I decided the engine had to be rebuilt. This entailed pulling the mizzenmast to get the engine out from under the doghouse roof. With one mast already out, it seemed a good idea to pull the mainmast as well and refurbish them both.

The old galvanized standing rigging had stood up well for nearly two decades. Only the forestays, abraded by the sail hanks, and a mizzen shroud showed any serious rust. Over the years I had come to appreciate galvanized wire over stainless steel because it does not work-harden and break when you least expect it.

Galvanized wire is cheaper than stainless, although the actual savings in cost would only amount to a small part of the total bill for a rerig job. Big savings, however, can be made on the galvanized fittings, along with the fact that the preparation work would be done not by a marine rigging shop but rather by a wire rope company.

"The old galvanized standing rigging had stood up well for nearly two decades. Only the forestays, abraded by the sail hanks, and a mizzen shroud showed any serious rust."

More important to me than the cost of the job, however, was peace of mind that results from knowing that any deterioration in the wire would appear only gradually. The rusted mizzen shroud, though looking bad, had plenty of sound strands of wire at its core. The chance of losing our rig, as happens all too often with stainless through the failure of a perfectly good-looking stay due to work-hardening, was slim.

The best wire

Tracking down the best-galvanized strand is imperative. Experts we consulted considered English wire the best. Chinese strand they said, was to be avoided at all costs. I found an industrial wire rope company that could supply me with both ½-inch and ⅜-inch 1 x 19 wire made up from good quality galvanized English strand.

The first vital step when the masts were laid horizontal was to accurately measure the rigging. I removed the old stays with all their shackles, links, and turnbuckles and laid them on flat ground. After winding the turnbuckles back to their previously marked “tight position,” Tere and I measured the length from clevis pin to clevis pin, checking, comparing, and re-checking the measurement of each port and starboard shroud. This became our reference “overall length” from which I could calculate the correct wire length.

The old turnbuckles had, at one end, a clevis pin that went through the chainplate. At the other end, an eye was shackled to the thimble on the stay. I wanted to eliminate the extra bulk of these shackles if I could. After re-galvanizing the old turnbuckles, my plan was to splice the new wire directly to the eye.

In order to accurately calculate the length of each wire from thimble to thimble, I needed to deduct the length of the turnbuckle from the “overall length.” But by how much? I took both the maximum and the minimum length of the turnbuckle and arbitrarily allowed 70 percent of that for setting up and stretch. The remaining 30 percent of the turnbuckle length would, I hoped, cover any shortfall the opposite way.

“When ordering wire, I allowed an extra 3 feet to bend smoothly around each thimble. If cut too short, the worked end of the wire tends to unlay itself on the bend. The tail would later be cut off and discarded.”

Even this badly corroded stay, top, had plenty of good metal left. Removing all the mast hardware, above.

Two hand-splices

As a child I had watched a rigger spend half a day laboriously making two beautiful hand-splices on a new shroud for my dad’s boat. Today the industry uses Nicopress splices. This involves bending the end of a wire around a thimble and then squeezing the tail onto the standing part with a Nicopress sleeve. A giant press, using tons of pressure to mold the sleeve around the wire, does this work. It now takes hours, not days.

When ordering wire, I allowed an extra 3 feet to bend smoothly around each thimble. If cut too short, the worked end of the wire tends to unlay itself on the bend. The tail would later be cut off and discarded.

While the stays were being made, we set to work on the aluminum masts. Tere and I stripped the hardware, then we removed the old paint with scrapers. Next we sanded the masts with fine paper on a random-orbital sander.

The amount of paint required took us by surprise. The total surface area of two masts, booms, and spinnaker poles totaled as much surface area as the topsides of the boat. The constraints of re-coat times for the different paints had us worried. The paint company representative had said, “If you don’t complete Step 3 without a break, you must scrape the primer off and begin again.”

This was the schedule:

Step 1. Wash with an acidic cleaner. Wait till dry, a maximum of four hours.

Step 2. Coat with aluminum primer. Wait a minimum of three hours and a maximum of 24 hours.

Step 3. Coat with polyurethane, silver for the bulk of the spars and

Michael cleans the old paint off the stripped masts, top. Preparing the aluminum spars, center, using a fine random-orbital sander. Tere touches up the overlap from white to silver paint, above. This photo also shows the mast-support gantry and spreaders.

white for the top quarter of each mast. Wait 4 to 24 hours.

Step 4. Overcoat all the polyurethane with high-gloss clear finish. Recoat in 12 to 24 hours.

Despite the fact that we were working outdoors and dodging autumn squalls, we somehow squeaked through all the steps within the allotted time frame. The spars were ready. The turnbuckles had been re-galvanized, and the wire was being spliced.

I began to rebuild both masts. This involved a lot of fiddly work: refitting the spreaders, winches, cleats, electrics, and other fittings. Fortunately, I had made careful notes as I dismantled things. Now I slavishly followed these notes. Tere and I checked each item, cleaned it, and refitted it. Where screws were tapped into the mast section, I cleaned the threads using a tap in a slow-speed cordless drill. To prevent electrolysis between stainless and aluminum, I coated the screws with an insulating paste and bedded all fittings in Sikaflex.

Many of the bands and fittings were originally fixed with ¼-inch roundheaded machine screws. I screwed these home with a large flat-bladed screwdriver. During our next cruise a small but significant problem revealed itself. Metal burrs, almost imperceptible to the eye, had formed around the slots of the screw heads. The sharp edges caused significant chafe on halyards lying against them. I had to go up the mast to file each screw head smooth.

I also discovered later at sea, when the masthead light failed, that it is as important to *let* water out of the light fittings as it is to *keep* it out! The fitting had probably leaked from the beginning. Now I made a drain hole at the lowest point. Fortunately I had remembered to clear the drain at the foot of the deck-stepped masts.

"The amount of paint required took us by surprise. The total surface area of two masts, booms, and spinnaker poles totaled as much surface area as the topsides of the boat."

Crevice sealer

The masts were ready when the new wires arrived. Into each thimble, Nicopress sleeve, and worked wire end, we applied an epoxy metal crevice sealer, followed by a high-build epoxy coating, hoping to prevent water from pooling there. Later we coated the lower part of each stay — which is subject to heavy wear and salt corrosion — with the same epoxy coating. We discovered that the paint had an unexpected added advantage of making the wire less abrasive to the sails.

All our careful planning and tedious attention to detail paid off the day the crane lifted the masts aboard. With many hands to help, the masts dropped neatly into place. We fed the labeled electrical wires through the deck. We fixed the turnbuckle clevis pins to the chainplates. The crane was on its way in less than an hour.

Tensioning the rig took a little

Tere applying the sealer to the new wire, at left above. The mizzen swings back through the doghouse roof, at left center. Securing the mizzen rigging — a ketch once more, at left bottom. The turnbuckles are filled with Lanacote, at right.

longer. I made sure the masts were plumb. Starting with the cap shrouds, forestay, and backstay, I adjusted them using the turnbuckles. After both masts looked right I tensioned the triatic stay, the intermediate shrouds, and finally the lower shrouds. How relieved I was to find nothing too short and each turnbuckle with a few spare turns left.

After I was satisfied with the tension of the stays, I packed each turnbuckle with a lanolin-based preparation, Lanacote, then wrapped the exposed threads with Lanacote-impregnated bandages and a covering tape.

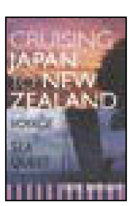
I checked the lead of all ropes and halyards to minimize wear and chafe. In the next few weeks Tere and I made new baggywrinkle and wound it onto the backstays at the chafe points.

The mast refit turned out to be far more complicated than it had first appeared. The masts were heavier and longer than I realized. Getting them on and off the trailer required the help of at least eight other shipyard volunteers with good backs. I built simple frames to support the masts, but turning them to scrape and paint required the use of a block and tackle.

The notes and dimensions I took as the mast came apart proved essential during the rebuilding process. Containers of such things as winch parts or spreader-light mounting screws, each marked to show its specific contents, helped to ensure that parts were not mixed up or lost.

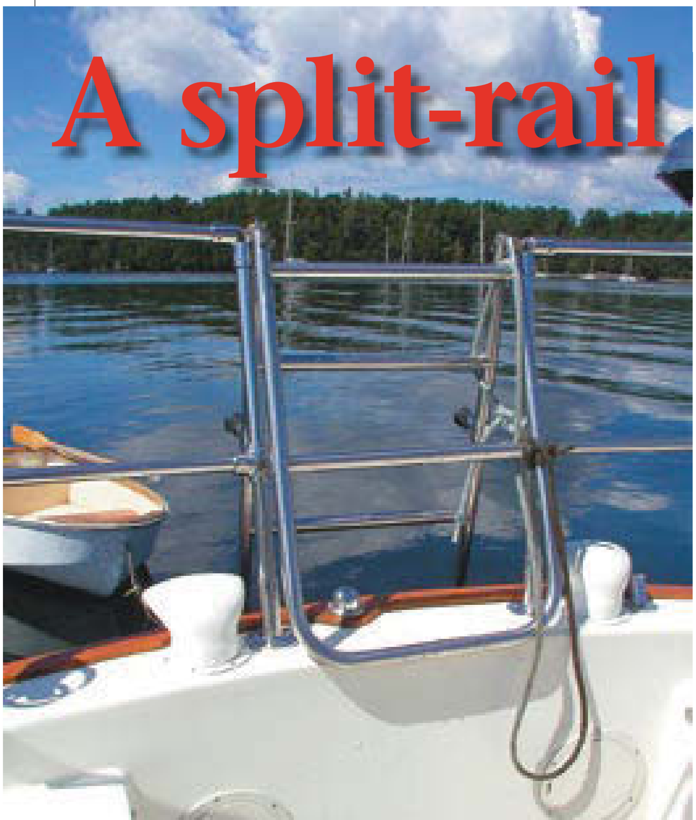
A re-rig in a vessel's mid-life should outlast the cruising years of most couples. We now have a brightly shining pair of masts and hardy rigging that we expect will last us another 20 years with luck. Now that we are out cruising again, the exertions of the job have been forgotten, but when that ol' wind starts to blow, we bless those bright new shrouds and are glad we undertook the task of renewing them.

For further reading...



Sheridan House just released Tere Batham's new book, *Cruising Japan to New Zealand: The Voyage of the Sea Quest*, available at <http://www.goodoldboat.com/bookshelf.html> or by calling 763-420-8923.

A split-rail fence



Cutting away the stern pulpit eases the boarding problem

by Andrew Wormer

WITH A STERN-MOUNTED LADDER AND A CONTINUOUS STERN pulpit, climbing aboard our 1977 C&C 29, *Echo*, from a dinghy meant climbing up and over the rear rail, a task that required ninja-like agility. Most new boat designs solve this problem by splitting the rail, scooping out the transom, and building in a swim platform. Swim platforms are nice, but I figured that modifying the rail would satisfy both the tiniest and oldest members of my crew.

First I contacted a welder to get a price for cutting out an opening in the rail. This certainly might be a logical course for those looking to minimize the appearance of the joints, but browsing through the catalogs of a few marine suppliers made me realize that I could do the same thing with a few standard rail fittings and a length of 1-inch-diameter rail without having to remove the rail and take it to the welder. After all, I was only going to cut out an opening in the rail the width of the stern ladder, terminate the cut ends with elbow and tee-fittings, and run the new vertical legs of the rail down to new stanchion bases.

The first thing I did was to check how much cant the stanchion bases would require to match the angle of the rail. Stock stanchion bases have around 4 or 5 degrees of cant, but I needed stanchion bases that angled out 12 degrees. I used a scrap 24-inch length of 1 x 1-inch pine held against the railing, traced the angle across the bottom, cut the wood to the angle, and double-checked the fit. When it looked right, I used an adjustable drafting protractor to determine the angle I had made. At approximately three times the price of stock stanchion bases, these custom bases added considerably to the project's overall cost, but they matched the existing boat hardware better.

Echo's **new stern ladder allows access without requiring ninja-like agility. Andrew says the new stanchions at the opening were the major expense in the project, but they match the existing boat hardware better. Notice the round access ports in the transom of this C&C 29.**

Would they fit?

The next order of business was to see if I could coax the right-sized opening out of the limited space available on the stern. The existing ladder predetermined where everything should go; the question was, would the stanchion bases fit? They did, but not with much room to spare. I had planned to leave about an inch or so between the top elbow fitting and the ladder when it was folded in the up position and then figure out some hardware configuration that could be used to securely attach the ladder to the rail when it wasn't being used. But the vents on the stern prevented this. The opening turned out to be — by necessity — exactly the width of the ladder. This was actually a blessing, because the ladder hangs over the opening with the lower end draping slightly inside the stern pulpit. The friction fit keeps it from rattling around. It's nice not to have to tie it when we leave our mooring or an anchorage.

Andrew's C&C 29 awaits the return of the Wormer family in the dinghy.

I got the parts from Bo'sun Supplies after doing a quick bit of research on the Internet and making a few phone calls. The parts included two custom stanchion bases, two 90-degree rail fittings, two 90-degree tee fittings, and 4 feet of 1-inch outside-diameter stainless-steel tubing to make up the two new vertical legs.

Before cutting, I placed the new fittings against the existing railing to verify where the cuts should be made. Then I used a hacksaw to cut out the approximately 16-inch-wide center sections of the upper and lower rails. I should note here that the lower rail section was smaller in diameter than the 1-inch diameter of the rest of the railings. Fortunately, I found that a sleeve cut from the 1-inch-diameter rail fit perfectly over the skinnier rail, so I could insert the sleeve in the tee fitting and then insert the end of the lower rail into the sleeve for a snug fit.

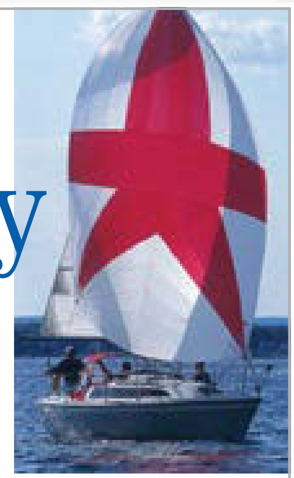
Plywood backing

After checking the fit and verifying the stanchion base locations, I marked where the holes should be drilled in the stern. After drilling the holes, I cut out backing plates from ¾-in plywood. My boat has access ports that allowed me to reach the area underneath the deck where I was mounting the backing plates for the stanchions. After trimming the backing plates to fit and extending the holes drilled through the deck on through the backing plates, I mixed up a batch of epoxy and put the plates in position. Next I mounted the stanchion bases, using the through-bolts to hold the plates in place as the epoxy cured.

Then it was time to assemble the pieces. My initial concerns about the rigidity of the new railing were groundless. There's a solid feel to it when we use it as a handhold when entering or leaving the boat. It looks reasonably good too. At a little less than $250 for parts and a few hours of labor, it's probably been one of the most cost-effective improvements I've made on the boat.

Resources

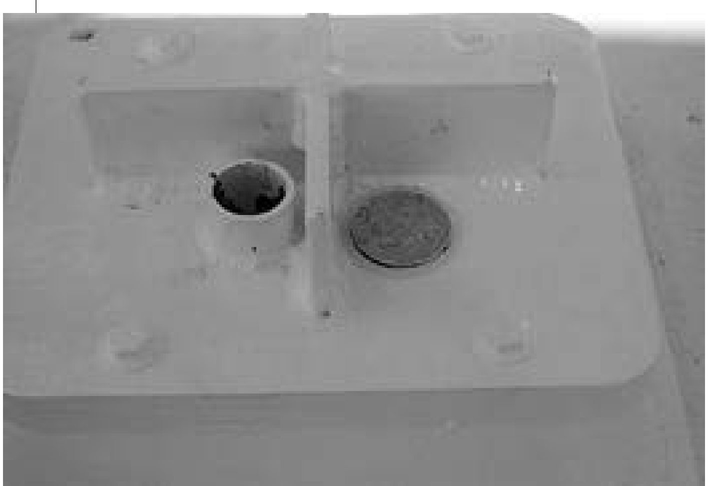
Bo'sun Supplies
888-433-3484; <http://www.bosunsupplies.com>



Better mast step

Elegant solution avoids mast replacement

by Jamie Harris



Hilary Naylor

"WELL NOW, THIS DOESN'T LOOK GOOD." THE MARINE SURVEYor was kneeling on the deck looking at the base of the mast where it was stepped on the deck of the venerable Spencer 35 I was in contract to buy. His words brought an unwelcome change to the survey. For more than an hour he had been inspecting, poking, and prodding all over *Onrust* (the name is Dutch, meaning "unrest" or "restless"). While he had pointed out a few minor irritants (slightly corroded nuts on the underside of a stanchion backing plate, and a GFI outlet that was needed on the 120-volt circuit in the forepeak), *Onrust* was showing up as solid and well-maintained. But now he had found two vertical cracks on either side of the base of the aluminum mast, each running about an inch and a half up from the cast-aluminum step plate.

"We'll have to get a rigger to look at this" he said. Soon, Mark Rinsler from Western Yacht Commissioning was aboard. After checking the cracks and surrounding metal, he said we'd have to look closer after the mast was pulled. But he thought the damage was local enough that it wasn't a serious problem. When the mast was out he would simply cut two or three inches off the bottom to get to solid undamaged metal and all would be well.

Shortening the mast by two or three inches worried me. I could foresee a lot of trouble: shortening the standing rigging, repositioning the gooseneck, and other possible adjustments necessary for a mast that would be several inches shorter. More importantly, why was the base of the mast sporting these cracks anyway? Was there some structural problem in this lovely, sweet-sailing, 35-year-old boat?

Cause identified

Cracks and corrosion in the base of aluminum deck-stepped masts are not rare. In fact, Don Casey discusses the problem in *This Old Boat*. He concludes that, because of the issues cascading from shortening the mast, "replacing the mast is always a better alternative." I've concluded that this isn't necessarily so.

With the mast off, we identified the cause of the problem. As originally built, the base of the mast was held in position on the base plate by a tightly fitting oval collar rising about an inch up from the plate inside the mast. This seems to be a very typical and logical arrangement for deck-stepped masts. Over time, though, the collar had suffered from corrosion. In aluminum, corrosion means expansion. The thickness of the collar was greater than that of the mast wall, and the expansion pressure of the collar against the inch or so of mast contacting it was too much for the mast section to restrain. Hence cracks to relieve the pressure.

Mark and I came up with a simple, elegant, and affordable solution to shortening the mast that did not involve replacing it. He designed and built a new mast step that would maintain the mast's original height and eliminate the threat of repeating the problem.

First he fabricated a solid phenolic base block with a thickness exactly equal to the amount cut off the base end of the mast. Then he built a new aluminum step plate to go atop the phenolic block with both bolted through the deck. The new plate, however, did not utilize a collar to hold the mast in place. Instead, it features two vertical plates intersecting at 90 degrees to form a stubby cross on top of the plate. Only the ends of the cross contact the mast section. Continuous contact around the whole inner circumference

With the mast suspended by a crane just above his head, Jamie quickly leads the ends of the spreader and masthead wires through the mast step into the junction box on the cabinroof, at right. The new step with *Onrust's* lucky coin, above.

of the mast, as with the old collar design, isn't necessary. The load is all downward.

Minimal contact

Forces that could cause lateral movement of the base on the step are infinitesimal compared to the compression load holding the mast in place. Thus only minimal contact area is needed to keep the mast where it belongs on its step plate. For this, the ends of the crossing vertical plates are quite enough.

To finish off the installation, four small weep holes were cut into the very bottom of the mast, each placed to drain one of the quadrants on the step plate created by the vertical crossing plates. A 1-inch-diameter hole was cut in the phenolic base and the new plate so wires could pass through the deck for connection inside.

While we were at it, all the old wiring inside the mast was replaced and run inside a new PVC conduit riveted within the mast. A braided messenger line was also put in to pull through any future wiring I might need for new mast-top installations.

On re-stepping the mast, the stays set up perfectly. The new base and plate look great on the cabintop with two coats of white epoxy paint. *Onrust's* lucky coin (a 1922 silver dollar we found when we pulled the old step plate off the mast) was cleaned, polished, and bedded in clear sealing compound on the new plate inside the mast where we trust it will continue to bring *Onrust* fair winds and following seas for years to come.

The case for a gallows

It's not traditional on a catboat but it sure looks salty

by John Butler

WANNABE WORLD CRUISERS DOTE on their alter egos, looking for ways to make them ever more perfect, capable of meeting every demand and whim of that dream voyage. Might a boom gallows make your South Pacific odyssey just a bit more perfect or at least enhance that weekend cruise across the big lake?

Although my boat will likely never leave her lovely inland lake, she never lacks continuing improvements. One was the addition of a boom gallows. Since she is a wooden one-off Cape Cod Catboat, circa 1963 and finished bright, any addition had to be carefully designed, skillfully built, and lovingly finished.

Before ordering the handsome finished product from my local sailmaker-cum-boatbuilder, I needed to convince myself that *The Old Cat* needed one. More importantly, did I need one and *why*?

Fond memories often intrude into rational decisions. I have fine, if faded, memories of my first good old boat, the *Maleta*, a Matthews Motorsailer, a 1920s or '30s vintage. About 26 feet long and fully equipped, she was this teenager's home at night. Each day she took summer tourists sailing on Lake Michigan's Green Bay, offering quiet relief from the waning days of World War II.

My fondest memories are those of courting a young lovely with long auburn tresses aboard the old motorsailer. Brave little soul, she never did really take to boating while heeling, but at least she still takes to me after 59 years.

The *Maleta* had a boom gallows, and the imprinting began. After a lifetime of sailing a wide variety of sailboats, I decided I needed to sail with a boom gallows once again. But first I had to justify all the work and expense.

The Old Cat **at her dock, furled sail on the boom gallows. Note the boarding steps on the rudder and transom.**

In the summer of 1946, I first sailed with a boom gallows on *Maleta* and courted my future bride.

Nine good reasons

Very well, then. Here are nine reasons for a boom gallows:

1 The basic purpose of the boom gallows is for parking the boom and furled sail (and gaff) when not sailing. A boom crutch does that, but not as well and certainly not with as much class. A gallows is the perfect place. If you plan to trailer your boat, the gallows makes a great place to store the aft end of the spars while on the road.

2 Safety should be a prime consideration for any equipment that is added to a sailboat. A cardinal rule of catboat sailing is to set a reef before you need it, even before you may *think* you need it. Even then, reefing down 270 square feet of canvas on my small cat can be a demanding task, and a boom crutch isn't always up to those demands.

3 One of the signature characteristics of Cape Cod Catboats is their very long booms extending well beyond their transoms, a far cry from today's rulebreakers with booms shorter than their whisker poles. Besides reefing, there is removing and installing the sail and cockpit covers, adjusting the outhaul for varying winds, or altering the boom lacing. Each requires leaning far over the transom, an activity that is not easy with a fully functional balance system. A form of stroke 27 years ago left my balance severely impaired, so I need all the help I can get. The gallows provides physical support when I'm working aft of the transom.

4 My habit when sailing is to sit at the back of the cockpit, facing forward, while leaning against the high cockpit coaming. This habit has already led to the installation of a steering wheel, a device I previously derided as "yachty." Heck, even those huge, 8,000-hp Mississippi River towboats (pushers) have tillers. With my wheel, I now could sit as I wished, but the back support of the coaming was less than ideal. When inclined aft a bit, the nearly vertical gallows frame makes a fine backrest.

5 I had a boom-supported cockpit cover to keep the sun off the brightwork. Sometimes, when anchored overnight, I put the cover up to extend my cabin space when rain looks likely. A boom gallows broadens the aft end of the covered area, making a more usable foul-weather cockpit. It provides an additional ridgepole for a cockpit awning or Bimini.

6 When motoring into a narrow cove for a night's anchorage, I sometimes stand on the cockpit seat, steering with one foot, looking ahead for submerged tree stumps. (My sailing area is a Corps of Engineers impoundment; many trees were flooded to make cover for the fish.) The support of a sturdy boom gallows is quite comforting when standing on one foot while steering with the other.

7 World circumnavigators Lin and Larry Pardey's cutters both have a very functional boom gallows. I suspect one use was for safety. As a youngster already envisioning his ideal boat, one of Larry's three qualifications was the ability to carry a hard dinghy on deck. *Seraffyn's* gallows is high and wide enough to ensure that the boom could never crush her 6-foot 8-inch dinghy stowed over the cabin trunk.

I had a safety concern similar to Larry's: when either of the two halyards (peak and throat halyards on a cat) is slacked off, the boom will immediately drop. My boom is Sitka spruce, 19 feet 1 inch long and weighs 40 pounds. (*The Old Cat* is 18 feet 6 inches overall.) If any part of the complex halyard system fails when close-hauled or coming about, anyone sitting under the boom would be in for a rude awakening at the very least. So I agree with Larry: provide an extra measure of safety for gear and crew.

8 Of course, you can't mount a radar or other electronic equipment on top of the gallows; that area is reserved for the boom. But some boats use the aft side to mount a stern light, a sort of minor eighth reason. To augment that flimsy eighth, I find the gallows very handy when coming aboard after a swim. My 85-pound rudder is hinged to the transom with three heavy bronze pintles and gudgeons. Like many cruisers, I have boarding steps on the rudder and transom. Envision climbing a common house painter's ladder with your hands at stomach level: it's awkward. The higher handholds of the gallows are great.

9 I could add a ninth reason: gallows look salty. Unfortunately, my cruising area is known for Wal-Mart's headquarters, major trucking lines, and massive chicken and turkey farms, not saltwater circumnavigators. But I knew I would appreciate having a boom gallows, and that's enough to validate that ninth reason for me.

Not traditional

Not all of *my* reasons apply to every boat, but I had enough to justify my need for a gallows. However, did *The Old Cat* need one? Boom gallows aren't traditional on Cape Cod Catboats. The original design was for commercial fishing, and the design has remained virtually unchanged for 150 years. Some pleasure sailors do cruise in catboats, but I've heard of only a few with gallows.

I also knew that every coin has a flip side. What are the disadvantages of a boom gallows? Installing a prototype was the only way to find out. The obvious disadvantage is one of additional weight and windage. This might be a consideration for some sailors.

My first model was a length of 1- x 4-inch pine, cut to three appropriate lengths, the top bolted to the uprights and the resulting crude frame clamped to the coaming. A half-circle saddle in the middle of the top was the boom's home base. The width of the crosspiece was governed by the width of the cockpit coaming, and the height of the uprights was selected to provide the same height of the saddle as with the boom crutch.

With the sail properly triced up, the boom cleared the crutch as well as the head of anyone sitting in the cockpit

***The Old Cat's* gallows and wheel, below at top. Brass plate at the mortise-and-tenon joint, center. The gallows' saddle with leather and brass covering the tacks, at bottom. Note the bungee cord with the toggle to tether the sail. It notches in the bottom of the gallows. A later version has a longer bungee cord with two toggles for "easy" and "tight" securing.**

"After a lifetime of sailing a wide variety of sailboats, I decided I needed to sail with a boom gallows once again."

by several inches. One of my early "improvements" to *The Old Cat* was the addition of a nylon strap across the top of the boom crutch. When I lowered the sail or set a reef, the strap effectively held the boom to the crutch. To accomplish this task on my prototype, I ran a length of bungee cord through a hole in the crosspiece and through a short section of 1-inch dowel (see photo on Page 37).

Holds it firmly

With the boom in the saddle, I bring the cord over the boom and down into a notch in the underside of the crosspiece. The tension on the bungee holds the toggle firmly in the notch.

I sailed with it a few months and found I liked everything but the propensity of the mainsheet to foul on the gallows as I came about. Adjusting the location of the forward block minimized that.

This cover hides the mounting bolts.

The base of the gallows and wedge to incline it aft.

In addition, the narrow width (3⅝ inches) didn't provide as much backrest as I wanted. So I progressed to my second prototype. I used 1- x 6-inch pine this time.

Like on the old *Maleta*, and the same on *Seraffyn*, this prototype's top had three saddles so the boom could be secured on either side of the centerline. This would make it easier to stand at the helm while navigating confined areas under power.

I sailed with this gallows for some months, wanting to be absolutely sure that there were no undiscovered disadvantages to scuttle the project and to be just as sure that eight of my reasons were not rationalizations for the ninth: that a well-designed and built boom gallows looks great.

I soon found that I didn't use the two outboard saddles. Long before this evolution, I had designed a second boom crutch, long enough when installed for the boom to be well above my head while powering into a narrow winding cove for a night's anchorage. Because the boom crutch fit into brackets on the aft side of the cockpit coaming, I had to be sure my prototypes didn't lean aft too far to prevent installation of this crutch. As things worked out, the wedges between the bottom of each gallows leg and the coaming, when sized to make my backrest lean back comfortably, were just right to accommodate that long crutch (see photo at bottom left).

Reasons justified

In the end I decided (rationalized is probably more honest) that I really *did* need a proper boom gallows. My reasons were justified, the disadvantages were minimal, and one would fit and look very nice indeed on *The Old Cat*.

My sailmaker friend, Matt Ross, had already agreed to build it. With his artistic eye, he refined my plans to make the overall shape harmonious with my boat's coaming and general shape. Matt still had some of my heavy mahogany 2 x 6s at his shop, leftovers from previous jobs, and he used one to construct the frame. Finished out, the uprights and top are 5⅜ by 1¾ inches. The crosspiece is 47 inches wide and stands 33 inches above the cockpit seat at its lowest points.

Concerned with moisture entering exposed and open vertical grain and causing rot, he joined the uprights to the top with mortise-and-tenon joints. With his cabinetwork quality, only the change in grain pattern discloses the joint. The resulting glued joint is strong, but Matt knew I would lean heavily on the crosspiece, so he fashioned four heavy brass plates to support the joints. To save money, I had the completed frame delivered unfinished. I sanded, sanded, and sanded it some more until the entire assembly was as smooth as a baby's bottom. An obsessive number of coats of polyurethane varnish gave the mahogany a beautiful color and mirror finish. The brass plates were likewise polished, then protected with clear acrylic.

Securing the frame to the boat was straightforward. Four ⅜-inch lag screws pulled each upright snugly to the coaming, all properly sealed against the elements. To cover the eight utilitarian hex heads and large washers, I made two covers from my scrap pile of mahogany. Hollowed out on the business side, they hide the screws. A single screw holds each cover to the aft side of the coaming, and that recessed screw is covered with a plug that is easily removed, should access to the lag screws be required (see photo at top left).

Fine leather

Well-designed crutches and gallows have sailmaker's leather lining the saddle to protect the boom's finish. My ditty bag yielded a fine scrap of leather left over from other projects. I soaked the leather in water and stretched it to cover the saddle, tacking it in place. When the leather dried and shrank, it was tight and wrinkle-free.

The tacks and edges of the leather were unsightly, so I used semicircles of the same heavy brass to cover them. This gave the gallows a shipshape and finished look (see photo on Page 37).

I also tacked a patch of the sailmaker's leather to the underside of the boom so that if (*when*, as it works out) the boom slides along the crosspiece to the saddle, it will not mar that beautiful finish.

One final change completed the job. The short bungee has to serve two purposes: it holds the boom, furled leach, and gaff to the gallows when the full sail is furled. That does not require a strong hold. However, when I'm setting a reef in a blow, the boom must be very securely tethered to the gallows. I added a second toggle to the bungee. The first provides the short section with firm tension, and the second and longer section provides just a moderate tension for the boom, sail, and gaff.

After a couple months of sailing, I had validated all of my reasons except the Pardey/Butler reason to avoid serious damage in case of a catastrophic halyard failure. I don't look forward to that test.

And so I declared the boom gallows project completed and 100 percent satisfactory.

Fixing a corroded mast

It's simple, really: Just cut a bit off, add a bit on

by Phillip Reid

When we had our boat surveyed before purchase, the surveyor noted "yellow moisture readings" on the moisture meter at the mast partners. The mast collar had pulled away from the deck, leaving a gap of broken caulk. At the mast butt on the keel, he found extensive corrosion damage, where the aluminum mast had sat in a pool of salty bilge water (kept higher than normal by the leaking mast collar) for who knows how long. He said we weren't in danger of a catastrophic failure, but the mast butt would need to be sawed off at some point. He was matter-of-fact about it, but it sounded like an awfully big deal at the time…and wouldn't it screw up my rig to have my mast a few inches shorter?

When I got around to facing it three years later, I did the work myself, I did a fine job, my rig's the same height, and it cost me very little.

There's a chance that any older keel-stepped mast is corroded at the butt, but chances are it's no big deal. You pull the mast, saw off a few inches, and make a riser to compensate for the lost mast height. Then you screw the riser to the keel and the mast step to the riser. The mast is no longer sitting in bilge water. If you have leaks and some water penetration of the deck at the partners, you address those at the same time. When you put it all back together, your boat's probably better than new.

Before pulling the mast, make a list of everything you want to do to the rig and to mast-mounted equipment while the mast's down, and budget the time and money for the entire project. If the standing rigging's due for inspection, this is a good time to do it. I even pulled all the chainplates for inspection, cleaning, and rebedding, since I had no idea what kind of shape they were in.

Pulling the mast

If your mast butt's badly corroded, the mast and step may be corroded together. Locate a supplier for a replacement step casting before you pull the mast, in case the step casting is too far gone to repair. Also make sure you've located the exact position of the step casting before the mast is pulled, in case the step bolts are so corroded that the step casting comes up with the mast. The position of the mast — up and down, fore and aft, and side to side — must be the same when the repairs are done as it was when the boat was built. Mark things, drill pilot holes through mating parts, make jigs. Do whatever it takes to position the mast as it was before.

When the mast is lifted, you should be below to keep the butt of the mast from scraping the bulkheads or other interior surfaces and to tend to the electrical wires coming out of the mast butt. Have some rags handy to forestall a potential mess. Have a hammer handy too. If the casting sticks in the mast tube, you will have to tell the lift operator to stop. If you can't pull the step off, you'll have to smack it off with the hammer. It may break, hence my advice to locate a replacement source in advance.

Repairing the mast partners

Even if you don't have access to a moisture meter and there's no external evidence of a problem, you'll be able to tell pretty quickly what kind of shape the mast partners are in once the mast is out. Many fiberglass production boats of the 1960s, '70s, and '80s have balsa-cored decks. Some builders used marine plywood instead of balsa in high-stress areas, especially anywhere something passed through the deck. Your deck sandwich probably consists a top fiberglass laminate (with non-skid gelcoat or paint), wood core, bottom fiberglass laminate, a thin layer of adhesive (or gap), and finally the headliner.

What many builders didn't do was seal the edges of the opening to prevent leaks from working into the deck core. Over a few decades, there's probably been some water intrusion. If the boat's been reasonably well cared for, it probably isn't anything major — a few inches of penetration all around — and it's pretty straightforward to fix.

If the boat was seriously neglected, there may be extensive rot in the deck core, and this may require a more extensive repair than the one described here. If you can't gouge out the wet core back to dry material by working through the mast hole, you have a much bigger problem. Tap the deck

Phillip's mast before the repair, above. Note how the mast collar has pulled out of the deck. Once the mast was out of the boat, the truth became all too apparent, on facing page at left. You can cut through a mast with a good hacksaw with a sharp blade. Be careful to cut it straight, far right.

with a plastic hammer to see how much wet core there is. Good core has a sharp sound; wet core makes a thud. The two sounds are quite different. You'll know.

If, like me, you are looking at yellow readings on a moisture meter and you know your mast collar has been leaking, but without softness or bulging above or below, you're probably looking at gouging out some rotted core to a depth of a few inches, cleaning out the void, and putting in new material. This should make (at the risk of getting too technical) one heckuva strong mast partner.

The whole scenario

Here's the whole mast-partner scenario: a cast-aluminum collar fits around the mast on deck. It may or may not have a flange that goes through the opening and it may or may not have a lip for a mast boot to fit around. The mast passes through a cutout whose edges are not sealed. The only thing keeping water out of the deck is whatever mast boots have been used over the years. Underneath against the overhead, you may find a trim piece (teak-veneer plywood, in my case) that fits around the mast. Over the years, water may have gotten well into the deck core, rotting some of it around the opening. It may have rotted out the interior teak trim piece (if present) and stained liners. It's possible that water could have damaged the tops of bulkheads. Inspect any wood in the general vicinity.

"Whatever might keep you lying awake in your bunk worrying in the future, it won't be your mast partners."

Here's what needs to happen to this setup, if it has become waterlogged: Once it's all taken apart and cleaned up, you may want to prime, fair, and paint the aluminum collar, then clean out the rot and fill the void and screw holes with thickened epoxy. Use the rotten interior trim piece as a template to make a new one out of teak, the hardwood of your choice, StarBoard, or exterior-grade plywood saturated in epoxy and painted with two-part polyurethane (my choice). Drill through the epoxy and interior piece so you can through-bolt everything from the aluminum collar down, bed the aluminum collar and the interior piece in sealant, through-bolt all of it with stainless bolts bedded in sealant, and end up with mast partners from hell. Whatever might keep you lying awake in your bunk worrying in the future, it won't be your mast partners.

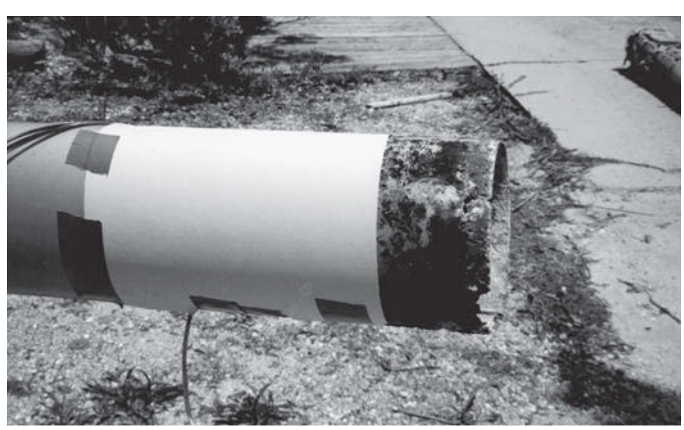
Sealing the edge of the hole

With a flat-bladed screwdriver or chisel, scrape out all the wet core. If you are finding soft, rotten, easily-removed core material as far back as you can reach, you are going to need to take a different repair approach, perhaps involving the injection of liquid epoxy through the upper laminate or removal and replacement of the top deck laminate and core around the partner. If the water has migrated that far, it is a much bigger project.

If there's loose, crumbling adhesive between the headliner and bottom deck laminate, chip it out with a knife blade or the edge of a screwdriver. You'll pack epoxy in there too. The safest way to dry the remaining core that is not rotted or delaminated is with low temperature heat and air circulation. Acetone will help water flow through the core but in all directions, and it is extremely flammable. Drying will probably take several days. Once the core is dry, drill out the screw and bolt holes to twice the diameter of the fasteners and clean out the void.

Wearing safety glasses and gloves, brush epoxy on the edge of the exposed core to seal it. Make up plywood pieces to fit in the void where the core has been removed. These should be a good fit with the remaining core and each other. Remember to leave at least ¼ inch between the front edges of the plywood and the opening; the edge of the finished opening needs to be filled epoxy, not plywood.

Mix up thickened epoxy to fill the gaps. Thicken it to the consistency of peanut butter. Use the proper hardener for the temperature you're working in. Pack your first batch into a cardboard caulking tube. Whatever you do, don't forget to put the cap into the end of the tube before loading it into the caulking gun and applying pressure. (Don't ask.) Jam a piece of clear vinyl tubing over the caulking gun nozzle; this will



allow you to get the epoxy into the back of the gap.

Squirt thickened epoxy into the gap, all around. Put in enough to fill the gap between the old core and the new core. Don't leave voids. A good fit for the new plywood core will help. Coat the plywood all over with unthinned epoxy as you put it in.

Large volumes of uncured epoxy will get too hot as they cure. This damages the epoxy, ruining its properties, and is a fire hazard. Let each small batch get through its exotherm before adding more. You may need to work in stages so the filled epoxy does not "go thermal," as it surely will if you put too much in at a time. Work in the shade even if you have to rig awnings. Smooth the edge of the hole to knock off peaks, but make sure it completely fills the gap with no indentations. Err on the side of too much; you can grind it off after it cures.

After the epoxy has cured, use a file bit on a drill (a powerful drill works best) and carefully smooth the epoxy at the edge of the opening, making sure to keep the edge vertical.

The deck collar assembly

When you're not on the boat, you can be working on the mast collar and its backing pad. The mast collar is probably aluminum and may be significantly corroded. After I wire-brushed mine down to clean metal, I washed it with acetone, prepped it with a two-part zinc chromate-based self-etching primer wash for aluminum (the marine paint companies make this), faired the pits with epoxy, sanded it smooth, washed it again, and painted it with four coats of two-part linear polyurethane paint. Make sure it's straight (not bent or warped) before you finish it.

If you already have an interior trim piece under the mast collar, you can use it as a template for your backing pad (or use the piece itself if it's still strong and intact). If there's no such piece, use cardboard to make a template.

You'll want the opening to match the opening in the deck exactly when the piece is through-bolted. To ensure this, put the deck collar in place (after you've finished and cleaned up the mast partners) and mark the screw-hole locations exactly on the deck, making sure the deck collar is centered exactly over the opening and doesn't move while you're marking. Remove the deck collar and clamp the interior piece or template exactly in place underneath. Drill the holes the correct size for the machine screws or bolts you're going to use, all the way through the interior piece below. Make sure they're as straight as you can possibly drill them. Replace the deck collar and check all the screws to make sure they fit. Make sure the interior piece fits exactly — opening and screw holes — before finishing it. The only way to do that is with a complete dry-fit. Once you're satisfied, over-drill the screw holes in the interior piece, clean out the holes, and fill them with epoxy. After the epoxy cures, re-clamp the piece in place and re-drill the correct size holes from above. Dry-fit it again. Then you're ready to finish the piece. My interior piece was rotted, so I used it as a template and made a new piece out of plain old exterior-grade plywood saturated in epoxy and painted with two-part linear polyurethane.

Make sure all surfaces are clean, then apply bedding compound to seal everything. Clamp the parts together lightly. Don't fully tighten until the caulk has started to tack; this helps form a better seal. Smooth out the edge of the caulk where it squeezes out into the opening; you want a flush-walled opening.

Shown from above, the mast partner area before repair has work to be done.

Clean partner area ready for epoxy fill.

Shown from below, loose adhesive between the headliner and bottom deck laminate has been removed. Note that the staining on the headliner has been cleaned off. There was only cosmetic discoloration of the bulkhead tops. Inspect any bulkheads in the immediate vicinity for water damage.

¼-inch x 4-inch-square aluminum tubing scrap with the outline of the original step casting. This will become the mast step riser that sits on the keel. It's worth less than $10 from a scrap metal dealer.

The mast butt

The first thing to do is to examine the mast butt itself. This is much easier when the mast is out of the boat and the butt is dry. Wipe the crud off and examine the metal for severe pitting (large in area and penetrating well into the wall thickness of the metal). On my mast, significant areas of metal had been completely eaten away. Establish how far up the mast the bad corrosion goes. Minor superficial pitting that looks like pockmarks doesn't count. Unless your bilge is really deep, you should get away with cutting off just a few inches. But before you cut, figure out what you're going to use for a riser. On my Pearson 28, 4 inches seemed to be the rule, which is why I used a scrap of ¼-inch x 4-inch-square aluminum tubing.

Stuff like this is available from scrap metal (and new metal) dealers who may have small pieces lying around. Scrap metal is really cheap. New metal dealers may be willing to cut you a piece.

Other owners of your type of boat are a gold mine for leads on stuff like this. If you can't find or can't use a piece of square tubing, you can have a metal shop put something together for you for $50 or so. You don't need stainless steel or bronze; aluminum is fine. If you have something custom made, an I-shaped structure will work.

Use the step casting base as a template. An alternate take on the I-shaped riser will work if your step casting is salvageable; clean it up and have the metal shop weld the step casting directly to the vertical piece, eliminating the top plate of the riser (and a welding joint).

If you use tubing, your life will be easier the closer you can match the footprint of the step casting. The surface of the keel may be uneven, and if the footprint of the new riser is wider than the step casting, it may not sit down completely, causing your mast to be just a little bit taller and your stays and/or shrouds to be just a little bit shorter, which is irritating and expensive to remedy.

Cutting off the mast butt

The principle is simple: cut off exactly the same amount of mast butt as the height of the riser you're going to use. Measure up from areas of the bottom edge that are still straight and intact. Use the edge of a file folder wrapped around the mast to connect the dots, and tape it in place to use as a guide. You can cut through the mast pretty handily with a good hacksaw with a sharp blade. Be careful to cut it straight. File or sand the cut edge smooth.

Optional, but recommended: clean up the section of the mast that lives below the cabin sole and apply a full aluminum treatment of zinc chromate primer wash, epoxy barrier primer, and two-part polyurethane paint to the area — inside and out — to protect the mast from further corrosion. If you've always wanted a painted mast in the cabin, go all the way up to the overhead.

Keel-stepped masts may be stepped in a variety of ways. In some cases, the butt of the mast sits in a casting on the keel. In other cases, the butt of the mast sits in a casting that rests on floors or stringers or both. These may rest on the keel but commonly do not.

The mast step has been removed from the boat.

The mast step is now clean and bare with the ears cut off and holes drilled. Note the area where it corroded all the way through. This will be filled with thickened epoxy.

Phillip bedded and through-bolted the step casting to the top plate of the riser. Then he bedded and screwed the riser to the keel. He coated the screws and bolts with 3M 5200 where they contacted the aluminum.

forced area above the keel. If any parts of the structure that supports the mast are made of wood, inspect them for rot, delaminated plywood, or other kinds of failure. If the structure is metal, inspect for corrosion. If any of this structure needs replacement, it must be done with a plan to bring the new surfaces to the same point in space as the old ones so the mast butt will be in the same place. If you designed the new step to be higher than the old one by the amount you cut off the mast,

Do not assume that the loading is all compression, straight down. With a keel-stepped mast there is considerable side loading and there can be loading fore and aft, particularly if there is any mast bend in that direction. Study the original mounting for clues to the designer's intent.

Nice feature

Shims are a nice feature if you can work them in, because you'll have recourse if the mast needs to be raised or lowered a bit. This may happen if the mast was already short from wearing in the step casting.

In all cases, there should be a direct metal path from the mast to the metal keel. This can be either metal structure or wire. Use at least #8 wire to ground the mast to the keel, unless there is a direct metal structural path for the lightning bolt you hope you never meet. If wire is used, it should make as few bends as possible to reach the keel. Even a partial turn or bend in the wire adds inductive reactance to the circuit in a lightning strike. Any resistance to current flow increases the likelihood of side flashes, which are a danger to the crew.

The moment of truth is when the mast is back on the step and the turnbuckles are re-attached. If something is a little off, one or more shrouds or stays aren't going to go back on. In my case, I had to add an eye-jaw toggle to my headstay. No hanging matter — the mast is straight — but it was irritating and stressful. I think the bottom plate of the riser, a little wider than the step casting, sat up a little higher, which is why I strongly recommend making triple-sure the riser sits exactly the way the step did, even if that means a custom-made, welded, I-shaped riser.

I put in some temporary wedges at the partners, tuned the rig, and used Spartite to chock and seal the mast partners. I covered that with a rubber mast boot and covered that with a Sunbrella mast boot cover. I don't expect to ever worry about the mast again.

Author's note: Even when I do a boat project "alone," I don't really. Thanks to Michael O, Lou, and Cap'n Ron of the Pearson 28 Forum (<http://www.geocities.com/CptinRn>) for getting me started on this, and thanks to

Chainplate restoration

One sailor's solution

by David Cowell

These bushing cores brought relief. The wood in the bore of the holes had been worked by repetitive forces but was not wet or damaged.

I was in the cabin of *Mas Tiempo*, my Islander 30, when I noticed something different in the symmetry of the shroud chainplates. These chainplates are attached to the main bulkhead with carriage bolts. The shine and robustness of their polished stainless steel sends a comforting message of strength. But I noticed that some of the bolt heads weren't flush with the chainplate. They were tipped.

This — and my recent experience with setting up the standing rigging — were sending an entirely different message: a red flag. When I set up the rigging, the shroud turnbuckles had needed almost full-length adjustment to take up tension. Yet on a hard reach, the lee shrouds seemed too slack. I had noted this but, as the boat had been out of the water for nine months without the mast, I thought I'd let it "settle in" before re-tightening the shrouds.

Slack shrouds can be an indication that a deck-stepped mast is settling. The mast base won't properly support the mast if the cabintop is weak or the compression post underneath is deteriorated. I had just replaced the mast base plate and hadn't noticed any signs of gelcoat cracking or cabintop distortion, and the plate hadn't leaked into the cabin. Instead, it appeared that the boat's chainplates were pulling out.

I bought *Mas Tiempo* out of salvage after owning an Islander 24 for a couple of years. The construction and strength of that smaller boat had impressed me, but it was a little too snug. When the 30-footer came up, I jumped at the chance to upsize. I spent winter and spring getting her ready for launching. I did a total hull repair and added an epoxy barrier coat and antifouling paint. I overhauled the engine and installed a new shaft and folding prop. I replaced the wiring systems and re-rigged the running gear.

What happened?

"But," I pondered, "what had happened to the chainplates?" Forces on the chainplate's mounting bolts had caused them to crush the wood around them. Then, because the full thickness of the wood was no longer available as a bearing surface, the round bolt hole elongated into an oval, and the bolt tipped. Bolt holes elongate when mast loads are greater than expected, when the wood becomes punky due to rot, or weak through age, or when the nuts aren't kept tight and the bolts are able to gain leverage on the wood. On a boat that's 30-something, these things can happen.

The bulkhead wood will rot when the deck seal fails and water seeps into the cabin, soaking the wood around the plates. Marine surveyors are always alert for water stains and rust around the chainplates. The wood can also fail if the system is carrying greater loads than the designer calculated or if something happens to the mast system, as it might in a knockdown. However, those things usually lead to a catastrophic failure, whereas my problem was indicative of age fatigue.

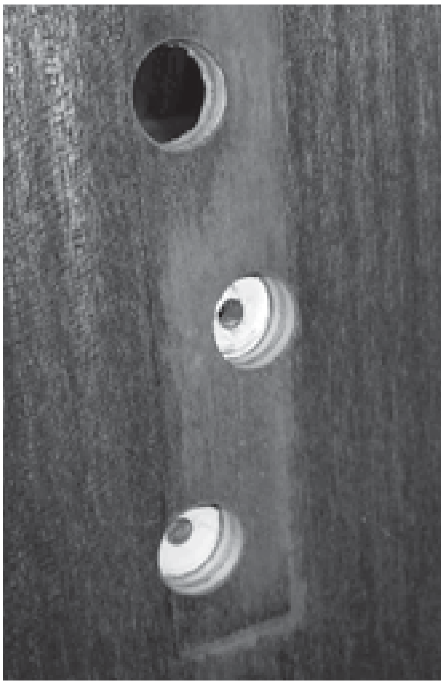
There are many ways to fix loose chainplates. One alternative is to repair the chainplate bolt holes. Another is to add chainplate extenders. A third is to replace the chainplate itself. These solutions require that the bulkhead wood be dry and in good condition. If that is not the case, another, more extreme, alternative is to replace the entire bulkhead.

Chainplate extenders bolt over the old plates and extend down the bulkhead to increase the number of bolts in better wood. This has the effect of decreasing the load on the original bolts but doesn't really repair their weakness. Adding extenders requires adequate room below the old plates. Extenders look a bit "patched up," but they're cheap to buy, simple to install, and they do solve the problem.

> **"There are many ways to fix loose chainplates. One alternative is to repair the chainplate bolt holes. Another is to add chainplate extenders. A third is to replace the chainplate itself."**

Different locations

The next rung up the repair ladder is to replace the chainplates with substitutes that use different bolt locations



Chainplate holes drilled for bushings, top; a washer with epoxy ready for insertion, center; and a washer and epoxy packing, bottom.

and perhaps extend farther down the bulkhead for additional load area. This is cosmetically more appealing, but more costly and more difficult. My original plates have four 5⁄16-inch carriage bolts and are not quite 2 feet long.

If the wood isn't sound enough, the only option is to replace the entire bulkhead. This requires cutting away the old bulkhead with implements of destruction, fitting in new wood, which must then be tabbed to the hull, deck, and associated cabinets and joinery. It's messy, labor-intensive, and expensive. The bulkhead plywood must be marine-grade, the veneer will have to match the original, and there is a temptation to increase the bulkhead thickness as added insurance against future problems. This is a major undertaking requiring carpentry and fiberglass skills. The accessibility of the tabbing is a major consideration and other nearby cabin woodwork may be damaged in the process of removing the bulkhead. Still, if your aim is to have a strong-as-new result, then bulkhead replacement and new chainplates are unavoidable.

When I was buying this boat I looked for water stains on the bulkhead and rust on the plates. I didn't find any, nor had the loose and tipped bolts appeared since the mast wasn't stepped and the chainplates weren't loaded. Whether I would have bought the boat with the failing chainplates is a good question…but a moot one.

As I plan on sailing this boat aggressively and far, the problem had to be fixed properly. But I balked. Since I had been involved with so many other needed repairs I was reluctant to jump into bulkhead or chainplate replacement. I hadn't enjoyed sailing her enough!

Inspected holes

I removed the plates and inspected the holes and wood around them. I noted that the nuts weren't locknuts and weren't very tight. In some places the washer had crushed the wood. This might have allowed enough play to let the bolts tip and upset the holes. I noted that the bolts had a carriage bolt-style head that mated to square-punched holes in the chainplates. This gives the round bolt head a smooth look and relieves the installer from having to wrench the head. Using oversized bolts would mean drilling out a square hole and losing that clean appearance.

I inspected the chainplates carefully, looking for corrosion in the deck-joint area, elongated clevis-pin holes, and cracks radiating from any of the holes. Any sign of failure of the chainplates themselves also should be investigated. Machine shops can magnaflux, inspect with dye penetrant, or X-ray metal parts for cracks. In my case, the plates were sound.

Inspection of the bulkhead holes showed no sign of rot. The wood in the bore of the holes was somewhat gray but not black. It had been worked by repetitive forces and had fatigued. What a relief! I wouldn't have to replace the bulkhead. I only had to repair the holes and reset the plates.

So how do you repair an oval hole in wood? You could drill it out to a larger hole and use a larger bolt. You could fill it with filler and re-drill it. You could drill it out to a larger diameter and install a bushing to get back to the original size. You could move it to another location. Each method works but has its own advantages and disadvantages.

Not best-looking

Using larger bolts would have meant drilling out the plate and having a hex bolt head where the smooth round one was. I decided this was not esthetically pleasing. Drilling out the square hole in my plates would have created its own problems, and I couldn't punch larger square holes in the plate without special machinery.

"Whether I would have bought the boat with the failing chainplates is a good question …but a moot one."

> "What a relief! I wouldn't have to replace the bulkhead. I only had to repair the holes and reset the plates."

The idea of using a filler brought up the question of what material might be suitable for the expected loads and how to get it to adequately transfer these loads to the surrounding wood. Epoxy filler is typically used for reinforcing and filling holes in boats. The usual method is to completely fill an oversized hole and re-bore it to the required diameter, thus creating an epoxy bushing.

Epoxy has its drawbacks, though. The first is how to make the liquid epoxy completely fill the hole while in a liquid state. The stuff has a tendency to ooze, and any void left behind is likely to be at the top of the hole where the load will be. A void could possibly crack the bushing. The use of fillers makes epoxy more like putty that can be pressed into an oversized hole. But it's hard to drill a hole in epoxy that is stronger than wood. The epoxy bushing could break loose and spin in the hole before the hole is drilled through.

A metal bushing would work. A metal bushing won't crack or ooze out when pressed into wood. There are standard threaded wood inserts made of steel. These might have met the need but, as they are generally made of steel, they will rust. Stainless-steel bushings would have to be custom-made. A third choice was to use stainless-steel washers stacked to the right thickness. Such a stack would form a decent bushing if the hole could be drilled out to just the right size to accommodate the washers' outside diameter.

Washers and resin

My solution was to use stainless-steel washers and epoxy. The epoxy filled the void between the washers and the wood and bonded the washers and wood together. Once I had the concept, the technique was simple. I drilled out the deformed holes to a size just larger than the washers so they would be a close fit and concentric with the original hole.

I determined how many washers were needed by stacking them to the same thickness as the plugs I had cut out. Holding a bolt in place with a fender washer and some duct tape, I buttered a stainless-steel washer with epoxy and filler and put it into the hole. I continued to add buttered washers to create a washer sandwich. In this state, the sandwich was thicker than the bulkhead. I placed another stainless fender washer over the end and tightened the whole with a nut, compressing the sandwich into the bulkhead. This pressure squished the epoxy out into the void around the washers, filling it. Since hydraulic pressure is equal all around, the epoxy flowed everywhere, including into the porous wood.

If you choose to use the chainplate and the original carriage bolt when making the bushing, they will be epoxied together and leave no way to subsequently remove the bolts, short of hammering them out (possibly destroying the bulkhead). But using a hex bolt and fender washers allowed the bolt to be removed by unthreading it. The epoxy forms perfect threads which can be drilled out for the original carriage bolt or used as a threaded insert. Using the chainplate means one has to load the sandwich from the back side whereas using a second fender washer and hex bolt means one can load it from either side.

Back in position

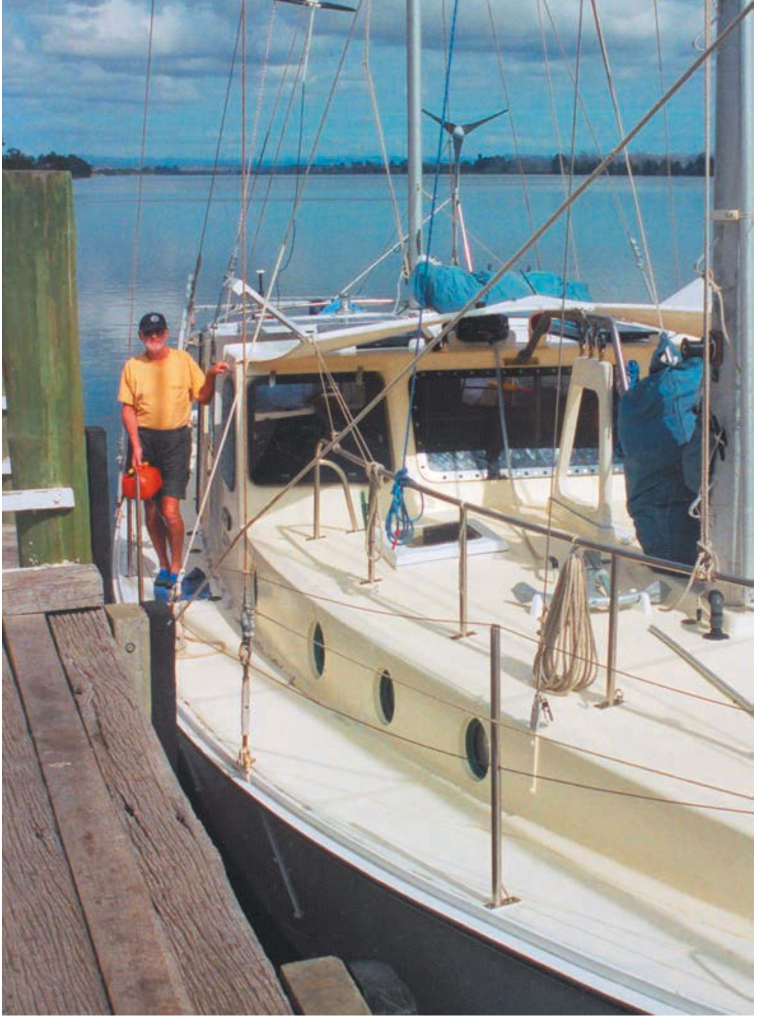
After the epoxy has cured, the chainplate can be bolted in its original position. It then must be sealed at the deck joint. I used 3M 4200 for this, as it forms a flexible bond to the metal and the gelcoat of the deck. The shrouds can then be installed and tensioned as needed.

Chainplate backing washers, at right; the finished repaired chainplates, far right.

Is this system strong enough? The weak link in the chainplate shroud system is the aging wooden bulkhead and its metal-to-wood junction. Since the wood isn't easily replaced or structurally reinforced, the best thing is to reduce the stress on it. The applied compression loads from the shrouds aren't changed. Therefore to lower the wood-to-steel interface stress, it's necessary to increase the bearing area. Increasing the bearing area from the original 5⁄16-inch bolt to a 3⁄4-inch washer means the wood will experience less than half the original stress at the interface. I tested the epoxy-washer sandwich with a piece of plywood to ensure the joint would be solid. The increased fender-washer cap will eliminate the washer compression of the wood.

I believe this system is stronger than the original and will last the remaining life of the bulkhead and the boat.

David Cowell is a retired electrical engineer. He and his wife, Jamie, enjoy sailing in the Sacramento Delta and San Francisco Bay in their Islander 30, Mas Tiempo*. As this issue went to press, Dave was indulging his passion with a cruise in Mexico.*



Pilot rails

A better way to keep the crew on board

by Alan Lucas

Author Alan Lucas aboard *Soleares*. Alan's pilot rail can be seen on the cabintop. This convenient handhold adds safety for those moving about on deck, helps contain sails when they're being furled, and is a great place for tying off any halyards not in use.

Commercial vessels have a lot to teach their recreational cousins, yet many of their lessons go unheeded. A prime example is cabintop handrail systems. Recreational boats' handrails along the trunk cabin are generally too low to properly complement the dynamics of the human body, forcing us to reach down in such a way that instability, rather than security, can result. Most cabintop handrails on yachts and small motorboats become little more than convenient stowage sites for such items as a rolled awning, a boathook, and the tender's oars, instead of something to wrap your hand around and hang onto for dear life.

Alternative handholds on these vessels, such as shrouds and stanchions, are mostly outboard of the person seeking security when walking around the sidedecks. However, the most secure grip should be inboard. Outboard handholds ❶ are much appreciated at times, but they are containment devices rather than truly useful means of hanging on. The best way to really hang on securely while moving around the deck is to reach inboard ❷, and most cabintop rails tend to defeat this object by being much too low (unless you crawl).

This is where commercial vessels can teach us so much. The next time you see a pilot boat at work, note how the pilot manages to hang on without a lifeline, regardless of sea conditions, yet is clear to leap directly from the sidedeck onto a ship's ladder. The rail he uses (aptly named the pilot rail)❸ is inboard of the sidedeck and, most importantly, is around waist height where it complements the human frame by not obliging him to bend down to hang on. Holding a deck-hugging rail near knee level is an unstable and unsafe position for a person who depends on absolute security while executing vessel transfers. By extension of that simple logic, anything less than a pilot rail on any type of vessel gives little more than a false sense of security.

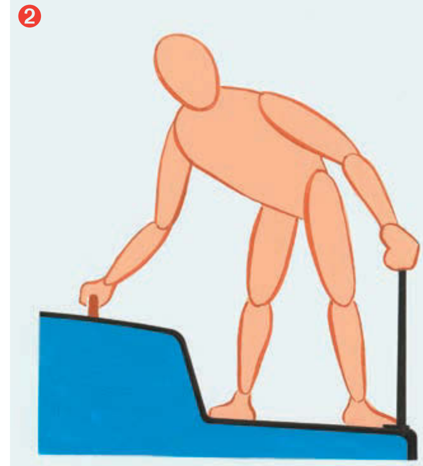
Compatibility question

Comparing the pilot rail to the standard cabintop version raises the question of its compatibility with a small recreational vessel, especially a sailboat whose boom cannot be raised without too great a loss of sail area. The answer is a compromise between a normal roof-hugging handrail and one so high it interferes with the boom. Anywhere between the two is far superior to one too low, especially if you use it as a storage rack. If it is only high enough to give clear and immediate hand access above the stowed items, then an advantage has been gained. However, a much higher

❶

Outboard handholds are containment devices, perhaps, but they're not useful for hanging on.

❷



Cabintop rails cause sailors to bend over awkwardly (unless they're crawling to the foredeck and back).

> **The answer is a compromise between a normal roof-hugging handrail and one so high it interferes with the boom.**

rail, reaching close to waist level, is the ideal system and is possible on most vessels, especially those of more than 35 feet.

Presuming your vessel lends itself to the fitting of a pilot rail, consider its need for bracing. Generally speaking, the average pilot rail only needs one brace at each end, with its longitudinal curvature adding plenty of rigidity to its overall strength. The governing factors here: curvature of the rail (following the cabin's shape on each side), height of rail, the diameter of tubing used, and stanchion spacing.

In the design and fabrication of a pilot rail, there are no hard-and-fast standards, but the experienced worker in stainless steel will instinctively know sensible tube diameters and stanchion spacing related to length and height of the system. The rail's length will be subject to cabin length; its height will be a factor of cabin height plus the remaining distance between cabintop and a person's waist. The total height is typically around 3 feet 6 inches, but this can be lowered a foot if necessary and still produce a rail that will be infinitely superior to what is on most sailboats.

Spread of sealant

Regardless of precise overall dimensions, stanchion bases should have enough area to accommodate a good spread of sealant between them and the cabintop. Through-bolts are the preferred fasteners on glass and wooden cabintops. These should be complemented with under-deck plywood or solid glass pads of maximum area to spread the stanchion's loading. If an existing traditional, cabin-hugging handrail is being replaced with a pilot rail, then its route can be followed using the doubling that should be already in place.

This presumes that the old route is far enough inboard to satisfy another virtue of the system (presuming it is wanted and is possible). This virtue is the way in which a pilot rail can also produce a very secure seating area along the cabin ❹ for those needing to rest while working the foredeck but who are unwilling to return to the cockpit between bursts of exertion. Depending on the distance inboard of the pilot rail, a person can sit on the cabin edge with arms hooked back over the rail, which then becomes a backrest as well as a very firm handhold. It is an ideal place to seat guests in port or fair weather when the cockpit reaches capacity.

Not only does the pilot rail provide security for standing and seated persons, it also acts as a secure cabintop pulpit against which feet can be braced while furling the mainsail in a seaway. ❺ It is true that when returning to the deck it can also trip the unwary, but this is a matter of familiarization and it is, in any case, an accident that should not happen, thanks to yet another advantage of this multipurpose rail.

This advantage is the way in which it can be used as an alternative place to tie off extra halyards when not in use. By tying them around the rail (or perhaps to a small crossbar cleat under the rail on one or more of its stanchions), the halyards are not only handy when needed but, because they are restrained away from the mast, slapping is minimized or eliminated. Because a pilot rail invariably becomes festooned with a number of halyards, they provide secure handholds when climbing over the rails to handle the mainsail.

Pilot rails are such an intrinsically safe and secure means of working the deck of a small boat that, once tried, the traditional cabin-hugging grabrail will be abandoned forever. If your sailboat is too small to adapt to the system, consider losing a foot of mainsail. In most cases the loss is more than compensated for by that wonderfully confident feeling of being a real part of the vessel, rather than an irritant she constantly endeavors to reject.

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The pilot rail is inboard and waist high so a sailor can reach it without bending. A brace is essential at each end of the rail.

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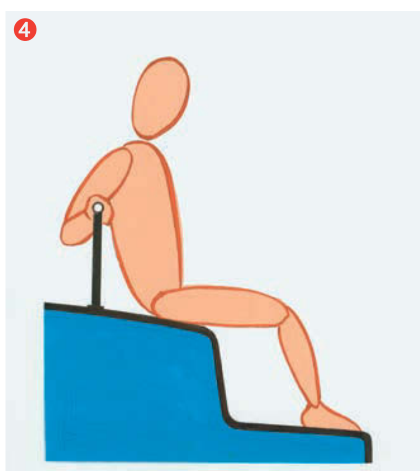

The pilot rail provides a secure backrest and seating area for crewmembers taking a break between foredeck activities.

❺

A pilot rail also offers a foot brace for working on the mainsail in a seaway and a handy attachment point for halyards.

Adjusting your standing rigging

It's as important for cruisers as for racers

by Ted and Claudia Bowler

HOW LONG HAVE WE BEEN SAILING? Twenty years? Thirty? How many different sailboats have we owned? Five? Ten? Had we ever tuned our rigging? Never! And yet, since sailboats depend so much on their masts, it's hard to believe that at no time had we touched our standing rigging.

We had numerous excuses, among them: "We're cruisers. We're not interested in racing." However, every time we were on the same course as another sailboat we continually gauged our relative speed, always trying to get every last fraction of a knot from our course and sail trim.

We also rationalized by saying: "If it ain't broke, don't fix it" and "We don't have enough money to pay a professional." We made all these excuses and more to avoid the confusing job of tuning the rigging on our boats.

After purchasing *Fiddler's Green*, a 28-foot Bristol Channel Cutter designed by Lyle Hess and built in 1977, we noticed she was not performing to our expectations. First, she would rarely reach theoretical hull speed. Theoretical hull speed in knots is 1.34 times the square root of the waterline length in feet. This mathematical expression predicts the maximum speed expected for a displacement hull. Our boat, with a waterline of 26.25 feet, has a theoretical hull speed of 6.9 knots. We regularly sailed at 6.0 to 6.4 knots but seldom went faster.

Second, our speeds on starboard tack and port tack varied. We knew these should be equal. Third, our boat had excessive weather helm. It was tiring after only a few hours of sailing in even moderate winds. And finally, our boat never seemed balanced. We were always fighting to develop a balance that was never achieved.

Knowledgeable people around the dock and professional riggers told us all these deficiencies could be caused by our standing rigging being out of tune. They told us mast rake is very important for boat balance, speed, and weather helm. Decreasing the aft rake of the mast (standing the mast more upright) would decrease weather helm. However, we didn't even know what the mast rake on our boat should be. Sailing was becoming a chore. We could not put it off any longer. We set about studying the art and science of rig tuning.

Since those days of "rigging ignorance," we have developed a step-by-step cookbook approach to tuning our

Horizontal spreaders or spreaders pointing downward are indications of problems (1). An inclinometer helps determine mast rake (2). A deck bracket allows some horizontal positioning of the mast base (3). Reposition gear to attain even trim (4).

standing rigging to make the process simple, understandable, inexpensive, and easy. Our regular tuning allows us to sail at or near hull speed, speed is equal on both tacks, weather helm is greatly reduced, and the boat is balanced, requiring much less effort to sail. Sailing pleasure is increased dramatically.

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Standing rigging

The standing rigging consists of stays, shrouds, spreaders, tangs, chainplates, wires, terminals, and turnbuckles. The stays are mast-supporting wires that run fore and aft. The shrouds are mast-supporting wires that run athwartships. Spreaders separate shrouds to reduce compression loads on the mast. Tangs attach the wires to the mast, while chainplates attach the wires to the deck or hull. The attachments at the wire ends are called terminals. Turnbuckles allow fine adjustment of the tension in the standing rigging. Wires can be galvanized steel, stainless steel, or rod; 1 x 19 stainless-steel wire is the most common in use today.

Before you begin tuning your rig, it's best to know what's on your boat. Measure the diameter of the wires with a rigging-wire gauge or a caliper. If you can trace the history of your rigging, try to determine what alloy the wires are made from. The diameter and alloy will be important in determining the breaking strength of your wires, which, in turn, is a factor in how you tune your rig.

Mast-tuning objectives

There are three objectives to rig tuning. The first is to keep the mast straight (in column) and perpendicular to the deck under all points of sail. A second objective is to set the desired amount of fore-and-aft mast rake. The third objective is to pretension the rigging.

Contrary to popular belief, a loose rig is not good for a boat. If the rigging is too loose, it produces excessive shock wear and structural damage. On the other hand, if the rigging is too tight, it can overstress the hull and stretch wires. It may even cause fittings to fail.

The boat designer determines the amount of mast rake. It can range from 10 degrees in a classic boat to none at all on some modern designs. Masthead rigs commonly rake the mast a half to a full degree aft; fractional rigs commonly will rake the mast 2 to 3 degrees aft. Extreme racing designs will exceed these norms. No designers rake the mast forward anymore, although this was done on some classics long ago. Sailmakers design their sails to account for the rake of a mast, and in some cases the sailmaker or owners' association may be able to tell you what is a good starting point for your boat's mast rake. When the rig is properly set up, there should be a slight weather helm, so that if the wheel or tiller is let go, the boat will slowly head up into the wind. As the mast is raked farther aft, the boat will have increasing weather helm. If it is raked more forward, some weather helm is eliminated. There is a limit to what can be achieved with mast rake. Some designs simply have a lot of weather helm, particularly when excessively heeled, and raking the mast forward will not correct it completely.

Spreader angles are important, but it is not uncommon to see spreaders set up incorrectly. Horizontal spreaders or spreaders pointing downward will cause the boat to experience much higher rigging loads. Spreaders should bisect the shroud, making equal angles with the wire above and below. A simple way to insure that the angles are equal is to fold a piece of paper at the correct angle above the spreader. Then rotate the paper to measure the lower angle. If possible, move the spreader up or down until the angles are equal. Some spreaders and spreader sockets are configured so the spreader angle cannot be adjusted. In these situations, it is probably better to accept the angle of the spreader that is built into the spar.

> "Sailing was becoming a chore. We could not put it off any longer. We set about studying the art and science of rig tuning."

Dock analysis

It is false economy to try to tune your rigging without a rigging tension gauge. Start by documenting exactly how your rig is currently set up and tensioned before making any changes. Record the tension of each wire and the rake of the spar.

Choose the right days

For the dockside part of the tuning process you need calm weather. Wind and chop increase the tension on the windward side of the rigging and cause rolling, making it difficult to determine the exact mast rake. The second part of the tuning process is done under sail. For that, a good stiff breeze is needed in a place where waves have not yet developed.

Each type of rig design is tuned

Center the mast base (5). Tighten or loosen turnbuckles one turn at a time (6).

somewhat differently. If we ignore ketches, yawls, and schooners, we still have four common single-mast rigs: the masthead sloop and cutter, and the fractional rig with or without running backstays. These vary further, depending on how many spreaders and how many lower shrouds they have. We will focus mainly on the masthead rig because it is a more common cruising rig. There are seven parts to tuning most rigs:

1. Hand-tighten cap shrouds to make the mast vertical as viewed from ahead or astern.
2. Adjust mast rake with the forestay and backstay.
3. Tension the cap shrouds to 15 percent of the wire's breaking load.
4. Set the mast pre-bend, if this is part of the rig design.
5. Check and adjust maximum mast bend.
6. Check and adjust the cap shrouds under sail.
7. Straighten the mast sideways while under sail by adjusting the lowers and intermediates, if there are any.

The process is slightly different for fractional rigs. There are two main types of fractional rigs. One uses running backstays and spreaders set perpendicular to the keel. For this rig, the second step involves setting mast rake with the forestay and the running backstays. The other kind of fractional rig uses aft-swept spreaders. In this case, set the mast rake with the forestay and backstay, but set the cap shrouds to 20 percent of breaking strength. This is needed to keep the forestay tight.

First trim the boat

To begin, insure that your boat is level. You will need to be on the shore or at a pier to trim your boat. There should be no list to port or starboard. Examine the fore-and-aft position. The boat should float on its lines. Return to the boat and use an inclinometer or level to verify that it is level. Sadly, boats are less symmetrical and uniform than you might think. Try several ways to determine level, perhaps placing a very flat plank across the seats or even using a level on the galley table. If the boat is not in trim and is listing one way or another, adjust the position of the gear and supplies on board to attain proper trim side-to-side and fore-and-aft.

Slacken mast attachments

Slacken all attachments including sheets, topping lifts, shrouds, and stays. There should be no tension on the mast. Support the boom or remove it. Now is a good time to lubricate the turnbuckles. Spray the threads with WD-40 and clean off all the corrosion. We find it easiest to clean the threads with a small stainless-steel wire brush. Place a rag on the deck to catch the over-spray. Once the fitting is clean and free of corrosion, apply a small amount of Teflon grease. We use an old toothbrush to get lubricant into all the small threaded areas. Remove all cotter pins, split rings, and seizing wire. Place a small piece of masking tape on one side of the turnbuckle to help you remember the exact position. Count the number of turns of the turnbuckle as you tighten or loosen each fitting. You can also define the adjustment of an open turnbuckle by measuring the span between the ends of the threaded studs.

Center the mast

Now check to see if the mast base is centered. Use a tape measure and measure from the outer edge of the mast to the inner edge of the chainplate, port and starboard. The distance should be equal. Our mast is mounted in a deck tabernacle, which is supported by a compression post extending to the keel. This bracket allows for some horizontal change in the position of the mast base. If your mast is keel-stepped, it might take some work to reposition the step, but you can easily adjust the way the mast is positioned as it passes through the deck. This is an important step. If the mast is off-center, the boat will be unbalanced.

Next, check to see if the mast top is centered. If you take the mainsail halyard and extend it to the inner edge of the port and starboard chainplate, the distance should be equal. If it is not equal in length, you will have to begin adjusting the upper shrouds, pulling the masthead into proper position. Slightly tighten and loosen each upper shroud until the distance measured by the halyard is equal. After each adjustment, sight up the mainsail track to insure the mast remains straight. Note: tighten and loosen only one turn at a time on each side.

When tightening and loosening the stays and shrouds, always keep a wrench on the wire side of the fitting to insure you are not twisting or untwisting the wire.

Mast rake

Place an inclinometer (purchased at any hardware store) along the mast and read the angle of the mast rake. This gives you the rake for this particular position on the mast. If the mast is straight along its whole length, this is your mast rake. However, if your mast is not straight the whole distance, this angle is not accurate.

A more precise way to determine your mast rake is by placing a weight at the end of the mainsail halyard. This creates a plumb line hanging vertically from the top of the mast. Measure how far back the line is where it crosses the boom. If you know how far behind the mast the halyard is when it leaves the sheave box, the length of the mainsail luff, and where the plumb line crosses the boom, you can calculate the angle of rake. This calculation may be of some academic interest, but knowing the actual angle is not as important as just knowing how far back the plumb line is when it crosses the boom. Many sailing classes simply tune by measuring the distance of the plumb line from the mast. It is actually a more sensitive measure than the calculated angle, which is necessarily quite small.

If you want to decrease weather helm, rake the mast forward. If you want to increase weather helm, tip the mast back. Move the mast by adjusting the forestay and the backstay on masthead rigs. Fractional rigs that have their spreaders swept aft will make this adjustment using the forestay and upper shrouds instead of the forestay and backstay. Fractional rigs that do not have their spreaders swept aft will use the forestay and running backstays. Remember to measure rake before you adjust it and then afterward, so if you don't like the way the boat handles, you can go back to the way it was before you started "improving" it.

Forestay/backstay

When you have a bunch of wires holding a post up, it is almost intuitively clear that changing the tension of any one of them will change the tension of all the others. Still, many people tune rigging without taking this into account. Keep in mind that wires directly opposite the wire being adjusted will be changed the most. There is a weak relationship between cap shrouds, a stronger one between lowers, and a very strong one indeed between the forestay and the backstay. Think of the length of the forestay as determining mast rake and the tension of the backstay as determining the tension of the backstay and the forestay.

Keep in mind that if the size of your rigging wires has been increased at some point, you should not tension the rig to the percentage of the breaking strength of the new wires. Tension it to a percentage of breaking strength of the old (as the rig was designed) wires. The hull and mast step may not be able to withstand the higher rig tension of the new wires. Their higher breaking strength is only useful as a safety margin.

With the mast rake set, tension the backstay to 30 percent of breaking load and then back it off to 20 percent of breaking load. This will cause the forestay to be tighter than 20 percent of breaking load because it is at a steeper angle to the mast. Measure the forestay, and ease the backstay if the forestay is above 30 percent of breaking load. There may also be maximums given by your boat's manufacturer for either the backstay or the forestay. Don't violate these maximums. Manufacturers have seen hydraulic backstay adjusters damage hulls and rigging. They know the safe limits. Follow their requirements.

The tension of the forestay and backstay combination will have a major effect on forestay sag when sailing. We want to keep sag to a minimum when beating in strong winds. Too much sag decreases windward performance. Remember that the length of the forestay controls rake; the tension of the backstay controls the tension of the forestay and thus its tendency to sag off to leeward on a beat. On a typical 30-foot boat, 4 inches of sag might be OK, but 6 inches would be considered too much.

Upper shrouds

The wires needing the most tension after the forestay are the upper shrouds. Tension here should be in the range of 15 percent of the breaking strength of the cable. Tighten both sides hand-tight. Then sight up the mast to see that it is straight. Begin tightening one side at a time, one or two turns at a time, until the desired tension is achieved. Sight up the mast regularly to insure it's straight. If you develop a bend to starboard or port, the shrouds have uneven tension, and you need to loosen and tighten the respective sides until the mast is straight once more. Remember that the tension of one side will have some effect on the tension of the other. In the case of a fractional rig with aft-swept spreaders, set the cap shrouds to 20 percent of breaking strength. This is necessary to get enough tension in the forestay. If the forestay tension is still not enough, and it sags off too much to leeward on a heavy-


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The plumb line method can determine the rake of the mast (7). Re-check all tensions to insure they are correct (8). Use the link tang extension to lengthen your rigging wire, if needed (9).

Check for breaks in the rigging wires (10). Check for cracks on the fittings (11). A common do-it-yourself swage-less fitting (12).

weather beat, pre-tension the cap shrouds to an absolute maximum of 25 percent of breaking strength.

Mast pre-bend

At this point, mast pre-bend should be set if the rig is designed to have pre-bend. On masthead rigs the bend can be achieved with a baby stay or with the forward lowers. It may also involve moving the mast step aft, so the mast is bent over the partners at the deck by the backstay. On fractional rigs that have the spreaders swept aft, the tension of the cap shrouds will force the middle of the mast forward at the spreaders. Set up the lowers to limit this pre-bend to the desired amount. The amount of pre-bend on a masthead rig can be as much as half the fore-and-aft thickness of the mast, but in no case should it exceed 2 percent of the total mast height above deck.

Mast bend on a fractional rig may be adjustable while sailing. This is done to flatten the mainsail in heavy air. The total bend, including the adjustment range, may be as much as 1½ times the fore-and-aft thickness of the mast. In all cases, even with the backstay set up to the full allowed tension, the bend should be limited to no more than 2 percent of the height from the deck to where the forestay joins the mast. Sails that are cut for some pre-bend will not set right without it. The best source of information about how much pre-bend to put in your rig will come from your boat's designer or builder. The sailmaker will know how much pre-bend was allowed for in the cut of the mainsail, and some class associations will have valuable opinions as well. Many cruising boats are set up with no pre-bend at all.

Inspection and cleaning tools

- Cotton rags
- Stainless-steel wire brush
- Rigging dye
- Mirror
- Magnifying glass
- Teflon grease
- Soap and water
- Miscellaneous line for downhaul

Tools to tune the mast

- 5- to 10-pound weight
- Tape measure
- Adjustable end wrench
- Screwdriver
- Pliers
- Stainless-steel wire brush
- Teflon grease
- Masking tape
- Rigging tape
- Level
- Inclinometer
- Tension gauge
- WD-40
- Toothbrush

Lower shrouds

Set the lowers by hand-tightening them to just snug and then tightening each side one turn at a time. The lowers can be quite loose compared to the uppers before the final adjustment is made while sailing. The forward lower shrouds should have greater tension than the aft lower shrouds. The aft lower shrouds should have one or two turns greater than "finger tight." After each adjustment sight up the mast to insure that it remains in column. Don't tension these wires to 15 percent of breaking strength yet. They typically need not be as tight as the uppers to keep the mast in column side to side.

Intermediate shrouds

Finally, if you have them, tighten the posterior intermediate shrouds or runners. These should be tightened just enough to keep the mast straight to counteract the force of the inner forestay. Our inner forestay has a large pelican clasp intended as a quick-release lever. This enables us to easily remove the inner forestay when we are flying a large jib. Tighten the inner forestay as tight as you can and still release and close the lever.

After all adjustments have been made at the dock, sight up the mainsail track and insure the mast remains straight. Re-check tensions on all stays and shrouds. Opposing shrouds should have equal tension.

Stay or shroud too short

During your tuning you may find one of the rigging wires too short. You can call a local rigger to the dock and have him replace it. Better yet, save some money by removing the rigging wire yourself and taking it to his shop with instructions for how much longer it must be. However, if your measurements are incorrect, the rigger cannot be responsible. Another alternative is adding a link tang extension, which will extend your existing wire so you do not have to replace the wire. Use the link tang extension with confidence if the breaking strength is greater than the breaking strength of the existing rigging wire.

Stay or shroud too long

If during your adjustments you find that the wire is too long, you can have new wire and fitting constructed by your local rigger at the dock. You can save money by taking the rigging wire down and delivering it to rigging shop yourself. The rigger will swage on a new fitting at the length you direct. Nevertheless, if your measurements are incorrect, you will be stuck with an extra wire that does not fit anywhere. If you have any doubts, let a rigger complete the whole procedure. Finally, you can cut the wire yourself and install your own fittings. Swageless fittings are expensive, but you get the experience of doing it yourself and the fittings are generally reusable with a new central cone. If you go this route, follow the instructions and you should have no problems. For more on doing it yourself, see the *Good Old Boat* article in September 1999.

> **"Our regular tuning allows us to sail at or near hull speed, speed is equal on both tacks, weather helm is greatly reduced, and the boat is balanced . . ."**

Tuning under sail

The final adjustments are done while sailing. The seas should be as flat as possible; the wind should be strong enough to heel the boat 20 to 25 degrees. Select, perhaps, a time in the morning just as the sea breeze begins to fill in. The vast majority of your work has been done already at the dock. Only small adjustments will be needed under sail. Typically, at this point the forward lowers will be tighter than the aft lowers, and any intermediate shrouds will be hand-tight but tighter than any of the lowers.

On a beat, check the leeward cap shroud. The wire should be hand-tight and not flopping about. If it is too loose, give it a turn or two. Tack and set the other upper shroud tighter by the same amount. Then evaluate again. When the leeward shroud is just tight enough so it does not flop around, the cap shrouds are set properly.

Now, sight up the mast. If the mast is not straight, tighten the lower and intermediate shrouds to bring it into column from side to side. In each case, to make an adjustment to a turnbuckle, tack to put it on the leeward side. Your goal is to set up the lowers and intermediates so the mast is straight. If the boat has both fore and aft lowers, adjust both a turn at a time so that the pre-bend is preserved. After adjustment is completed, the forward lowers should still be tighter than the aft lowers.

That's it. When the mast is straight, the adjustment is done. Return to port and record the tension of each wire for reference. The tension of similar wires should be equal from side to side. If you still have too much or too little weather helm, you can experiment with the adjustment of the backstay and forestay to rake the mast more or less. After each rake adjustment, set the tensions back where they were.

Secure the turnbuckles with cotter pins, split rings, or seizing wire to insure they will not back off as you sail your boat. We like split rings, as they can be removed by hand without going to the toolbox for the right tool. Finally, use rigging tape to cover any sharp edges so they don't cut or tear the sails.

Rigging inspection/care

Once or twice a year, inspect your rigging. Use a magnifying glass and a small mirror and inspect all the terminals on the rigging. It is generally easy to see any cracks beginning on the fittings. If you have any specific concerns, use a "rig-check dye." Follow the instructions on the box. (Typically, you first clean the fitting and apply a dye. A contrasting medium is then applied so the dye shows through, staining the flaw.)

Next check the wire itself. We tie a rag saturated with soapy water to a halyard and the shroud or stay. We attach a "downhaul line" to the rag as well and then slide the rag up and down, cleaning the corrosion and dirt off the stainless steel while checking for broken strands, or "meat hooks." If the soapy rag snags, it is an indication that a strand is broken. Once all the rigging has been gone over with the soapy rag, we spray it down with fresh water to eliminate the soap scum that will accumulate dirt. If you find any cracks in the terminals or breaks in the wire, replace the failed component. Consider the age of your rigging and, if it is past its prime, the first crack or two in fittings may be telling you to replace the whole set.

While cleaning and inspecting the rigging, it's a good time to check the tune of your mast. Sight up the mast to insure it is straight and in column. Stand on the dock and gaze at your spreaders to insure that they point slightly upward. The top spreader should have a greater upward angle. Bring out your log and your tension gauge and insure the tensions remain what they were at your previous tuning session. If everything checks out, you can be sure your standing rigging will be safe and functioning optimally in the months to come.

A bit of expertise

Now people come up to us and ask: "What is the rake of your mast? What is the tension on your forestay? Is your mast tuned? How can we decrease our weather helm? Do you regularly sail near maximum theoretical hull speed? What has your mast tuning done to your overall performance?"

We can confidently answer these questions and more. We are cruisers, yet we now have the knowledge of racers and can simply and easily tune our own rigging for increased safety, speed, and balance.

For further reading . . .

While this issue was in production, your editors discovered an excellent rig-tuning DVD that offers helpful visuals and a succinct overview: *Tuning Your Rig*. Master rigger Brion Toss teaches the fundamentals of rig tuning. This 90-minute overview was produced by Western Media Products, 800-232-8902, <http://www.media-products.com>.

Replacing chainplates

Dire necessity drove this 24-hour emergency repair

by Connie McBride

SHORT-TACKING IN AND OUT OF ANchorages is one of my favorite types of sailing. With a competent husband/captain, crew in the form of three sons, and a sturdy boat, I thoroughly enjoy the challenge that shoal water, twisty channels, and strong winds provide. (Of course, since we haven't had much luck with our diesel in the past four years, we have had ample opportunity to practice these skills while cruising in our 34-foot Creekmore.)

so all eyes went to the water trailing us, waiting to see what we had hit. When nothing appeared, we considered other possible sources of such a noise and vibration. One of us suggested "rigging," and we all looked up as if expecting the mast to fall. We had moved the cutter stay and tied it to the port forward lower shroud to keep it out of the way so the genny would tack more easily. Our sailboards are also attached to the shrouds which added to the illusion that all was well with the rigging.

> **"I was trimming the genoa when we heard a SHRBOING! and *Eurisko* gave a sickening shudder."**

So in spite of having no working motor, we weren't intimidated by 20 knots of wind blowing into the entrance as we were leaving Coral Bay, St. John, U.S. Virgin Islands, headed for Trinidad in July to avoid hurricane weather. We put a reef in the main, sailed off the anchor, and were doing 7 knots by the third tack. *Eurisko* was enjoying herself at 20 degrees of heel, racing toward each shore. We couldn't bear to rein her in; we left her slightly over-canvassed with the intention of putting in another reef once we were in open water.

I was trimming the genoa when we heard a SHRBOING! and *Eurisko* gave a sickening shudder. Earlier in the year we had hit a large UFO (Unidentified Floating Object) in the Mona Passage,

Failed chainplate

Finally, Dave spotted the slightly slack windward shroud, saw we had broken a chainplate, and kicked into emergency mode. "Ready about!"

Knowing we would react immediately, he didn't even wait for a reply. As soon as the load was off the port shroud, he went forward, shouting orders. "Nick, furl the headsail, get her down to three reefs. Connie, take the wheel and return to the anchorage." He used the staysail halyard to rig a temporary shroud while we shortened sail and limped back to Coral Bay at 2 knots.

While the boys and I anchored, put sailcovers on, raised the windvane, and launched the dinghy, Dave tore apart the head locker to get a better

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After 26 years fiberglassed to the inside of the hull, *Eurisko's* chainplate fittings were giving out. When the first one broke, Dave tore into the head locker to learn more about what had happened (1). Not wanting to remove what was left of the existing (but broken) chainplate, Dave had a replacement made and bolted that new piece to the old. Note the plate at the deck (2) and the broken piece with the replacement (3).

The dazzling effects of a polish job (4), and Dave with the drill (5).

look at what had happened. Our 1979 Creekmore is built like a floating tank. The only aspect of the design that has ever worried us is the chainplates, which were fiberglassed to the inside of the hull and were therefore not easy to inspect. After 26 years, we knew there was a good chance that they needed to be replaced, but Dave could never design a good way to do it. Thankfully, only one broke and we were not very far from a safe anchorage. Besides, St. John is a great place to be stuck, and stuck we assumed we were.

For five years, Dave had been trying unsuccessfully to invent an easy method to fix the chainplates, yet by the time *Eurisko* was settled on her anchor, he had a solution. How true it is that necessity is the mother of invention. The plate had broken inside the 1¼-inch plywood deck so the part below that, which was fiberglassed to the hull, was still there. Dave measured the length of the original piece, where the bend was, and where four holes could be drilled through it around the woodwork of two lockers with shelves.

Inside attachment

The plan was to lay — just inside the original — a new 24-inch piece of ¼-inch stainless-steel stock with the appropriate bend and holes and to drill through the fiberglass, old chainplate, and hull to attach new to old and both to the boat with bolts. The only drawback was that the new one would come through the deck ¼-inch inside the old, not changing the geometry of the rig significantly, but changing the hole in the deck. Dave used a drill saw — a drill bit that allows you to drill and cut — to increase the hole in the deck and caulked around this hole to fill the ¼-inch gap. Further activities had to wait until we had a new chainplate in our hands to be sure reality would match theory. I gave the boys instructions for finishing the school day, grabbed my purse and a backpack, and we were off to Cruz Bay. It was 9:30 a.m.

As is so typical there, while waiting for the bus in Coral Bay we were offered a ride. After hearing our story, the driver gave us directions to Frank, the welder, and suggested two other options, one of which included faxing the information to his friend in Virginia, who could airmail us a new chainplate.

Frank proved to be easy to find and quite accommodating. He had the 1/4-inch stainless stock, a brake for the bend, and a punch for the holes. He offered to make it while we waited, and his price was so reasonable we had him make two: $95 total. It was noon.

Back on board, the plate fit perfectly and three of the four holes were usable around the interior cabinetry. After repeatedly measuring and marking, Dave started drilling extremely slowly, using oil as a lubricant. We used a small 140-watt inverter that plugs into a cigarette lighter outlet to charge the battery of his drill. Waiting for it to recharge after he drained it each time was the most time-consuming part of the process.

Stepping up

He started with a 9/64-inch bit (the smallest cobalt bit aboard) then stepped up in size — anywhere from 3/32 to 1/8 inch each time using whatever size he happened to have — ending with a 9/16-inch bit to accommodate the 1/2-inch bolts we had purchased. Since we couldn't be sure of the thickness of the fiberglass, old chainplate, and hull until the holes were drilled, and in the interest of saving another row to shore, we had bought 2-inch and 2 1/2-inch bolts. As the thickness of the fiberglass varied from hole to hole, we ended up using a few of both lengths before all of the chainplates were replaced, months later.

After drilling the holes and "dry fitting" to be certain all was according to plan, we put the three bolts, with 3M 5200 on them, through from the outside: washer, hull, old chainplate, fiberglass, new chainplate, washer, lock washer and nut (see illustration on Page 28). Within 24 hours we were ready to continue our journey south. We debated what to do with the second chainplate: replace the other port lower since we would be on a port tack for the next 450 miles; replace


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Friends say *Eurisko* looks more salty these days with the bolts showing on the exterior of her hull (6 and 7), but the important thing is the peace of mind that comes from finishing a nagging maintenance problem. Now the McBride family can delight in the occasional over-canvassed romp up a channel.

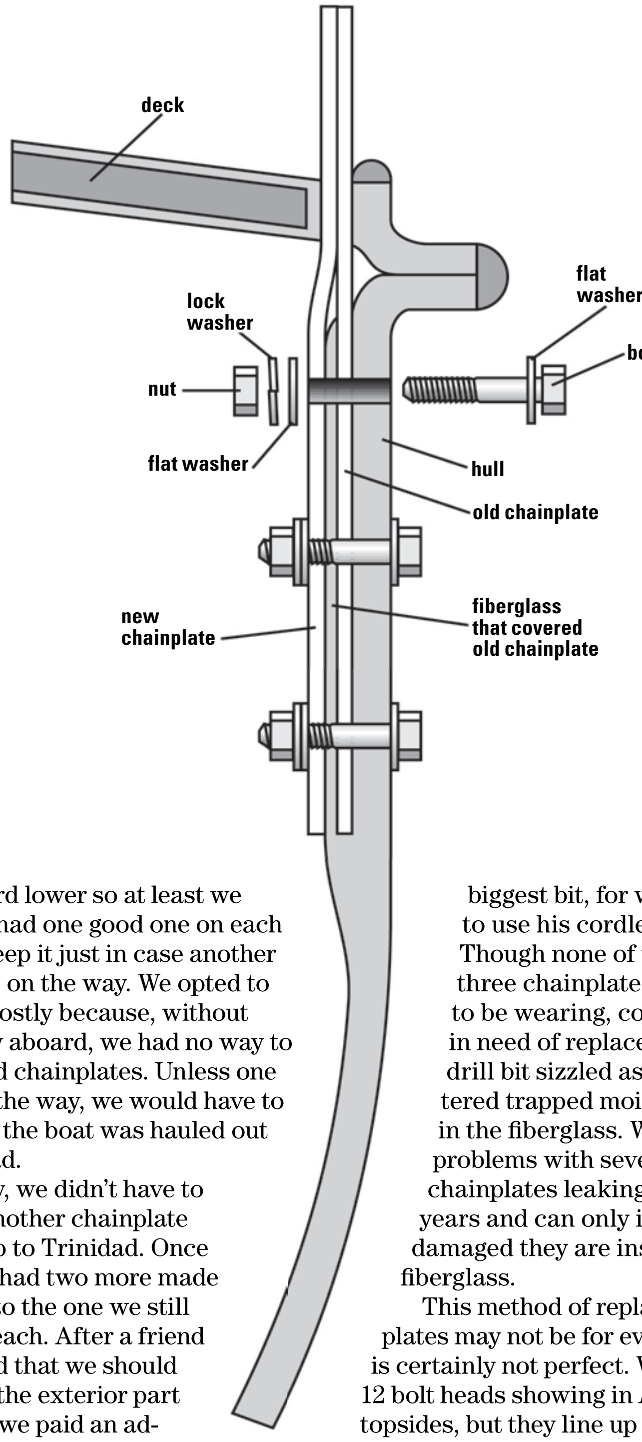


ILLUSTRATION BY TED TOLLEFSON

a starboard lower so at least we knew we had one good one on each side; or keep it just in case another one broke on the way. We opted to keep it, mostly because, without electricity aboard, we had no way to cut the old chainplates. Unless one broke on the way, we would have to wait until the boat was hauled out in Trinidad.

Luckily, we didn't have to replace another chainplate on the trip to Trinidad. Once there, we had two more made identical to the one we still had: $37 each. After a friend mentioned that we should have had the exterior part polished, we paid an additional $10 to follow his advice. Our upper and intermediate shrouds are on the same chainplates which, rather than being fiberglassed to the hull, are through-bolted to bulkheads. Since they can be inspected, we did not change them.

Below deck level

Dave used his grinder to cut the other three plates just below deck level in each case. We emptied the lockers he would be working in and placed wet towels around to catch the hot sparks. Since we were on land at this point, with access to electricity, he could use his electric drill for all but the biggest bit, for which he had to use his cordless again. Though none of the other three chainplates appeared to be wearing, corroding, or in need of replacement, the drill bit sizzled as it encountered trapped moisture hidden in the fiberglass. We have had problems with several of the chainplates leaking over the years and can only imagine how damaged they are inside the fiberglass.

This method of replacing chainplates may not be for everyone and is certainly not perfect. We now have 12 bolt heads showing in *Eurisko's* topsides, but they line up with and are obviously part of the rigging. We don't find that they detract from the aesthetics. A friend said they actually make her look salty.

In hindsight, our only regret is that Dave cut out the three chainplates that didn't break. He later realized that the toggle jaws were wide enough to accommodate both the old and new chainplates. Redundancy is always nice, but it was too late by then. All our chainplates can be inspected and replaced easily now, thanks to one of Dave's better brainstorms devised at anchor, while running on solar power, and in haste to get south between hurricanes.

Rig inspection and maintenance

Simple steps to keep your mast standing

by Petrea Heathwood

This sailor is on her first trip up the mast. The line hanging down on her left is the new halyard she is going to fit. She and her husband discussed roles and decided that he would winch her aloft as she wasn't confident that she would be able to haul him aloft.

A STRONG, SEAWORTHY RIG IS AN INTEGRAL PART of any cruising boat, but inspection and maintenance of the rig is often overlooked. This is more likely due to lack of knowledge than intentional neglect. Based on my experience as a professional rigger, I'd like to suggest some practical steps for a rig inspection and maintenance program for the typical sailboat owner. Following these steps should help you determine whether your rig is in good general shape. This discussion is meant as a guide; if you have any doubts about any component of your rig, please seek a professional opinion.

I'll focus on the vast majority of production boats that have aluminum spars and stainless-steel wire rigging, and I'll assume that you leave your mast standing and must do your maintenance tasks on a vertical spar. I'll also assume the rig is correctly specified and constructed with appropriate materials.

Apart from neglect, the main threats to rig integrity are wear and tear, fatigue, corrosion, and UV degradation. I sail in the tropics, so corrosion and sun damage figure more prominently in my experience than for people in higher latitudes. It's important to keep the effects of hot weather in mind if you will be heading south in your good old boat.

Running rigging

Running rigging consists of all the parts of your rig that move, such as halyards and sheets. All running rigging is prone to wear and chafe. Each part should be inspected regularly and the reasons for chafe should be eliminated. Chafe is caused by movement and will occur wherever a line rubs against something. Lines should lead fair and run over adequately sized, well-lubricated sheaves. Get into the habit of checking all visible components whenever you're sailing. Train yourself to notice if anything is amiss: a line leading incorrectly, a twisted block, a sheet caught up, and so on.

End-for-end your lines

To improve the lifespan of running rigging, it's worth end-for-ending each line at least once to even out the wear. This is easy with sheets and furling lines but it's also fairly simple to do the same thing to internal and external halyards and reefing lines.

Use a rug hook to thread the end of a strong cord through the end of the line you'll reverse. Tie it with a secure knot, like a bowline, and then tape the join so it won't catch on anything. If you tape toward the direction of the pull, the overlaps on the tape will cover each other, rather like the way you install roofing material from the bottom up to allow the overlaps to shed water. This helps to prevent the tape from catching as it's pulled through.

Carefully pull the line out, leaving the cord in its place. Swap the cord to the other end of the line and reverse the process. If you have a spliced eye on your halyard, it will have to be re-done at the other end. You'll need some extra length available for this. *(**Note:** Splicing old line is difficult. **–Eds.**)*

Caution: always keep tension on both the line and the cord to prevent them from snagging. This is especially important with halyards as

The cracked locking nut is the sort of thing that can be noticed by regular checks of the lower rigging and deck hardware. On facing page: the bubbling of white paint adjacent to the chainplate, at left, indicates corrosion of the aluminum hull. Kinks in the all-wire halyard, at right, are caused by the wire being compressed on the winch. Also notice the corrosion sites on this spar.

the weight of the heavier line will drag the cord away from you too fast and could cause it to snag somewhere.

All-wire and rope-to-wire spliced halyards

Check wire halyards carefully for meat hooks, or broken strands in the wire. Run a rag along the wire rather than risk injury to your bare hand. It's worth flexing the wire sharply in the wear areas. This will pop any hidden breaks into view. Meat hooks are an indication that the wire needs replacement. The areas most prone to fatigue are:

- where the wire bends over the masthead sheave in the hoisted position;
- right above the swage sleeve; and
- at the apex of the thimble.

If the wire is still supple, it will return to shape when you straighten the bend. If it remains kinked, it has reached the end of its useful life and should be replaced. You can actually feel the difference between "dead" and supple wire.

Rope-to-wire spliced halyards obviously cannot be turned end-for-end, but if the rope is still in good order, it's possible to splice new wire to its tail. Providing they have a little extra length, you can end-for-end all-wire halyards. The end on the winch will have acquired permanent kinks and flat spots from being wound around the winch drum. Because these kinks won't run past the masthead sheave, you'll need to cut back to good wire.

If you can, use proper cable cutters to cut any wire. Alternatively, tape the wire tightly at the point of the cut, hold it in a vice or use Vise-Grips and cut it with a hacksaw, using a fine-toothed blade (about 24 teeth to the inch). Do this away from your deck since fine steel particles from the saw blade will turn to rust spots wherever they fall. Steer clear of bolt cutters, which will mangle the end of the wire. If the wire strands spring apart when the tape is removed and resist being re-formed to shape, the wire is fatigued and should be replaced.

Thread a strong cord into the wire using a hollow splicing fid. Tape it securely into a neat parcel that won't snag on its journey through the mast. Pull the wire through as described previously. The swaged eye will have to be cut off and re-made on the other end of the wire.

To replace the swaged eye, be sure to use the correct type and size of swage sleeve. Sleeves for stainless-steel wire should be copper or tin-plated copper. Sleeves for use with a hydraulic swage press are oval. With a hand swager, the sleeves should be a figure-eight shape. I'd recommend having the swages done with a hydraulic machine to ensure their strength.

Halyard end-fittings vary from the bare end of a rope to spliced- or swaged-on shackles or snapshackles. Now is a good time to check whatever fitting you have. Ensure that it is undamaged and working smoothly. Snapshackles may benefit from a drop of light machine oil applied to the spring mechanism. Be frugal here — you don't want your snapshackle to fly open because it's over-lubricated.

Next the standing rigging

Standing rigging includes all the fixed components, usually 1 x 19 wire, which hold the mast or masts in place. Standing rigging generally fails first at the lower ends, so this is the logical place to begin your inspection. If the lower ends are in good shape, it is normally safe to assume the rest is OK also. This doesn't let you off from inspecting aloft, but unless you are about to set off on an

Inspection equipment

Although you don't need specialized tools, gauges, or equipment, these simple items will make the job easier:

- Strong cord (such as Venetian-blind cord) long enough to reach to the top of the mast and back again
- Plastic fishing spool to which to fasten the end of the cord and use to wind the cord on
- Craft worker's rug hook
- Small hollow splicing fid
- Paper masking tape or PVC electrical tape

You should already have on board:

- Wrenches to fit the rigging screws
- Pliers or Vise-Grips
- Waterproof grease
- WD-40 or other spray lubricant with a small delivery tube fitted to the nozzle
- Light household machine oil, such as sewing machine oil or 3-in-one household oil
- Rags or a roll of toilet paper
- Bosun's chair

extended voyage you don't need to remove each piece of rigging for inspection if the bottom ends are satisfactory.

Working on one piece of rigging at a time, release the lock nuts or pins on the rigging screws (turnbuckles). Mark the rigging screw thread with tape so you can replicate this setting after checking the wire. Turning the barrel or adjusting nut clockwise will loosen the tension. Unscrew them until you can release the wire from the rigging screw. Rigging screws tend to seize if not lubricated regularly so if there is resistance, apply penetrating oil or WD-40 to the threads and allow time for it to work. Caution: do not loosen any piece of rigging completely unless you are certain there is something else holding the mast in its place.

Having visually checked the wire for rusty or broken strands, make a sharp bend at the lower end just above the terminal fitting. This may reveal broken strands hiding just within the end fitting. Straighten the wire again. Supple wire in good condition will return to its former shape; fatigued wire that needs replacement will retain the kink.

Next, inspect the terminal fitting on the wire. It may be a roll-swaged end, Norseman or Sta-Lok fitting, or a spliced or swaged sleeve made around a thimble. Check for rusting cracks in the fitting, uneven wire strands, or (in the case of an eye around a thimble) broken strands of wire at the bottom of the eye.

The rigging-screw assembly should turn freely and the threaded part should be perfectly straight. This is a problem area on trailerable boats since the rigging screws can get caught and bent while raising the mast. Check all clevis pins and replace any that show signs of wear or corrosion.

While the rigging is disconnected, have a look at the chainplate to which it was attached. Signs of trouble here include cracking, rust stains, and elongated clevis-pin holes. Any of these warrant further inspection of the chainplate, both above deck and internally, especially if there have been leaks in this area.

When re-assembling the rigging screw, lubricate the threads with marine grease. A little goes a long way and is only useful where the threaded part contacts the rigging screw barrel. Cotter pins that have been correctly installed can be re-used, but since their cost is infinitesimal in the scheme of things, it's a good idea to replace them with new ones.

Black and red stains

Telltale black and red stains are hard to miss. Black stains emanating from any part of your rigging indicate metal grinding away, usually a working part like the gooseneck or sheave boxes. Rust stains show stainless steel breaking down in some way. Check for cracks in the fitting. Even international brands sometimes use inappropriate grades of stainless in parts of their fittings. Rigging-screw clevis pins are a common culprit. Be wary also of inferior brand-name copies. I've recently seen Asian-sourced copies of a major U.S.-brand rigging screw that failed in less than a year.

Mast and boom

Once you've worked your way around all the rigging, have a close look at the spars. Check that the drain holes at the mast base are not blocked with debris and that the mast base itself is clear of accumulated detritus. If the mast is keel-stepped, remove the mast boot and check the spar for signs of cracking and corrosion.

Aluminum mast and boom sections should be free of corrosion. Corrosion is mostly found where there are dissimilar metals, in this case

> "Supple wire in good condition will return to its former shape; fatigued wire that needs replacement will retain the kink."

stainless-steel fittings on aluminum. Once pitting has occurred, it is difficult to repair and beyond the scope of this article. Remedial treatment to prevent worsening of the problem is within the ability of most owners, but major corrosion significantly weakens the spar and should be dealt with professionally.

To prevent further corrosion, remove the offending fitting and brush off the corrosion using a

Is this your mast? There's plenty to check up here with mast steps, three furlers, and other add-ons, such as a radar dome. Facing page: this is an incredibly crowded masthead. How did they fit it all up there?

stainless-steel or brass wire brush. Never use an ordinary steel wire brush; it will shed small particles that will rust and stain your deck. You may need to use a revolving stainless-steel or brass wire brush attached to an electric drill to remove corrosion in areas of pitting. The idea is to get as close to shiny metal as you can. If the fastening holes in the aluminum are enlarged from corrosion, you'll need to rebuild the area. This is usually a job for professionals. If the pitting is minor, re-bed the fitting using either a physical barrier like thin rubber sheeting, Duralac anti-corrosion compound, or a combination of the two. Use Duralac or an equivalent barium chromate paste on the thread of all stainless-steel fastenings.

If you have to remove frozen machine screws, here's a tip: if the fitting has caused corrosion, you will usually find the fastening screws are also seized in place. Instead of forcing them free, which results in damaging the head or breaking the thread, try a generous application of WD-40. Allow time for it to soak in — maybe overnight. If this doesn't work, judiciously applied heat should do the trick.

Depending on the size and position of the fastening, this can be done with the tip of a soldering iron or small butane burner. You need concentrated heat; the idea is to heat the fastening and break it free from the surrounding corrosion. A combination of heat and WD-40 can be very effective. Be careful not to melt internal halyards or concealed electrical wiring. Another tool worth trying is an impact screwdriver. With any of these methods, the first step is to soak with WD-40.

Paint and corrosion

On painted spars it's common to see corrosion under the paint. This appears as chalky bubbles in the paint. The problem will continue until the corrosion is removed. This type of corrosion is usually found in conjunction with fittings of dissimilar metal to the spar or where the aluminum has been inadequately prepared for painting.

The short-term remedy is to scrape the paint away from affected areas. It will look unsightly, but cosmetics are less important than preventing further corrosion. Eventually, the corrosion must be cleaned up, its cause removed, and the spar repainted (see article in *Good Old Boat*, January 2005).

Going aloft

To complete a thorough check of your rig you'll need to go aloft. The options for maintenance aloft range from a basic inspection to removing each piece of rigging to check its condition and attachment point. If you feel the latter is necessary, it's probably better to pull the stick out and do a thorough check at ground level.

The first consideration in going up the mast is who will go up. Obviously, the lightest member of the crew will be easiest to hoist, but there is no point sending your teenager up to check the rig unless he or she knows what to look for. The safety of the rig is the skipper's responsibility, so the skipper should usually be the one to go up.

Your first time?

Climbing a mast can be daunting if you've never done it before. I disagree with the conventional wisdom not to look down. Once you've sorted out the safety aspects and the method you'll use to go aloft, my advice is to take it in small increments, getting used to the height as you go. Use your safety line at every stage so you can't fall if something goes wrong on deck.

Your bosun's chair should be strong and in good condition. Even if it's new, don't assume it's safe. There have been incidents of stitching giving way on new, brand-name chairs. Inspect and test the chair before trusting it. Even in my old faithful bosun's chair, I like to bounce a bit just above deck level before climbing any higher.

Use a conventional cloth-type chair with a solid seat. Soft-bottom wrap-around designs are promoted as having a snug fit, and this is certainly true. While they're light and compact to stow, for extended work aloft these chairs are uncomfortable and restrict circulation to the legs. Worse still are the adapted rock climbers' harnesses used by professional sailors on the pointy end of big racing yachts.

Choose a chair that fits you, neither too small nor too roomy. It should have large tool pockets. Make sure the hoisting point is low enough to allow you to reach the masthead. My own chair has secondary lifting rings at hip height. To get right to the top of a mast, I can cinch these together with a spare line and use it to hoist myself the last few inches.

Going up and down

Climb the mast only when the boat is afloat. Most boatyards ban the practice of climbing the mast of a boat on the hard. A keelboat propped up ashore is defying gravity to begin with, and your weight jerking around aloft can cause it to lose balance.

Since older painted masts are usually chalky, wear overalls or similar gear. Some people like the feel of climbing barefoot, but I protect my feet with shoes and socks.

Attach two halyards to the chair using separate shackles or knots. Don't trust snapshackles for this job. Use a safety line from the chair to the mast at all times. Three to four feet of ¼- or 5⁄16-inch line tied tight round the mast can be slid up or down manually but won't slide down if weight is thrown on it suddenly.

Assign two people you trust to control and keep the halyards taut. The people tailing the halyard must look up at the person in the chair instead of down at what they are doing. Keep the area below clear. Don't allow anyone to stand beneath a person working up a mast.

Once the chair is set up for hoisting, climb in and try it under your weight. I prefer to climb up and have the halyard tailers keep the halyards tight as I go. It can help enormously if they coordinate their pull on the halyard with your upward pull. Alternatively, you can just sit in the chair and have them winch you up if you're not fit. Either way, take it easy; don't overexert yourself. Halfway up the mast is no place to have a heart attack.

At each stop on the way up the mast, keep your safety line attached and have your assistants tie off the halyards. While you are at the top of the mast, your assistants should flake down their halyards, ready for the descent.

When you are ready to come down, the halyards must be untied without losing any tension. It's disconcerting to be dropped even a few inches when the halyards are released.

The primary halyard should take the weight while the secondary halyard is kept slightly slack. The reason for this is friction. As you descend, the halyard is eased out smoothly. It must be released under full control without sticking on the winch. Two turns on the winch is the maximum needed; one is usually enough. Too many turns will cause the halyard to stick, resulting in a series of surprising bounces as you are being lowered.

Doing the job

I check the rig as I climb. It makes the climb easier and seems logical. What to look at depends on the layout of your mast. I'll try to cover a "typical" mast. You're looking for much the same things as you did at deck level: corrosion of dissimilar metals, cracked fittings, seized sheaves, worn pins, stranded wire, and bubbled paint.

> "Climbing a mast can be daunting if you've never done it before. I disagree with the conventional wisdom not to look down."

Just above the gooseneck may be a group of sheave or exit boxes for halyards. Check that fastening screws are tight but not seized and that sheaves turn freely and are not worn on one side. If you have mast steps, check their fastenings. Spinnaker or whisker pole tracks should be well secured and not bent or damaged. Slides should run freely.

The attachment points for the lower shrouds will be just below the lower spreaders. Ideally, you will have someone loosen each shroud so you can check the clevis pin and tang for wear.

To service the spreader end, the leather spreader boot, above, will need to be removed and re-sewn. Note how the top forms a funnel to trap moisture and debris. Next time, the leather should be sewn around each wire individually. On the new boat, at right, recently delivered from the factory, the T-balls at the top of the lower shrouds do not line up with the angle of the wire. This will cause premature failure of the wire, as some strands will be taking more load than others.

The bolt holding the tangs should be straight. Check that the nuts are sitting flat and not tilted slightly toward the mast at their top. This would indicate a bent bolt, which needs to be replaced. Caution: when replacing bolts that go through the mast, take care not to dislodge the compression sleeve inside the mast. It will be visible when you remove the nut and tang.

If T-balls are fitted instead of tangs, check the T-ball for cracks and that the receiving plate is sitting snugly against the inner mast wall. Black marks around the rivets here indicate movement, which could be serious.

From this position partway up the mast, check the base of the spreaders for cracks and signs of movement. Move out to the spreader end and remove the spreader boot or covering tape. The cap or upper shrouds should be held to the spreader ends in some way. This could be a wire seizing, or a clamp welded to the end of the spreader arm. Undo the clamp and check for corrosion where the wire meets the aluminum. Apply Duralac paste, if necessary, and re-clamp the spreader end. Replace the boot or tape. If you have intermediate or diagonal shrouds terminating here, undo and check them as described earlier.

Often, the lower spreaders are the site for a steaming or deck light. If it works, leave it alone. If not, now's the time to take it apart and find out why.

As you climb farther up, there may be a second set of spreaders to be dealt with in similar manner to the first. Somewhere between the lower and upper spreaders there may be a fitting for a spinnaker pole topping lift and a tang for an inner forestay or babystay. Check these and lubricate any exit box associated with them.

At the top of the mast, check the pins for the forestay and backstay and the tangs and bolt for the cap shrouds. If you have a furler, check that it is not wearing the wire of the forestay and that its top cap, if any, is in place. By moving spare halyards over the sheaves, you can see if they, or their pins, are worn. Alternatively, poke the sheaves upward with a screwdriver. Movement here indicates a worn sheave hole or pin. Check that the sheave pins are straight. If they're OK, lubricate them with WD-40. I say WD-40 because it comes in an aerosol can. Light machine oil is better but much harder to apply in this situation.

Up at the top there may be all sorts of antennas and lights. Leave them alone unless there is a known problem. Try reaching up to whatever lights you have there just to find out if your bosun's chair makes this possible. Many chairs leave you just short of the top. In that case, you need to cinch yourself up higher on the safety line.

Now you've completed the work, relax and have a look around before preparing for the descent. You will have briefed your deck crew to lower you slowly and steadily. If they are new to this, remind them to look up and watch you as you descend.

The verdict

Once you're safely back on deck, you can be satisfied that you know the condition of your rig from top to bottom. At this point you may still decide to enlist professional help. If you do take that step, the work you've done will help you evaluate the advice of your rigger.

Petrea Heathwood is a yacht rigger and long-term liveaboard cruising skipper. She has been involved with cruising and racing since 1967. She operated her own yacht-rigging business in Brisbane, Australia, before retiring to cruise full time. These days she enjoys gunkholing along the Queensland coast in her Norwalk Island Sharpie 31, Talisman.

Equipment to take aloft

You'll need to take the appropriate tools for your rig but I would suggest:

- Pliers or Vise-Grips
- Flat-bladed screwdriver
- Stanley knife
- WD-40 with a tube on the nozzle
- Adjustable wrenches to fit any rigging screws you need to work on
- Rag or toilet paper roll
- Waterproof grease
- Allen or hex keys needed to fit spreader end fittings
- Duralac

To keep from spreading grease, Duralac, and WD-40 over myself and the equipment, I take along a roll of toilet paper instead of a rag, and I stuff used squares into a separate pocket on the bosun's chair.

The walk-through transom and resulting split backstay offered a neat solution for the owners of this Moorings 39.3. Their Bimini is laced to a tube attached to the backstay.

Twin backstays, anyone?

Two practical uses for two stays aft

by Bob Steadman

Twin backstays, or double backstays, a pair of aft stays that go all the way to the top of the mast, are becoming more popular these days on boats with walk-through transoms. Split backstays, which are split at the transom but typically join about a third of the way up the mast to form one stay, are also found on many boats.

In both cases, the helmsman can stand at the wheel and not have a backstay right behind his head. If equipped with a backstay adjuster, the racer can perform magic on a "bendy mast." And, with such designs, a great deal of aft-rail real estate is available for swim platforms. Sailboat designers, no doubt, had many more good reasons for the development of these adaptations to the backstays of yore.

I'd like to add one they never thought of. Newer backstay configurations provide mounting support for Biminis and radar mounts at a considerable savings over commercially produced radar masts and arches. In fact, since radar masts and arches are expensive, the installation of two new backstays and tangs might very well be a more affordable alternative for a boat with a traditional backstay. They don't steal any precious aft-deck space, plus there are no frame attachments on the cockpit coamings, which often get in the way of winches and sheet leads. (A quick note before you begin looking at your transom, however: remember that split backstays that have backstay adjusters are not suitable as mounting supports since their geometry will change as the backstays are tensioned.)

Because of its configuration, a split backstay provides a narrower base for the Bimini/radar support; however, a split backstay can be easily converted to a twin backstay configuration, if need be. The modification can be made with two longer stays and an appropriate toggle at the masthead.

The radar mount

I didn't want to put the radar antenna on the mast of our Cascade 36 because it would interfere with the leech of our staysail. A radar mast aft would have been difficult, due to lack of deck space available for mounting it.

Our double backstays offered an elegant solution: simply mount the antenna between the stays on a tubular mount. I first made a mockup using a 2 x 4 and some bits of plywood to see if I had all the angles right. From the boat's sail plan, I got the forward slope of the backstays. Making the platform level was easy then. The other angle I needed was athwartships between the two backstays. Since I knew their length and the distance between their chainplates, I could make a little scale drawing and measure the angle.

Installation was simple. I used four high-quality hose clamps. My welder reproduced my wooden prototype with ⅞-inch tubing. The finished assembly weighs only 5 pounds. He did a beautiful job and charged me $150 for labor. The tubing itself was probably worth less than $25, with another $25 for electro-polishing. The total was around $200, much cheaper than a radar mast.

Bimini mount

Our double backstays also came in handy when I wanted to add a Bimini for sun protection. I attached a length of 1¼-inch aluminum tubing to the two backstays using cable clamps to position the tubing and a simple lashing to secure it. Wooden closet dowelling or PVC pipe could also be used.

Our Bimini and its windshield were the products of a long evolution. Years ago, I was caught in a vicious storm and resolved to install a boom gallows to control my wildly swinging boom when the mainsail was down. I was true to my resolution. I placed this gallows not aft where you might expect it, however, but rather on the coachroof forward of the sliding hatch. After doing that, I discovered that the new gallows provides a great handhold when entering and exiting the cockpit. The real advantage of this gallows appeared later when we used it to provide the forward support for our Bimini.

The Bimini itself is made from a waterproof material called Boat Topping. This is a vinyl-and-Dacron laminate that we ordered from Sailrite. The fabric goes over the tube at the backstays and is secured with a zipper. Two small windows were installed overhead in the center so we can see the mainsail.

“Newer backstay configurations provide mounting support for Biminis and radar mounts at a considerable savings over commercially produced radar masts and arches.”

On night passages we like to be able to see the stars, so we unzip the Bimini, rolling it forward and tying it to the gallows. Having the ability to quickly roll it up is a great advantage, particularly when a sudden and violent squall approaches.

Because the sun will get under the Bimini early and late in the day, we designed side panels that zip on and attach to the lifelines. These panels also provide additional protection from the rain. None of this gear interferes with handling sails and can be left up at all times, although we prefer to take it down to reduce windage and for its own preservation when a squall blows in. The boom gallows was expensive — about $1,000 (more today) — but the Bimini ran about $220, since we made it ourselves.

Regretful choices

In 1978, when I had *Bettie's* hull custom-built by Yacht Constructors, I made some choices that I regretted later. After the hull was delivered, I spent four years finishing her construction before launching her in 1982. Because of this, I made most of my fitting-out choices before sailing her, sometimes based on the state of my pocketbook rather than on comfort or cruising considerations. One of the decisions I regretted later was my choice of a pram dodger instead of a full-width dodger. This smaller dodger was just the width of the sliding hatch and was designed to shelter one person sitting in the companionway. It worked, but I never liked the look of it.

Many years later our boom gallows provided a solution to this problem. We made a panel of isinglass, put some grommets in the edges, and stretched it over the front of the gallows. Now we have a windshield. While not as protective as a full-width dodger with side panels, it works quite well and provides great visibility. We attached the windshield with wire ties through the grommets. The bottom edge is held by a bolt rope extrusion. Total cost — about $80.

Bob Steadman found a creative use for the split backstay on his Cascade 36. He mounted his radar antenna on a tube supported by the two parts of the backstay, at right. The corner angles in the tubular mount prevent it from rotating under the weight of the antenna and allowing it to pitch forward.

***Bettie's* side and stern curtains can be zipped on or off as needed.**

While we were at it, we put a drain in the middle of the Bimini to catch rainwater. That worked pretty well, but we noticed that we were losing a lot of water as it ran off the edges of the Bimini. The solution was absurdly simple: we got a couple of funnels and suspended them under the forward edges of the Bimini. Short lengths of vinyl hose take the water to jugs that we empty into our tank when they are full.

Before we started our current cruise from Los Angeles to Boston, via the Panama Canal, and from the U.S. East Coast back to the Caribbean, I had already put 16,000 miles on *Bettie*. Living aboard and sailing a boat naturally causes one to make adaptations to the original equipment and layout, no matter how well planned it was to begin with. The most recent 11,000 miles have caused us to make further modifications to make *Bettie* more comfortable and to accommodate additional gear. There are many more miles (and modifications) left in our good old boat. We look forward to every one.

Bob Steadman and Kaye Nottbusch have been cruising for three years. Bob is a professional cinematographer and the two have produced a DVD, Cruising with Bettie. *The DVD can be found at <http://www.TheSailingChannel.tv>.*

New life for old rope?

To wash, or not to wash? Aye, there's the rub

by Tim Nye

Curiosity about laundering's effects on halyards led to a pile of broken rope, left, and a heap of data. The starting point was new rope, old rope, and a hot knife, below.

A while ago, I took a Saturday-morning rope-splicing class at a chandlery. As we were working away, someone asked about splicing old rope. The instructor said old rope has been stretched and is usually too hard to work with. I spoke up, saying that we've had good success washing rope in our home washing machine and, with a little fabric softener, the rope usually comes out almost as soft as new. Let me say this grabbed our instructor's attention.

According to him, washing rope is the *worst* thing you can do to it. Fabric softener is a chemical that breaks down the tiny fibers inside the rope, causing it to lose strength without warning, he said. The agitation of the washing machine causes the inner braid to break through the outer braid of the rope. In fact, he said, he sells a lot of double-braided docklines. People often bring them back with the rope's core poking through and ask for a refund. When he sees this, he asks them if they washed the line in a washing machine . . . and they always have. Eventually, he calmed down and we went back to our splices.

This information surprised me. I've washed bushels of old rope and never had a problem like that. Being the curious sort, I started to wonder just what *does* happen when you wash rope.

The reasons to wash rope are to clean it and possibly to make it softer and more pliable. In some fields, such as mountain climbing and emergency services, washing rope is standard operating procedure. In those applications, however, ropes are dragged through mud and sand that penetrate the rope and act as abrasives, slowly grinding away at the rope's fibers. In that case, washing, even if it might damage the rope, is far better than leaving the grit in it.

Sailing lines aren't normally dragged through mud. Seawater can leave salt crystals behind as it dries, but fresh-water rinses will dissolve this without the need for washing the rope. So, if by washing it we end up with cleaner and softer rope, are we paying dearly for it in terms of reduced strength?

As it turns out, the three tools necessary to answer this question were at hand. First, my latest good old boat, a 1973 Grampian 34 project boat, still had its original running rigging. The ½-inch polyester double-braided main halyard, which had reached the ripe old age of 34, could be sacrificed to the cause. Second, after an intensive training program, my dear wife certified me as competent to operate the Domestic Laundry Apparatus (aka, "the washer"). Finally, I teach mechanical engineering and have access to testing machines that can very carefully break things with quite substantial forces.

Testing to destruction

I wondered how we can tell if washing damages a rope and decided that one way would be to measure its tensile strength. The more damage, the weaker the rope becomes.

My old halyard was wire-and-rope. The rope portion thus likely didn't see great loads during its life. As far as I can tell, my boat spent her life on Chesapeake Bay. She was left rigged year-round, and this halyard was run outside of the mast. The rope was badly weathered and dirty. Cutting it open showed that it had started life as a white rope with blue flecks. In addition to being sun bleached, it was stiff and hard on the hands. I used an electric soldering gun, with the tip hammered flat, as a hot knife to cut the test samples.

The old halyard could help me answer the question regarding how washing affects the strength of old rope, but I also

wondered what happens to new rope? To answer this question, I purchased a hank of new ½-inch Bridgeline Ropes polyester double-braid so I could put it through the same tests as the old rope.

I cut both ropes into pieces about 3 feet long. I used the soldering-gun hot knife to cut and seal the ends of the ropes and to keep the inner and outer braids from sliding past each other. The table below gives the list of test cases.

I cut five pieces for each case on the old halyard, alternating along the rope. That is, starting at one end, I cut pieces for cases A-B-C-A-B-C . . . I also used the hot knife to score Roman numerals on the pieces to indicate their original locations on the halyard. Since the new rope should be very uniform, I cut only three pieces for each test case: D, E, and F. I didn't number these.

Test cases for rope

Case	Rope	Treatment
A	old	no washing
B	old	1 wash
C	old	10 washes
D	new	no washing
E	new	1 wash
F	new	10 washes

The test cases would be: no washing, to get a baseline on rope strength; 1 wash, to see if washing decreases the strength of a rope; and 10 washes, which is probably more than any rope could reasonably expect to see in its life.

I did the washing in our home machine using the smallest load setting (since this was a very small load) and an amount of Tide liquid detergent roughly in proportion to the small load. Since a fair amount of soap was left in the rope at the end of a wash cycle, I added a second rinse at the end of each load. I added Ultra Snuggle liquid fabric softener to the washer's fabric-softener dispenser in a quantity appropriate for the small load. As things sometimes turn out, the actual testing occurred six months after the washing, so if there are long-term effects of detergent and softening chemicals, they probably would be seen in these tests.

The first thing I learned is that the core really does pop through the cover when you wash new rope. This happened to two of three pieces after one wash. Old rope, however, doesn't experience this. So my splicing instructor and I are both right: washing does or doesn't cause the core to pop on rope, depending whether it's new or used.

I figured I'd inadvertently discovered a rope-manufacturing secret. Each braid is a hollow tube. When double-braided rope is made, first an inner braid is woven. This is followed by the outer braid woven over the top. The machine that does this apparently puts more tension on the outer braid as the second weaving takes place. The inner braid is being compressed along its length while the outer is being stretched. I expect this is done so that, once the rope is loaded and the spaces between the strands are worked out, the inner and outer braids end up at the same length so each will carry half the load on the rope. This tightening-up of the rope, no doubt, is what makes it hard to splice used rope.

Until a rope undergoes that tightening-up process under use, however, the inner braid is longer than the outer braid. The agitation in the washer allows gaps to open in the outer braid, and out pops the inner braid.

Fortunately, this is not fatal for the rope. If you see this happen, grab the rope from one end with one hand, squeeze the rope with your other hand, and slide that second hand toward the pop. This stretches the outer braid, "milking it" and causing the inner braid to be pulled back into the rope. You'll have to repeat from the other end and keep milking until the rope is back together. I know this because that is what I did to all the popped samples before testing them. I marked the locations of the pops on those ropes.

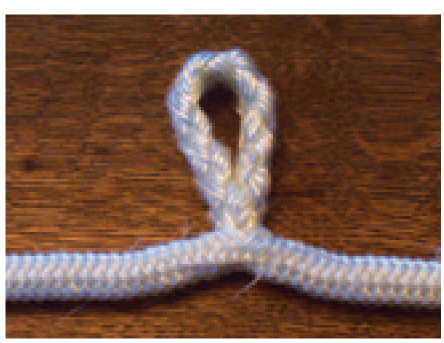
The old rope obviously got cleaner with washing, but it also became very fuzzy as washing continued through multiple cycles. Even the new rope fuzzed up when washed, although not nearly as badly. Given how much UV damage must have occurred in 34 years of continuous exposure, it's not too surprising that so many of the little polyester fibers broke to create this fuzz.

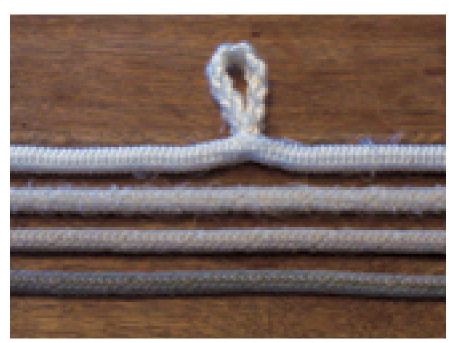
An early observation is that the old rope became considerably softer to the touch after one wash, and a little softer yet after 10 washes. In a "droop test" for stiffness, I set an equal length of each sample over the edge of a table. With a sheet of cardboard, I lifted the ends of the ropes level with the tabletop, then slid the cardboard away, allowing the ends to droop (see photo on facing page). The unwashed rope drooped the least. The once-washed rope was less stiff and drooped a little more, while the rope washed 10 times drooped considerably more, showing that more washes did make the rope less stiff.

Pulling strings

So on to the fun part: breaking things. For this, I used a laboratory tensile-test machine that can push or pull up to 30,000 pounds under very fine control.

Measuring the strength of a rope turns out to be something of a challenge. If the rope is bent sharply, as it is in a knot, its strength is considerably reduced by the sharp bend. Clamping a rope in metal grips also greatly reduces its strength where it is crushed. Ideally, the rope should be wrapped





The rope samples line up ready to be tested, left. From the bottom: A, B, C, D, E, F, per the table above. In some cases, washing caused the core of new rope to "pop" through the cover, center. Washing makes polyester rope fuzzy, right.

Washing old rope softens it, at left above. From the rear, the unwashed sample is the stiffest, followed by once washed and 10-times washed. Each rope sample was subjected to the 30,000-pound test machine, center, secured between two capstan grips, at right.

several turns around a large drum to gradually load the rope by the surface friction between the rope and drum, just as is done with a sheet on a winch. Unfortunately, it takes quite a bit of rope to make up a single test sample this way.

For this experiment, I used a pair of "capstan grips" (see photo at right). In these, the rope is wrapped around a 1½-inch diameter cylinder before being led through a hole in the grip and knotted. The cylinder allows the load on the rope to be gradually applied by the friction along the surface, rather than being applied abruptly. In this arrangement, about two-thirds of the load was applied to the rope by the cylinder, and the remaining third was carried by the knot at the end.

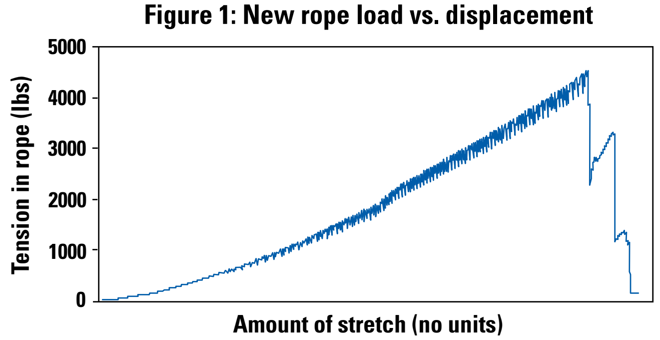
Ideally, the cylinder would have been considerably larger in diameter to reduce the stress concentration caused by bending the rope. This was a trade-off against how much rope was available for tests: a bigger diameter means each sample must be longer. This means I could have conducted fewer tests given the available rope. As a result, the ropes broke at somewhat less than their true tensile strength but, since all samples were tested in the same grips, we can see the relative differences in strength between ropes.

Figures 1 and 2, below, show the load vs. displacement recorded by the test machine for new and old ropes. On this machine, we controlled the displacement (how much the rope is stretched) and measured how much load the rope applied to the machine. When the grips begin to separate, they first pull slack out of the rope and it takes a while for the load to build up. As the new rope is pulled more and more (Figure 1), it stretches considerably (see photo sequence on page 30) and goes through an interesting process: it creeps a little around the cylinder on one grip, then a little around the other cylinder, giving out a little "snap" noise each time. This constant creeping is why the load plot seems to be vibrating up and down.

The old rope, on the other hand, didn't slide nearly as well over the cylinders. In this case, tension would build up until it finally overcame friction, resulting in a loud "Snap!" Each time the rope slid like this, the force (Figure 2) dropped quite a bit but quickly built back up.

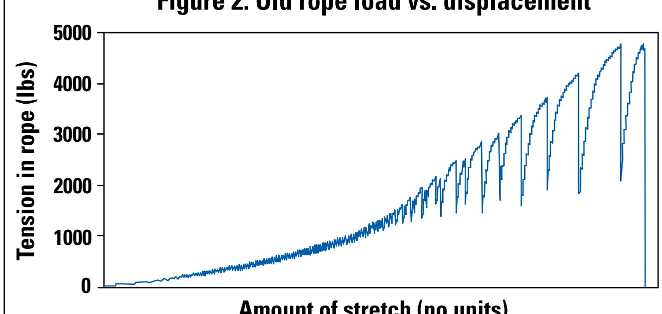
Eventually, each rope arrived at its breaking point. Here again, there was a major difference between the old and the new. The new rope went through a breaking process in which groups of strands reached their limit and broke with a "crack" noise similar to what you hear when breaking a stick. Usually there were several of these minor breaks

Figure 1: New rope load vs. displacement

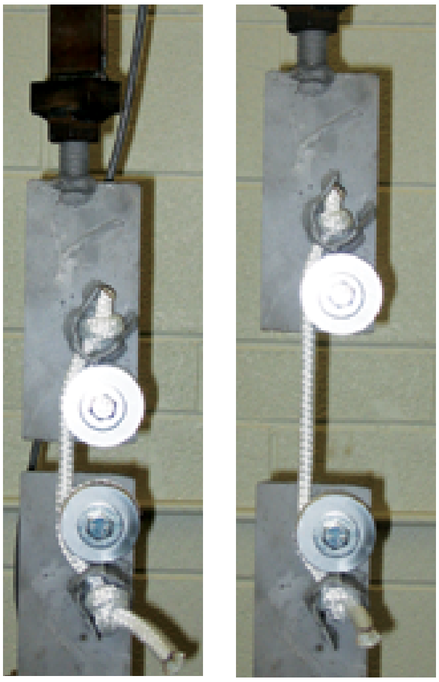


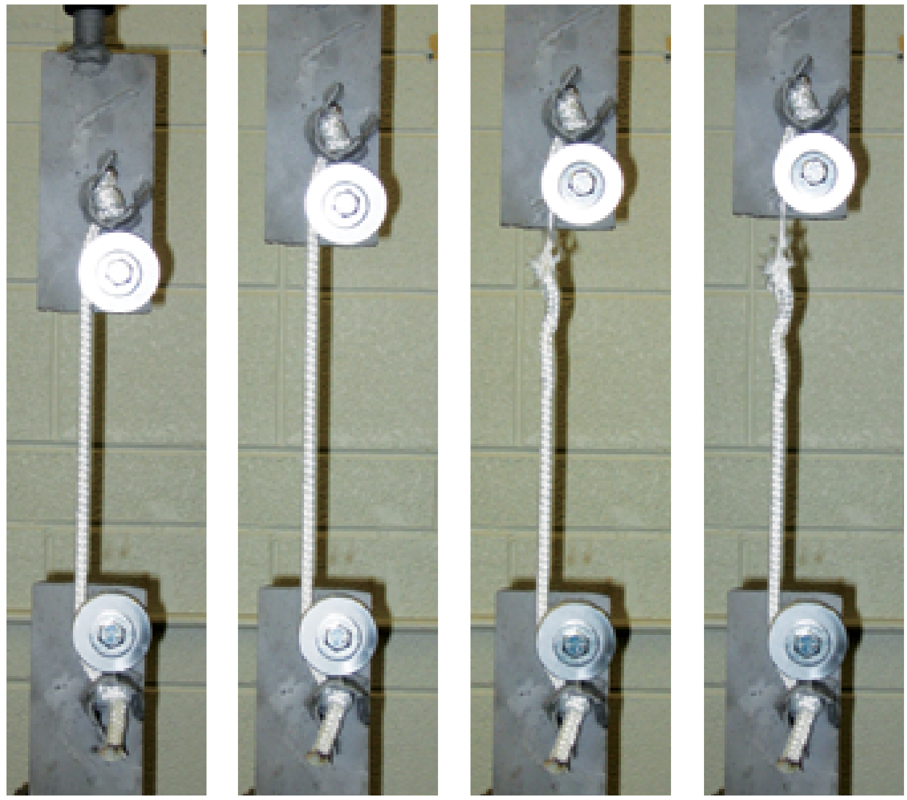
Load vs. displacement of a new rope sample in the test machine. Note the stepped failure at the right of the plot.

Figure 2: Old rope load vs. displacement



Load vs. displacement of an old rope sample in the test machine. Note the sudden failure at the right of the plot.





A sample of new rope goes to the limit. The machine's jaws move apart at a fixed rate, so when some fibers stretch after others break, it takes time for the load to come back on.

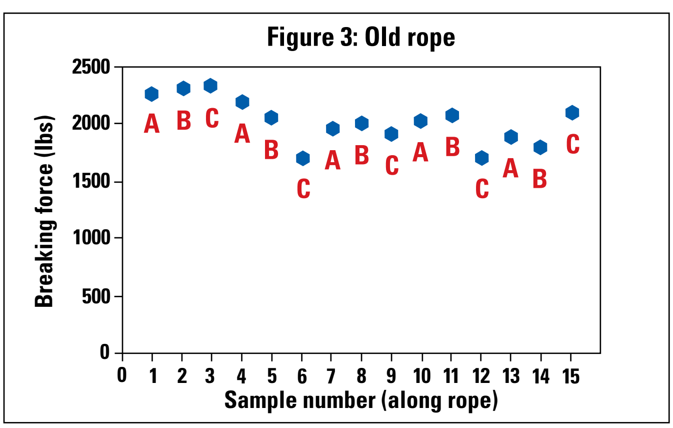
before the rope gave out, each one causing the load supported by the rope to drop and leading to the downward steps at the end of the plot. This machine pulled the rope at a rate of about 1 inch per minute, and it took up to 30 seconds for a new rope to go though the breaking process from first "crack" to complete failure. When this rope finally did break, the load was fairly low and there wasn't much drama. (This isn't usually the case in a rope break, however. See the Whiplash sidebar, page 32).

In contrast, the old rope, once the breaking load was reached, gave up suddenly. Each ended very quickly with a "tink-tink-BANG!" Fortunately, the ends of the ropes were still held by the grips, so they didn't go very far, although each failure gave the test machine quite a shake.

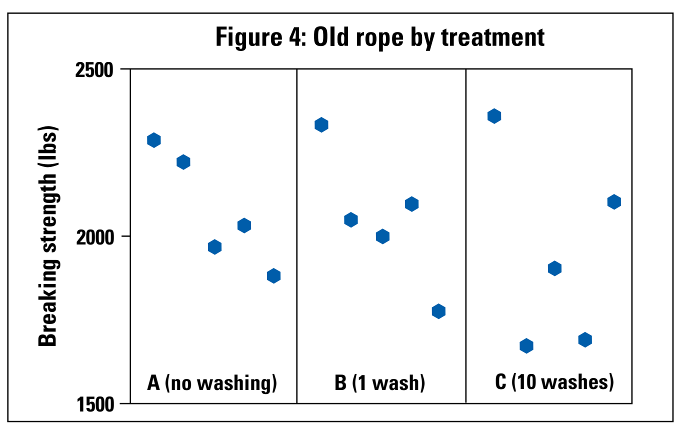
In all cases, the ropes broke as they were coming off the cylinder in either the top or bottom grip. Because the diameter was smaller than ideal, this point would be a stress concentration in the rope, so it was the point that reached its breaking point first. The new rope samples that had experienced the core popout during washing had these locations on the ropes marked. Two of the samples had the pop locations between the grips during testing but neither was a point of failure.

Results

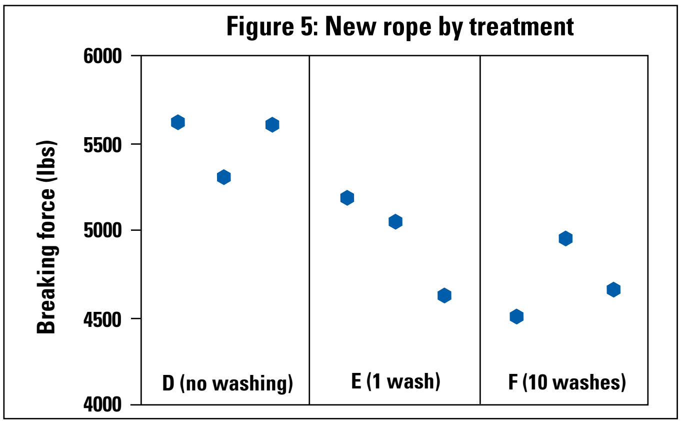
Figure 3, at left below, gives the breaking strength of each old rope sample along the original halyard (sample #1 was the bitter end). The letters "A," "B," and "C" below each point indicate the test case of that sample. The bitter end of the halyard seems to have been stronger, but no other pattern is obvious. This strength difference could have been due to having been exposed to less weathering or less loading during its



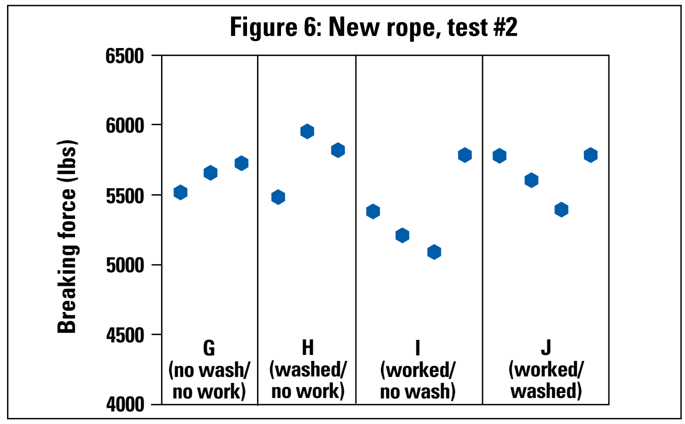
Strength of old rope samples according to their position in the halyard, "1" being the bitter end.



Strength of old rope samples by amount of washing. These results suggest that washing had little effect on the strength of the old rope.



Strength of new rope samples by amount of washing.



Effects on strength of washing (no detergent) and working.

life. The results are sorted by test case in Figure 4. While the 10-washes case has the two lowest points, it also has the highest. The bottom line: it doesn't appear as if washing the old rope has made any difference to its strength.

The results for new rope (Figure 5) show two things. First, notice that the breaking strengths are far higher (5,000 vs. 2,000 pounds) than those of the old rope. Granted, there may have been chemistry and manufacturing improvements in ropemaking in the last 30 years, but there is no doubt that the old rope has lost a considerable portion of its original strength.

Second, it certainly does appear that washing has reduced the strength of the new rope. The strength values after the first wash have dropped by about 10 percent, with perhaps a few more percent lost by the 10th washing.

This is puzzling. While washing had no effect on old rope, it reduced the strength of new rope.

Further research

This presented an opportunity for a follow-up test. Washing does three things: it wets the rope, it adds chemicals (detergent and softener), and it agitates the rope. It would seem safe to assume that getting polyester sailboat rope wet shouldn't cause it to deteriorate. So did chemicals or agitation cause the rope to lose strength?

The idea that mechanical agitation might affect the rope ties in with the fact that most riggers won't splice "old" rope, where they define "old" as having been used once. Working a rope (putting it under tension and bending it around sheaves in blocks and so forth) causes the fibers to tighten up, making the rope hard to splice. The agitation in a washer might also cause the fibers to move around, possibly leading to a change in strength.

To investigate these ideas, I performed a new test. I used only new rope since I had already used up the old halyard. To see if the agitation in washing had an effect on strength, I compared washed rope against unwashed rope. This time, the washed rope was rinsed twice to remove residual soap and softener before starting and some rope samples were washed in plain water with no added detergent or fabric softener.

I also incorporated "worked" rope in this test. The worked samples were run 10 passes while being turned through 180 degrees over a 2½-inch diameter sheave under a tension of 500 pounds. This represents a working load of about 1⁄12 the strength of the rope, probably a reasonable maximum load value for non-racing sailors. I also tested these worked samples in the washed and non-washed states. The complete set of test cases is given in the table below.

Cases for second test of rope

Case	Washed	Worked
G	no	no
H	yes	no
I	no	yes
J	yes	yes

Figure 6 is a plot of the results. Comparing the first two cases, non-worked rope that was not washed (case G) to rope that was washed (case H), shows the strength is about the same. Two of the three washed samples had strengths higher than the three unwashed samples, but then one of the three had a lower strength than all the unwashed samples. Comparing these results to cases D and E in Figure 5, where washing did drop the strength, suggests that the detergent and/or fabric softener did cause the rope's strength to decrease.

Comparing cases G and I — the unworked rope to the worked rope — shows there probably was a drop in strength of about 5 percent on average. Comparing the worked rope before and after washing (cases I and J), however, shows that the strength went back up to that of the original rope. So here, washing (without detergent) caused the rope's strength to increase!

And in cases A, B, and C (old rope) we saw that washing had no effect at all

Laundering tips

Throw a basketful of rope into the washing machine, turn it on and, when it's done, you'll have a great big ball of completely entangled rope. (Don't ask me how I know.) One way to avoid this is to tidy up each rope with the chain sennit knot (daisy chain and chain stitch are other common names). While you can make tight loops, there's no benefit, and smaller loops means you need to make a lot more of them. Once washing is done and the rope dried, the end knot can be removed and one tug will cause the sennit loops to fall right out.

Shackles and other potentially damaging hardware should be wrapped up in rags that can be tied off with nylon wire ties. The rags will protect the inside of the washtub. This step may be very important for domestic harmony.

on strength. If detergent and softener were chemically damaging the rope fibers, the fibers in the old rope should be damaged, just like in new rope. Since the old rope didn't lose strength, detergent and/or softener must not be damaging to rope.

So what gives? Let me offer a couple of theories. First, working the rope samples for cases I and J was done by running the rope under tension around a sheave 10 times. Each pass caused the rope to bend, then straighten. It's likely this bending caused the strands in the rope to redistribute themselves so they were tighter on one side of the rope and looser on the other. Putting such a rope into a tension test led to the tighter strands reaching their breaking point earlier, so the strength of the whole rope dropped a little. A trip through the washing machine would have let the strands slide back to their original positions, so the tighter ones could loosen and vice-versa. The strands in this washed rope would then be loaded more evenly in the tensile test and the rope's strength returned to the original value.

A theory that might wash

Second, as for washing new rope with detergent and softener reducing its strength, while washing new rope in plain water or washing old rope with detergent have no effect, let me propose the following theory.

Double-braided rope is made from tiny polyester fibers. When the fibers are manufactured, they are coated with a material called "spin finish" before they are made into yarns that are braided into rope. The purpose of this spin finish is to eliminate static electricity and to reduce the friction of fibers sliding over fibers, and fibers sliding over metal parts on the processing machinery. This is done so subsequent processing (spinning, weaving, and braiding) of the fibers is made much easier.

When we tension our rope, the fibers and strands slide past each other as the rope tightens up. The more easily the fibers can slide past each other, the more equally they will distribute overall load and the greater the total load the rope will carry. On the other hand, if fibers can't easily slide past each other, some will be tighter and some looser as the rope is loaded. In that case, the tighter fibers will tend to break first, reducing the total capacity of the rope.

When a rope is new, it has this spin finish material on the fibers. Washing with detergent probably takes it off. Washing in plain water may not take it off (at least perhaps not with a single wash). No doubt it wears off over time with exposure to the elements, so older ropes won't have any left. *Hence, we see new rope lose some strength when washed with detergent, but not when washed in plain water, and we don't see any change with old rope.*

Whiplash

Something to keep in mind when looking at Figure 1 (see page 29) is that sailors don't apply stretch to ropes; we apply loads. As the load increases, the rope will stretch more and more. Once we hit that peak in the curve, the rope won't carry any more load. Each fiber that breaks passes its load onto its neighbors, causing some of them to break and shed their load. This causes other fibers to break, and so on. This chain reaction occurs very fast.

What does this mean in practice? As you load and stretch a rope, it behaves like a big rubber band storing energy. When a rope breaks, all that energy is released in an instant. How much energy? If our sample ½-inch rope was acting as a jibsheet with 6 feet of rope under tension, it would release 3,600 foot-pounds of energy. In contrast, a bullet exiting the muzzle of Dirty Harry's .44 Magnum, "the most powerful handgun in the world," has 1,300 foot-pounds of kinetic energy. Granted, the energy in the bullet is a lot more concentrated, but I still wouldn't want to be in the path of a broken sheet. Chafed, elderly, damaged, and undersized lines put you that much closer to what might be a memorable event.

We could test these theories with more experiments, but they sound reasonable (to me, at least) and I'm sure we'd all rather go sailing.

Take-away points

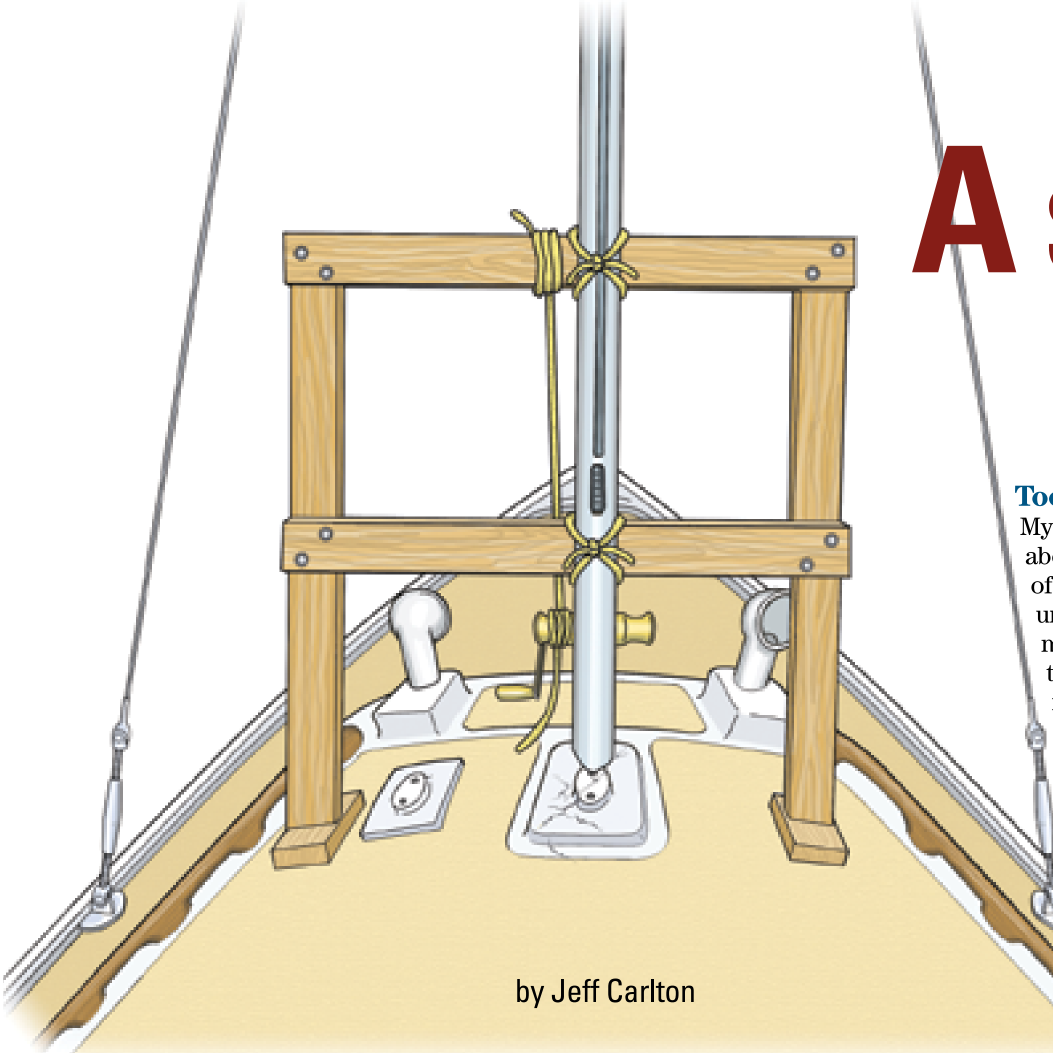
What have we learned? Let me offer the following:

- Washing doesn't seem to make any difference to the strength of old rope.
- New rope did lose some strength after being washed in detergent. This loss, however, is most likely due to the "spin finish" coating being removed from the rope's fibers, rather than from deterioration of the rope itself. Since this "spin finish" will wear away over time anyway, washing won't have any additional effect on strength.
- Washing a dirty rope once will make it considerably softer and less stiff. There was limited improvement with additional washings. So there's no benefit to washing a rope if it's not dirty and stiff.
- If you machine-wash new rope before it has been worked enough to tighten it up, expect the core to pop through the outer braid. If you have dirty "new" rope to clean, try soaking it in a tub and hand-washing to avoid this.
- If the core does pop out, "milk" the rope from the ends to pull it back in. Its strength doesn't seem to be affected.
- Old, weathered rope is probably drastically weaker than new rope. This is something to keep in mind when deciding which rope should be assigned to which job on (or off) the boat.

Tim Nye teaches mechanical engineering and in his spare time drags home and resurrects derelict machinery. After meeting and marrying Elizabeth, a sailor, he now drags home and resurrects good old sailboats. Their current boat is a 1976 Grampian 34, Sea Rose, *mostly complete and sailed out of Hamilton, Ontario.*

A slightly repair

by Jeff Carlton



Lashed just tightly enough to support the frame, the mast was free to rise up when the line tied to the top crosspiece was taken up on the winch.

ILLUSTRATIONS BY FRITZ SEEGERS

No matter how you looked at it, we had a serious problem. Our boat's mast step was compromised and would have to be repaired.

In December 2006, following an A-plus survey, I bought a 1977 Pacific Seacraft Mariah with a deck-stepped mast. I had it trucked from Florida to Lake Guntersville in Alabama and, to get the most use of the expensive crane, I stepped the mast the day the boat arrived, unaware that water had entered the step and delaminated the fiberglass skin.

In preparation for launching in May 2007, I tuned the rig. Ultimately, the boat's movement in the slip added just enough stress for the step to develop horizontal cracks on its fore and aft edges and one running lengthwise under the mast shoe. The cracks looked like a capital H turned on its side. When I calmed down and called the surveyor, he said he had only looked for moisture in the hull. (Contact me if you want his number.)

The idea of dismantling the ProFurl over the water, renting a crane, and pulling the mast, only to have to do the whole procedure again in reverse after making the repair, dismayed me utterly, until I asked myself, "What would Captain Jack Aubrey have done?" One of my favorite sequences of the *Master and Commander* movie was his refit at sea. And hadn't I read in Jack London's *The Cruise of the Snark* how one man stepped a mast with nothing but a hull for help? There had to be a way to fix this thing without all the work, expense, and drama of taking that darned mast off the boat.

Too scary to contemplate

My first thought was to jack the mast up about 3 feet, secure it with some sort of four-legged table, repair the step under the table, and then lower the mast back down. Too scary. The next thought proved to be the winner. Why not use the big winch on the mast for the lifting, open the turnbuckles as far as possible, raise the mast only 4 or 5 inches, and move the base of the mast off the step while it straddled the main bulkhead on a temporary step and shoe? Why not, indeed?

The most serious problems I faced were figuring out how to use the mast's own winch to raise it and how to prevent the disconnected base of the mast from sliding and bringing down the whole rig. Did I mention the pack of head-shaking naysayers taking bets from a safe distance on the multi-boat mast-crashing disaster that was sure to follow?

A frame to lift it with

My son, Kyle, and I built a lifting frame out of three 2 x 6s. We cut off two 6-foot vertical legs at angles to match the crown of the deck. We attached feet to the legs with 4-inch deck screws. Then we bolted two 4-foot crosspieces horizontally to the legs: one at the top and the other in the middle where it wouldn't interfere with the winch. Four-inch bolts with washers and nuts made everything tight. The lifting frame looked like a squared-off A.

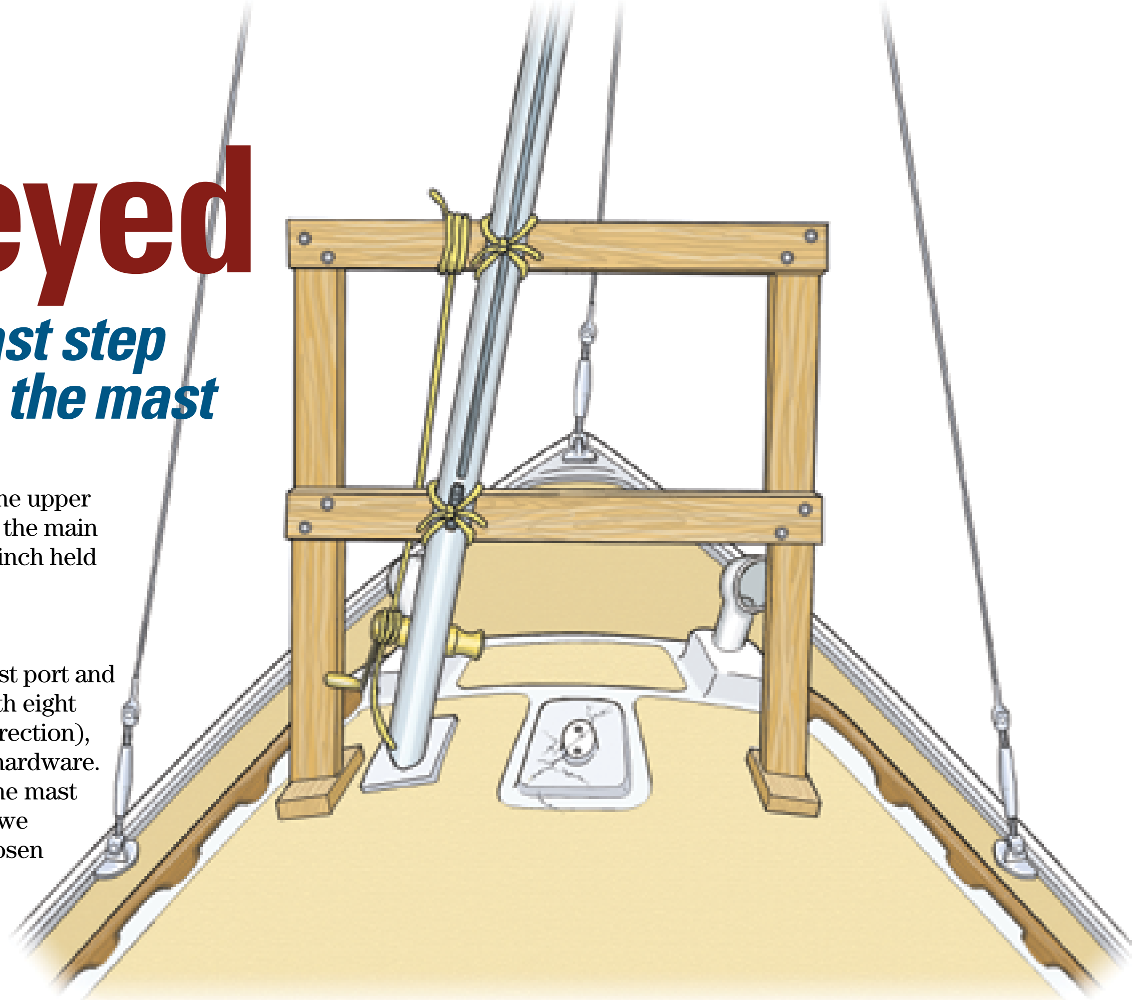
We lashed both crosspieces to the mast securely enough to keep the frame upright and loosely enough for the mast to slide upward and through the lashings. We positioned the feet where the force of the operation would be supported by the main bulkhead.

We made and placed a temporary plywood step and shoe to port of the step and between it and the foot of the lifting frame. We lined the bottom of the step with sponges to protect the deck and keep it from sliding. We centered this over the bulkhead for support.

Next we tied a 10-foot length of 1-inch double-

cockeyed

Fixing the mast step without pulling the mast



braided line to the center of the upper crosspiece and led it down to the main winch. The cleat below the winch held what we got from the lifting.

A maze of braces

We braced the base of the mast port and starboard and fore and aft with eight ratchet-straps (two in each direction), all of them secured to heavy hardware.

This controlled lifting of the mast turned out to be harder than we expected. The idea was to loosen the turnbuckles and ratchet straps just a little, crank on the winch, raise the mast through the lashings as far as possible, secure the tail of the lifting line on the cleat, and repeat. Make that: repeat about 100 times. What made it a pain was the fact that we were only two, my son and I, to man the nine turnbuckles and eight ratchet straps. We would go to bow and stern, port and starboard, round and round, making slight adjustments and lifts. This was no pleasant stroll around the deck; the spider web of straps made each circuit more like a low hurdles course. To be more efficient at this, you really need one grinder for lifting and four helpers for loosening and tightening.

We ran into one issue with the turnbuckles fully extended: the new standing rigging — being at the beginning of its life of stretching — would not quite give us enough room for the base of the mast to clear the top of the shoe.

Our remedy was to secure a halyard from the masthead to the stern through a bridle we ran through the two hawse holes. We secured another halyard to the port aft-lower shroud turnbuckle base. With these extra precautions, we were able to detach the port half of the split backstay and the port aft-lower shroud. This move allowed the mast to go up and tilt to starboard, giving us the room needed to clear the shoe and disconnect the in-mast wires. Most boats probably have enough rigging play to make this step unnecessary.

Pretty as you please

To shift the mast base to port, we loosened the starboard ratchet straps and tightened those to port. When the mast was over the temporary shoe and step, we uncleated the lifting line and eased her down as pretty as you please. We went wild with excitement. The worried look on my neighbor two boats down encouraged us to carefully tighten all the stays, shrouds, and ratchets.

Having to look at my boat with her mast askew and the lifting frame resembling a gallows was the worst part of this project. The unnerving sight prompted me to finish the repair ASAP.

With the mast out of the way, repairing the step was straightforward. Using a grinder, I cut off the gelcoated top layer of glass, being careful to leave the sides of the step intact. What I found underneath made me glad I'd gone to all this trouble. The double layer of 1-inch marine ply was soaked through. An hour with hammer, chisel, sander, and grinder produced an empty box ready for epoxy, heavy fiberglass mat, ¾-inch marine ply, and a plate of ½-inch stainless steel.

Since we knew the drill, putting the mast back in place was much easier. When it came down on the rebuilt mast step, we shouted with joy. As soon as the stays and shrouds were tight, we dismantled and removed the frame. What a relief it was to have the mast sitting straight up on a strong and dry step, even though the accredited surveyor tried to assure me that water-soaked lumber retains most of its strength. Still want his number?

Jeff Carlton is in advertising full-time, pastors a small church part-time, and with his wife, Cheri, sails their 1977 Pacific Seacraft Mariah, Sea Fever, *whenever he can.*

With the mast secured on its temporary step to the side, the work of repairing the mast step could proceed unhindered.

Mast raising made

Two good old boaters take the A-frame to the tabernacle

by Loren Lyndaker

Over the past several years, our cruises on *Whippoorwill*, our Cape Dory 27, have taken us to several places where we have had to lower the mast and carry it on deck in order to pass under low bridges. A few experiences along the way have inspired us to make changes to the boat to facilitate the procedure.

On a couple of occasions, when traveling across open water with the mast down, the mast began to move about too much. In each case, we resolved the problem, but only after venturing forward with a safety harness in less-than-favorable conditions. Once, we returned to a marina on the Hudson River to find that the mast supports we had stored there two months earlier had disappeared — not a big expense but an unexpected challenge.

When we stored our boat in Maine for the winter of 2004-05, during our Down East Circle cruise, we were required to take the mast down. We did all the prep-work for both operations on our 32-foot mast. Many times at our home marina, we (the captain and first mate) have raised and lowered our mast in about 15 minutes with the help of a gin-pole and a friend. So, when the yard charged more than $250 to unstep the mast in the fall and more to step the mast the following June, that planted the seed for this project.

Our goal was to create a system by which we could raise and lower our mast and that would include the hardware needed to secure the mast on deck for traveling in canals and under fixed bridges. As well as saving us money, carrying all the parts of the system on board would give us greater freedom in choosing our cruising grounds.

Weighing the options

We considered lowering the mast forward, but the jib furling hardware makes that difficult. Also, much more than half of the weight of the mast, including the radar antenna, would be forward of the bow pulpit when the mast was unstepped. We therefore designed a system to lower the mast toward the stern.

Whippoorwill has a hard dodger, which meant, we would have to raise the pivot point of the mast above the cabintop so the mast would clear it. The answer was a tabernacle. A nautical glossary defines a tabernacle as "the deck housing (usually a raised socket or post) for the heel of a mast, often with a pivot or hinged so the mast can be easily lowered . . ." The tabernacle, with its support system, also provides the means of securing the mast when it's stored on deck.

We designed and built the tabernacle and then experimented with a procedure to raise and lower the mast. We used the mast-raising method described by Ron Chappell in his article in *Good Old Boat* in May 2001. It worked, but it was clear that *Whippoorwill's* nearly 60-year-old two-person crew couldn't comfortably complete the task

without assistance. Because of the forces involved with our considerably larger mast, we quickly determined that a rigid A-frame would be a better choice for us than a yacht-braid-stabilized gin-pole.

Easy does it

After completing the usual preparations for unstepping the mast, we connect the legs of the A-frame — which is the 12-foot boom and matching aluminum tubing — and put it in place at the bow. We have to raise the mast slightly to insert the pivot pin through it and the tabernacle. We then attach to the A-frame halyards from the masthead and a block and tackle from the bow. We wrap the line from the tackle on the windlass.

Additional masthead lines connected to bridles at either side of the mast minimize sway as we lower the mast. After we release the forestay, one of us gets the mast moving by putting pressure on the backstay. The other eases it down with the tackle. This gives us good control over the lowering process, which we can easily stop or reverse. The first person, who has moved out from under the mast for most of the lowering, makes sure it lands safely in its support at the stern.

Stepping is a bit more work but not because of the lifting. The challenge is keeping lines and standing rigging from fouling — an unnoticed hang-up could put unsafe loads on the system.

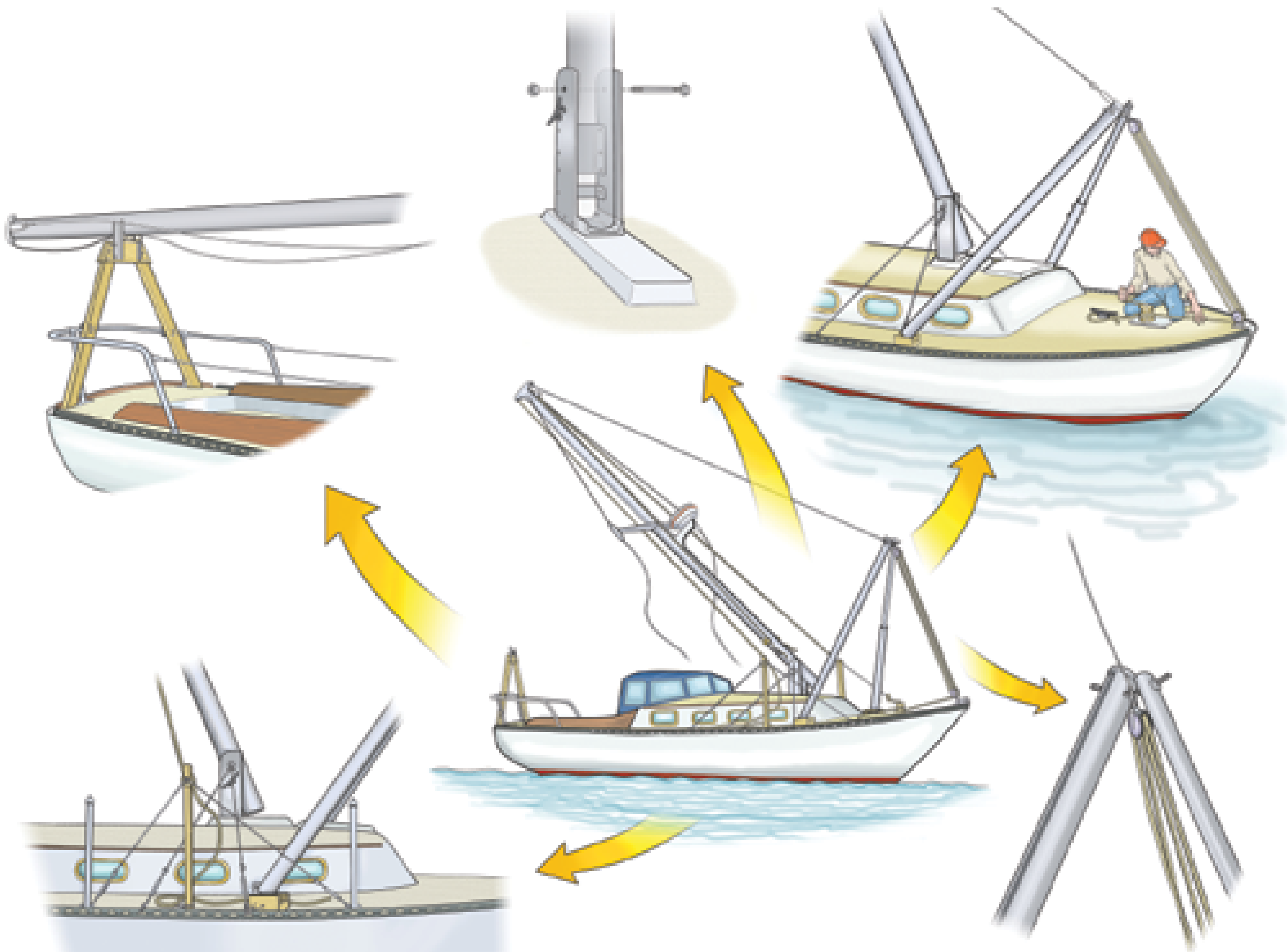
Constructing the tabernacle

After removing the original mast support from the cabintop and taking some measurements, we used ¼-inch luan plywood to construct a mockup for the tabernacle. We fitted this mockup to the mast and found the pivot point. The tabernacle itself is constructed of aluminum and is 5 by 6 inches by 23 inches overall. The side pieces are ⅜-inch thick, 5 inches wide, and 23 inches long. The bottom, front, and back supports are sections of 5 x 1.885 x .325-inch 6061 T6 aluminum channel cut to various lengths (10 inches for the back, 7 inches for the bottom, and 2 inches for a front piece that is fitted after stepping to secure the mast in the tabernacle). After considerable investigation into construction options, we ordered the material cut to length from OnlineMetals.com.

We used appropriate parts of the plywood mockup as patterns in the construction that followed. We cut an arc at the upper aft corner of each of the side pieces, filed them to remove burrs, and sanded them smooth. For the mast pivot point, we drilled a ½-inch hole in each side plate and, with considerable care, elongated the holes to allow the upward movement the mast needs when it rotates.

Next we assembled the four major pieces of the tabernacle and marked and drilled them for fasteners. Where clearance to the mast is not a problem, we through-bolted the parts with ¼-inch stainless bolts. The remaining points we drilled and tapped for ¼- by ½-inch long bolts which, when fitted, would be flush with the inside surface. We fitted other hardware, including the cleats, in similar positions relative to where they were on the mast and fastened a ¼-inch stainless-steel U-bolt on each side for attaching support cables when the mast is being stepped up or down.

Down she goes! The A-frame, on facing page, provides the lever arm, the tabernacle, above left, the pivot point, and the windlass, above right, the friction to control the drop and the muscle for the lift. The tabernacle and the mast heel plug await fitting on the boat, below left. Pivot boxes for the A-frame, guy wires to brace the tabernacle, and wooden supports for the side stays all play their part, bottom right.



FRITZ SEEGERS

The tabernacle is the fulcrum around which the whole system for lowering, raising, and transporting the mast functions. All the other components can be dismantled and stowed aboard when not in use.

At this point we took the tabernacle to the boat so we could mark the mast and drill it for a workable pivot point. We inserted a ½-inch outside-diameter, thin-walled aluminum tube in the mast's pivot-bolt hole and secured it with JB Weld. This makes it much easier to pass the bolt through the mast.

Adapting the mast

In order for the flat-bottomed mast to rotate with a 20-inch radius arc, some extra clearance was needed for the aft portion. We create some of this clearance by lifting the mast about ½ inch just before unstepping (to insert the pivot bolt). We gained the rest by modifying the mast.

To check the clearance needed to move the mast through a 90-degree rotation, we drilled a piece of wood the same width as the front-to-back dimension of the mast and mounted it in the tabernacle. That led us to chamfer the aft side of the bottom of the mast, starting ¾ inch up and cutting a curve for about a third of the distance. Since the mast originally stood on a male step and would now simply rest on a flat surface, we made a hardwood plug (shown at bottom left on page 19) for the bottom of the mast to distribute the pressure. We cut the shape and tapered the sides to make it a snug fit. Its contour matched the new shape of the mast heel, and we secured it in place inside the mast with screws, though the tapered fit provides most of the support.

We then drilled the new tabernacle to match the bolt pattern of the old mast step and installed it on the boat using four ¼-inch bolts. We made an aluminum plate to cover the heads of the bolts and to provide a flat surface for the mast.

The deck fittings for the forward- and aft-lower shrouds provide anchor points for the four support cables that attach to the U-bolts on either side of the tabernacle.

The cables are ⅛-inch stainless steel with hand-swaged fittings on both ends. Each cable support includes a turnbuckle so they can be tensioned. We fabricated the connecting hardware from 1 x ¼-inch stainless steel and were able to recycle turnbuckles we'd kept when we replaced the rigging in 2002.

Stowable parts

The exact configuration of an A-frame and tabernacle system would be unique to any vessel. For our Cape Dory, we chose components we could easily take apart and store aboard. We use the 12-foot boom for one side of the A-frame and made the other from two lengths of aluminum tubing, which we chose for its light weight and durability. We ordered two 7-foot pieces of tubing, one with an outside diameter of 2½ inches and the other with an outside diameter of 2¼ inches. They both had wall thicknesses of ⅛ inch. In theory, this would allow the smaller to slide inside the larger. We chose 7-footers instead of one 12-footer because we could stow the shorter pieces in a cockpit compartment.

When the tubes arrived, the smaller would not fit inside the larger. I used a belt sander, starting with 40 grit paper, to reduce the diameter enough so that about 1 foot of the smaller tube would fit inside the larger one. I drilled a ¼-inch hole through both so we could bolt the two tubes together to form the second half of the A-frame. We use a ⅜-inch threaded galvanized rod with an appropriate bend to connect the boom and tubing to form the apex of the A-frame. Two 5-inch by 7-inch boxes constructed of ¾-inch plywood with two 4-inch sides and two 2-inch sides provide pivot points on the deck for the A-frame's legs, shown at bottom right on page 19. They also protect the deck against possible damage from the A-frame.

Critical elements

The mechanics of the pivot point and support systems during stepping and unstepping are a critical piece of the puzzle. As a result of the first trial, we found that we needed a system to minimize the horizontal movement of the mast as it's raised or lowered. We accomplished this by establishing a pivot point at the same distance above the deck as the mast pivot point but directly above the toerail. The lines we use to center the mast horizontally run from the masthead through these points and then to the deck. Because the radius stays the same as the mast is being lowered or raised, the tension in these lines remains constant.

Each outboard pivot point is supported on a length of 1½-inch-square-section lumber tied to the upper-shroud chainplate and braced to stanchion bases by a pair of ⅛-inch stainless-steel cables with swaged loops at each end.

Secure and on the level

The tabernacle supports the mast base when the boat is sailing, but we needed a support system to handle the forces on it while stepping and unstepping and also to provide a solid point when it's carrying the mast horizontally. The tabernacle is the major component of our system for securely carrying the mast on deck. It eliminates any fore-and-aft movement, it minimizes side-to-side movement at the ends, and it's considerably more stable than any system we've previously used when carrying our mast.

The aft mast support sits on deck just behind the stern pulpit and is attached using U-bolts. It is constructed of wood and has vertical pieces of angle aluminum to support a 1½-inch diameter by 6-inch roller for the mast to lie on.

The roller is made from plastic drainpipe with drilled end caps. This roller takes much of the work out of moving the mast. It can be taken apart easily and stowed in the cockpit lockers. A couple of lines secure the mast in its traveling position, with the top of the mast resting on the roller aft, the main portion on the tabernacle amidships, and the foot on the bow pulpit.

"As a result of the first trial, we found that we needed a system to minimize the horizontal movement of the mast as it's raised and lowered."

Once we have stripped the sails and removed the boom, as we would have to do for a yard to unstep the mast, it takes us a further one or two hours to prepare for the drop. The actual lowering of the mast takes less than five minutes, after which we need another two to three hours to move the mast forward, secure it for travel, and stow the hardware.

The system's downside is that *Whippoorwill* must now carry a few extra pounds of hardware and lose some valuable stowage space. Approximate material costs in 2006 were $125 for the tabernacle, $120 for tubing, $120 for blocks and 5⁄16-inch line, and $40 for miscellaneous bits and pieces.

It took some time to achieve this solution, but it allows us to control the costs associated with raising and lowering the mast and gives us more freedom to choose where we cruise. And what better way can there be to fill long winter days in northern New York than by dreaming up boat projects? Our tabernacle meets our needs and will be useful on our next adventure: another trip south along the ICW.

Loren Lyndaker, a recently retired math teacher, and Betsy Lyndaker, a retired nurse practitioner, have owned their Cape Dory 27 for 22 years. They have sailed extensively on Lake Ontario and as far afield as the Bahamas. Currently, they are cruising the Intracoastal Waterway south to the Florida Keys.

A-frame at the ready, Loren and Betsy Lyndaker prepare for another controlled mast lowering.

Chainplate islands

An uplifting way to cure pesky deck leaks

by Don Casey

All the water that comes aboard our boat, whether from sea or sky, is supposed to drain off through scuppers in the sidedecks. Unfortunately, the scuppers are not the only holes there. Chainplates fastened to knees inside the cabin pass up through holes in the deck. Sealant is supposed to keep water from flowing below but, as everyone knows, the grip of sealant on the thin edge of fiberglass around the hole is temporary at best.

To me, this type of chainplate installation looks just like a pop-up bathtub drain, and functions about the same too. Mounting chainplates through holes in the lowest part of the deck has never struck me as award-winning engineering, but the fact that I have lived with this inanity for more than 30 years doesn't put me in the genius class either. Fortunately, I eventually met fellow Seawind owner, Bill Lynch, in Grenada. Bill had devised a solution: raise the hole above the deck. Duh.

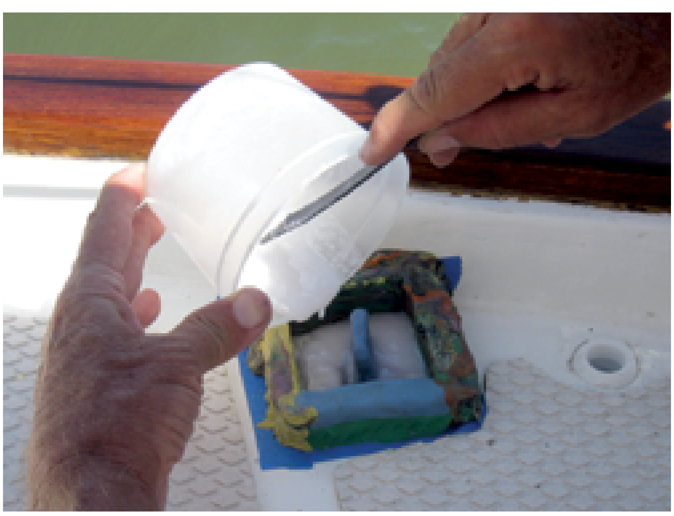
Bill fashioned spacers and bonded them to the deck. I felt there was still potential for water to eventually find its way under the spacers and opted instead to cast epoxy islands, confident that if I first ground the deck vigorously with 36-grit paper, the island and deck would essentially become one.

Blue tape and modeling clay

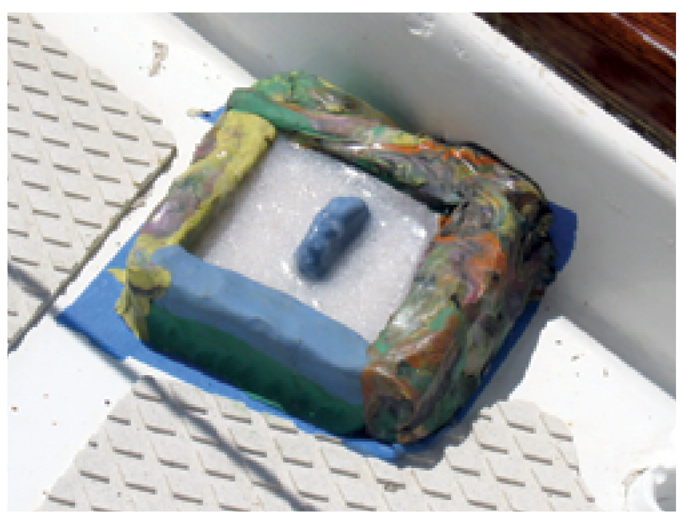
To get a truly permanent bond, carefully but thoroughly grind the deck around the chainplate. Outline the island with blue tape, then build the mold on the tape from kids' modeling clay. Be careful not to make the islands too tall, or you won't be able to pin the toggle to the chainplate.

Flush with the deck, a chainplate invites leaks.

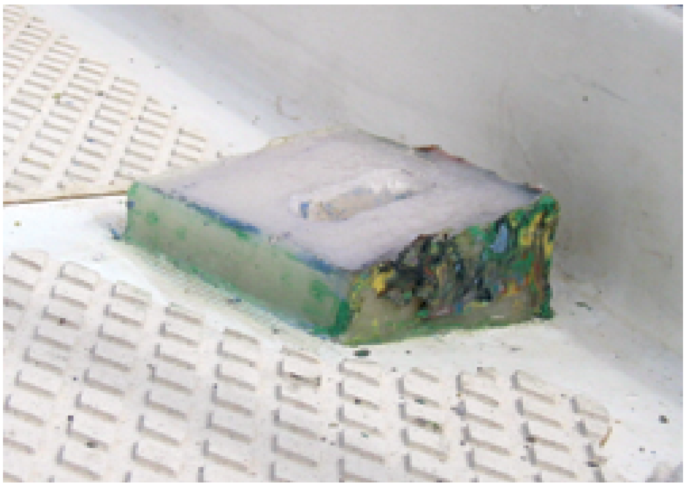
A mold of modeling clay defines the shape of an island of epoxy.



Epoxy thickened to a ketchup consistency flows just right.



The epoxy, poured in stages to avoid heat build-up, is allowed to cure.



Once the epoxy has cured, the mold can be removed.

Cleaned up and sanded, the island has become part of the deck.

A dry fit establishes that the island will meet expectations.

Once leak-prone, the chainplate is now high and dry.

I did one island at a time, re-using the same clay to cast six islands. If the clay is a dark color, shade it from the sun to keep it from going soft. Close the hole through the deck with tape. If you close it with clay, the heat from the curing epoxy will open it and the epoxy will drain below (don't ask me how I know this). A clay "chainplate" (sitting on top of the tape) lets you cast the hole rather than having to machine it. Make it slightly small and dress the hole to size with a rotary tool. Similarly, make the island slightly large and sand it to size and shape.

I used epoxy resin thickened with glass microfibers to a thick ketchup consistency which yielded ivory-like islands of admirable appearance and hardness. Do multiple pours so the heat generated by the curing epoxy doesn't soften the clay mold. I made three 1-ounce pours for each island, allowing each pour to gel before adding the next layer.

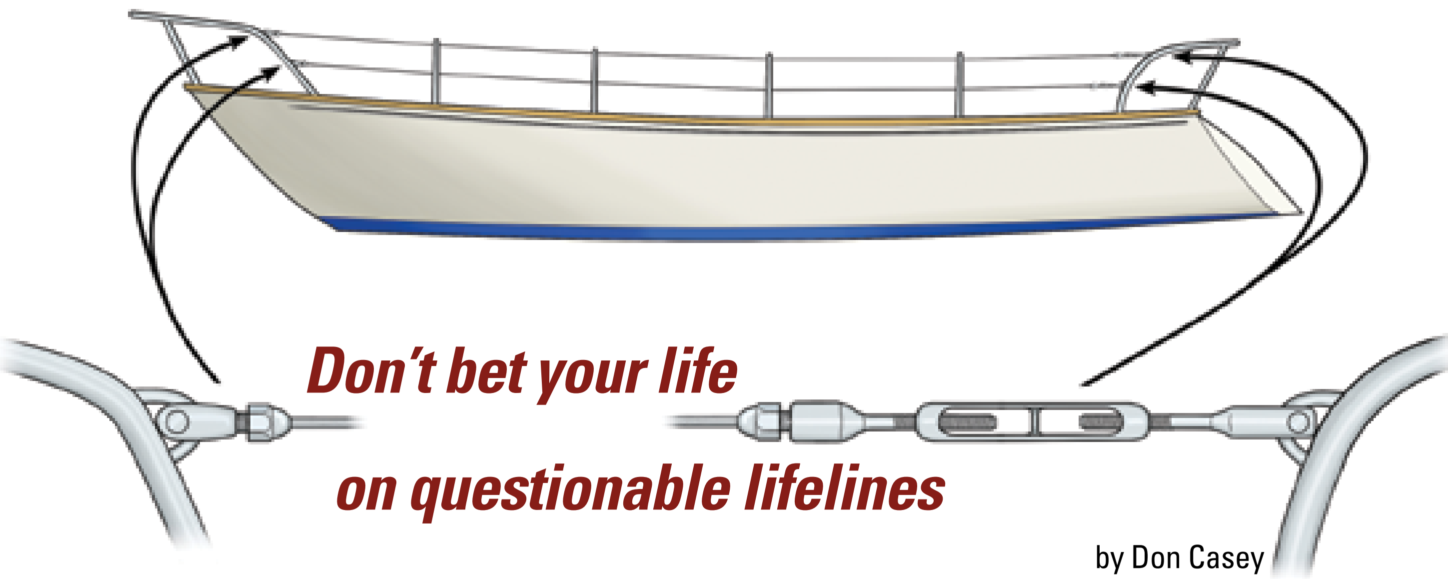
Let the epoxy cure at least 24 hours before sanding it to the final shape. When you reinstall the chainplates, you will happily discover that chainplate islands create a bonding surface for the sealant as wide as the island is tall, a vast improvement over deck thickness. Pump sealant around the chainplate, install the cover plates, reattach the rig, and your chainplate leaks will be a thing of the past. Paint the exposed epoxy to match the deck and to protect the UV-sensitive resin.

Don't drop your guard

There is a downside to this improvement. Chainplates that fail to *demand* attention probably won't get any — a risky oversight for stainless-steel hardware. Every few years, remember to pull your chainplates — no matter how watertight they are — and inspect them for corrosion. After you've gone to all this trouble, they should be as dry as a desert, but you cannot know without checking.

Don Casey became the authority on boat fix-it projects with This Old Boat. *He and his wife, Olga, have been cruising aboard their 1969 Allied Seawind,* Richard Corey, *since 2002. See the editorial on page 5 for more about Don and his connection to* Good Old Boat.

Maintain your perimeter



Don't bet your life on questionable lifelines

by Don Casey

The following is an excerpt from the second edition of Don Casey's This Old Boat, *published in April of this year by International Marine.*

FRITZ SEEGERS

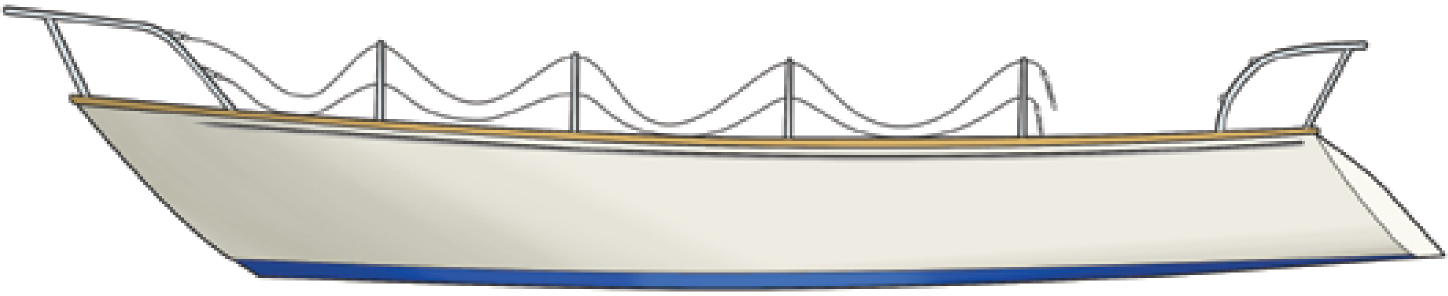
Most old boats have been delivered with lifelines rigged with coated wire. Coated wire is an astonishingly bad idea. Not only does the coating promote corrosion by depriving the stainless steel of essential oxygen, but by design the inevitable corrosion of the wire is hidden from view. The true strength of aging coated lifeline wire is a bad-odds gamble, with the ante being someone's life. That is why they are called lifelines. Just for the record, the Offshore Racing Congress (ORC) bans coated lifelines.

> **"A pair of boat-length runs of rigging wire can be a priceless onboard resource in the event of a rigging failure."**

Examine coated lifelines closely. As they age, the vinyl coating hardens and cracks, and soon enough rust appears at the cracks in the vinyl. This instantly condemns the wire — no ifs, ands, or buts. Likewise any kind of bump or lump in the vinyl covering means a tumor of corrosion inside. If you see rust stains anywhere on coated lifelines, even at the ends of the coating, put lifeline replacement at the top of your priority list. Falling overboard is far and away the most serious risk boaters face, and weak lifelines greatly increase your exposure. You are safer without lifelines.

I urge you not to replace old coated lifelines with new coated lifelines. The best wire for lifelines is Type 316 1 x 19 rigging wire. The same outside diameter will deliver more than three times the strength of coated wire, the 316 alloy will resist corrosion for a long time and, if any does occur, it will be immediately visible for evaluation. Given that safety at sea is surely more important than convenience at the dock, I also advocate abandoning gates in favor of a continuous lifeline from bow to stern. In my experience, gates are rarely in the right place anyway. They are like an open manhole in the dark if accidentally left open. They at least double the number of end fittings, thus doubling too the possibility of fitting failure, not to mention doubling the fitting cost. (If safety is your concern, you are paying more to get less.) And as an added benefit, a pair of boat-length runs of rigging wire can be a priceless onboard resource in the event of a rigging failure. On our boat, a ketch, the upper lifelines are the same wire as our main shrouds, and the lower lines are the same as the mizzen shrouds.

You have three options for end fittings. There are do-it-yourself hand-crimp terminals available that claim to deliver about 70 percent of the wire strength, but that is on 7 x 7 wire. I fear that the grip of these crimp fittings will have significantly less strength on the smoother surface of 1 x 19 wire. I have only anecdotal data to support this concern, but if you decide on the greater safety of uncoated wire, you should pair this with the greater strength of either machine-swaged or swageless terminals. You will need a rigging shop to install swaged terminals. Several manufacturers offer complete lines of swaged lifeline fittings, including integral pelican hooks, gate eyes, turnbuckles, and threaded



Don recommends stainless-steel lifelines be continuous between bow and stern, at left. Turnbuckles fitted at the after ends can be slackened and unpinned to create a convenient loading gate when needed, above.

adjusters. These make for very attractive lifeline installations and, because the swages live their lives horizontal, internal corrosion is less prevalent.

A do-it-yourself alternative is to terminate the lifelines with swageless terminals, typically fork or toggle jaws at the bow and studs or eyes at the stern joined to turnbuckles. You can lower the cost without much compromise of strength by eliminating the turnbuckles and substituting a multi-purchase lashing of high-modulus, small-diameter line to tension the lifeline and attach it to the stern rail. However, I prefer a turnbuckle because it allows tension to be eased and the clevis pin removed to drop the entire lifeline to deck level between any pair of stanchions, effectively giving you a wide and ideally located boarding or loading gate.

High-modulus (or hi-mod) lashings inevitably lead to the question, why not just replace the wire altogether with high-modulus rope? A ¼-inch double-braid line with a polyester cover for abrasion and UV protection and a high-modulus (Dyneema) core can have a breaking strength exceeding 4,000 pounds, about twice as strong as coated lifeline wire of the same outside diameter. The rope is more expensive than the wire, but only modestly so, and it has the advantage of being much lighter and more comfortable. A thimbled eye splice at each end would be all the "terminals" required, with one end tensioned with a multipurchase lashing. Hi-mod rope lifelines would require you to learn to do a core-to-core splice. Beyond this intellectual demand, the other drawback is that there is no way to tell when or if the strength of the line has been degraded by exposure. I would caution against trusting rope lifelines more than five years old, based on the life of polyester halyards that have the longevity advantage of being vertical rather than horizontally exposed to the sun's rays. By contrast, Type 316 lifelines should last two decades or more.

"I would caution against trusting rope lifelines more than five years old. Type 316 lifelines should last two decades or more."

Don Casey became the authority on boat fix-it projects with This Old Boat. *He is the author of a series of books in the International Marine Sailboat Library and of* Dragged Aboard: A Cruising Guide for the Reluctant Mate. *He and his wife, Olga, have been cruising aboard their 1969 Allied Seawind,* Richard Corey, *since 2002.*

Replacing a backstay

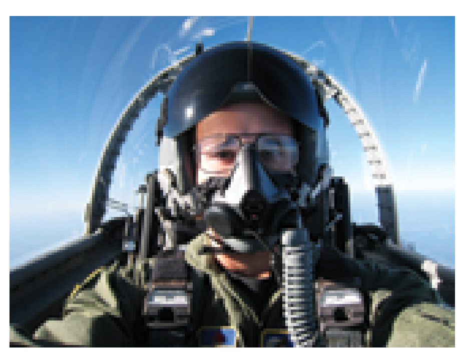
Here's a rigging project you can do yourself

by Andy Schell

My best friend Adam's new-to-him Tartan 37, *Audentia*, had never left the dock with him at the helm. He'd purchased her in February, and there is ice on the Chesapeake in February. She was berthed at a private dock in Whitehall Bay, just north of Annapolis, when Adam bought her. I had seen the boat before he did — Adam is a pilot with the Air National Guard stationed in Mississippi, so I became his ad hoc broker in Annapolis. I scoured the listings, talking to real brokers and diving into leads with the excited enthusiasm that accompanies any boat search, bolstered by the fact that I would not be writing any checks.

As a professional captain, and having just completed two boat searches in the past three years (for my father's Wauquiez Hood 38 and for my Allied Seabreeze yawl), I had the experience and confidence to fulfill my responsibility and find Adam the right boat. There are a lot of Tartan 37s out there, so the search was extensive.

Adam wound up buying his boat on my advice, after flying home to see her for himself. Unfortunately, on the day of the sea trial, she was iced-in, so her maiden voyage would have to wait. By the time the creek had thawed, Adam's dock lease was up and he planned to move her across Chesapeake Bay to the Eastern Shore. His insurance required a rigging survey, which revealed cracked swaged fittings on the backstay. He asked me to replace the backstay for him before we moved the boat.



A suspect swaged fitting, at right, led Andy to replace the whole backstay on a Tartan 37. He chose to use Hi-MOD mechanical fittings, center. Adam, the boat's owner, was away on business, bottom, leaving Andy in charge.

The backstay

I'm a firm believer in using mechanical, rather than swaged, fittings for all of a boat's rigging, and talked Adam into going with the relatively new Hi-MOD fittings made by Petersen Stainless Rigging in the U.K. (and distributed by Hayn Marine in the U.S.A.) for his new backstay. The Hi-MOD fittings work on the same principle as the ubiquitous Sta-Lok and Norseman fittings, that of using mechanical compression to keep the wire in the fitting. They have a clever addition to the inner cone, a crown ring, which keeps the unlayed wire strands perfectly spaced inside the fitting.

We ordered the wire and the fittings from Rigging Only (<www.riggingonly.com>). Once we had the wire and pin measurements, which required the first of many trips to the masthead, the guys at Rigging Only were very helpful in determining pin sizes and turnbuckle sizes for the new stay.

Measuring

The first step was to measure the old stay and determine what, exactly, we actually needed to replace. The rigging survey required the replacement of just the swaged fittings, not the wire, but Adam decided to scrap the whole lot and replace the stay entirely, including the turnbuckle. We weren't sure when the rig had been replaced last, and this Tartan had recently completed a circumnavigation with the previous owner. Better safe than sorry.

We used a simple wire gauge to measure the wire thickness (to the nearest 1⁄32 inch), the pin diameter on the chainplate, and the pin diameter at the masthead. With these measurements, the guys at Rigging Only advised us on what size Hi-MOD fittings and turnbuckle to order. We ordered the wire about 3 feet too long to give us room to botch the age-old rule of "measure twice, cut once." Once the shipment arrived, complete with detailed instructions for assembling the Hi-MODs, we set to work.

> "I slowly lowered the backstay with the lashing line while a helper below slowly pulled it onto the dock."

Removing the old stay

The key when replacing any piece of rigging on a sailboat is first, before actually disconnecting it, to properly support the mast wherever the wire is to be removed. To create a temporary backstay, I positioned one of the genoa sheet blocks as far aft on the track as possible, rove the main halyard through it, and cranked down hard with the genoa winch.

Up to the masthead I went to remove the fitting and lower the stay. Before removing the pin, it's imperative to tie a long, small line on the stay with a rolling hitch and lash it firmly to something solid at the masthead — the full weight of the backstay will at once be in your hand when that pin comes out, and dropping it on deck accidentally is not an option. I slowly lowered the backstay with the lashing line while a helper below slowly pulled it onto the dock, preventing it from touching the deck at all. With the old stay removed, it was time to build the new one.

Cutting and fitting

The easiest and most precise way to get the stay length correct in one go is to measure it against the old one. We stretched the old stay out on the dock, unscrewing the turnbuckle to its maximum length.

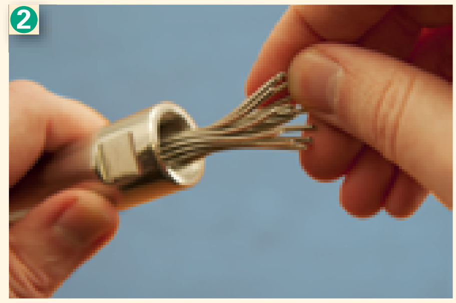
The next step was to assemble the Hi-MOD fitting to one end of the new stay. We chose to do the lower part, including the turnbuckle, in order to have something with which to compare.

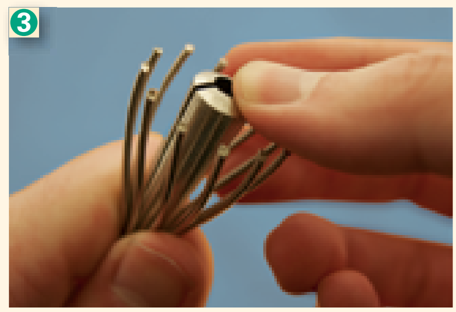
Assembly is surprisingly easy and intuitive. First, slip the body of the fitting onto the wire, then unlay the end of the wire. This is amazingly easy: with your fingers, simply twist the wire in the opposite direction to the lay and it should come right apart. Slide the cone onto the core of the wire and add the slotted crown ring unique to Hi-MOD on top of this. Now carefully twist the wire, this time in the direction of the lay, to bring the strands back together around the cone and the slotted ring. This is a bit tricky the first time, but once the strands are in place, the slotted ring keeps them there. Be sure to screw the whole lot together in a trial run, then disassemble it and re-assemble it using permanent thread locker (the red tube) on the outer fitting. This whole process takes mere minutes.

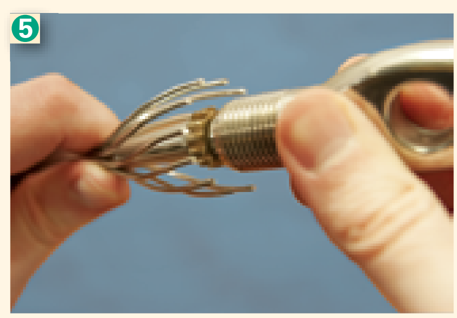
We aligned the new turnbuckle with the old one and stretched both wires out along the dock. The trickiest part was to measure the other end correctly — you must account for the length of the new eye fitting for the masthead before you cut the wire. I was surprised to find that a 32-tooth hacksaw cuts through the stainless-steel wire with moderate effort. It's essential to smooth the newly cut wire end with a file before assembling the Hi-MOD fitting. Follow the same process as with the bottom fitting and you have a brand-new backstay.

Installing the new stay

Adam chose to forgo, for the time being, both a backstay adjuster and SSB-antenna insulators on the new stay, for budget considerations. As he's not a racer, once we conservatively tuned the new rig, the odds of his adjusting it were slim even if he had an adjuster.

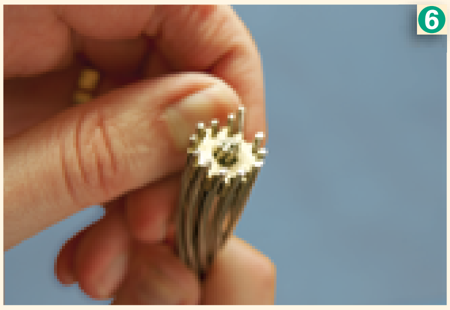






To install a Hi-MOD fitting, start by sliding the body over the wire (1). Unlay the wire for a short distance by twisting it against the lay (2). Slip the cone over the wire's core (3). Slip the slotted crown ring over the core behind the cone (4). Push the ring and cone along the core using the end of the terminal (5). An indent in the terminal's end sets the ring at the correct distance.

PHOTOS SUPPLIED BY HAYN ENTERPRISES LLC



With the cone and crown ring in place, gently twist the wire strands with the lay and set them in the slots in the crown ring (6). Pull the body up over the core and crown ring (7). Check that the wire strands are in order (8). Screw the stud into the body (9). The assembled fitting is neat and secure (10). *Audentia* awaits her new owner, and her new name, at right.

He'll add insulators before he goes cruising, but that's still years away.

To install the stay, I followed the same process as when removing the old one, this time in reverse. We attached the turnbuckle to the backstay chainplate, leaving it unscrewed to give me plenty of slack. I went up the mast a third time, but without the stay. Once at the masthead, I hoisted the stay with the same line we used before, making sure to lash it down to something before trying to fit it. It's amazing how heavy that wire is when you try to hold it with one hand and fit the pin through the masthead. We got the measurement correct, thankfully, and the stay went back together with no problem. Once I was back on deck, I tightened the turnbuckle.

Helpful hints

We tuned the rig at the dock, but I left the cotter pins out. I wanted to get the boat sailing and re-tune the rig if needed before locking everything down. Once we'd done this, I replaced the cotter pins with new stainless-steel ones. I almost always replace old cotter pins when I'm working with rigging.

The rig will need to be checked every few weeks, as the new stay will undoubtedly stretch under load when the boat is sailed hard a few times. In a worst-case scenario, the stay would have to be removed and shortened with the saw, but with the Hi-MOD fittings, this could be done quite easily without having to purchase any new parts.

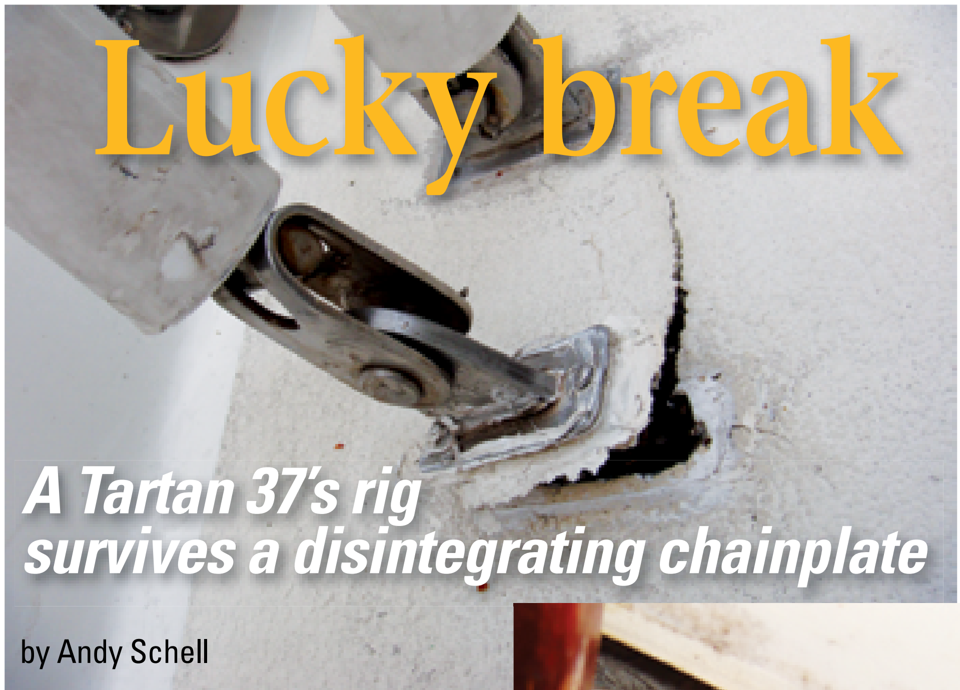
Ideally, Adam would have replaced all the rigging at once, thereby getting a better price for buying more material and also having the peace of mind of a brand-new rig. However, considering both the rigging survey and our own surveys turned up only the questionable backstay, we felt comfortable leaving the old rig intact for Chesapeake Bay sailing. He intends to replace the rest of the wire before heading offshore.

Many world-cruisers recommend using the same diameter wire for all of a boat's rigging. I agree with this and intend to re-rig *Arcturus*, my Seabreeze, using this philosophy. By using the biggest wire size required by the rig for every shroud and stay, I will beef up the rig and need to carry fewer spares when far from port. One length of wire and a few Hi-MOD fittings will be usable for any part of the rig that may need to be repaired, even under way. The only headache with this theory is the need to upgrade the chainplates in many cases. A rig is only as strong as its weakest link, and often the wire is stronger than the chainplates.

We both learned, quite painlessly, that DIY rigging solutions on old boats are quite feasible and can be quite enjoyable as well.

Andy Schell is a professional captain, rigger, and freelance writer. He lives aboard his yawl, Arcturus, *and runs sail training and navigation workshops with his father, also a captain. Andy and his fiancée, Mia, are currently in Florida, fitting out for their spring transatlantic to Sweden, Mia's home country. Contact Andy at <www.fathersonsailing.com>.*

A chainplate lifting from the deck, at right, was the first sign that corrosion had occurred in a place where a routine inspection would not reveal it, below right.



Lucky break

A Tartan 37's rig survives a disintegrating chainplate

by Andy Schell

At the time I wrote about replacing the backstay on my best friend, Adam's, new-to-him Tartan 37 (see *Good Old Boat* May/June 2010), I was smugly confident that, based on a professional rigging survey and my own inspections, the rest of the rig was in good shape and would be just fine for Chesapeake Bay sailing. I went on to note that if Adam intended to replace all the standing rigging, he would need to upgrade the chainplates as well. "A rig is only as strong as its weakest link," I wrote, "and often the wire is stronger than the chainplates." At the time, I had no idea that I was making a prophesy.

With the new backstay installed and the rig tuned conservatively at the dock, we prepared *Audentia* for the quick romp across the Chesapeake to her new home at Bay Bridge Marina. Adam was off flying fighter planes in Mississippi with the Air National Guard, so I stood in as skipper. It felt strange sailing his new boat before he'd had a chance to take the helm, but I was happy to do him the favor. With my father (a lifelong sailor and a captain himself) and Adam's father along as crew, we set off on *Audentia*'s maiden voyage on a cloudy, blustery day in April.

I'm not a racing sailor, but I do like to get the best performance from boats I sail, so I was eager to test *Audentia* in a fresh breeze. We set the main with a reef and unrolled the genoa. I immediately got Adam on the phone, excited to tell him that all of us aboard were convinced he'd found the right boat and that it sails like a dream.

As we crossed the bay, the wind increased, blowing strong from the north and kicking up a sloppy Chesapeake chop. I rolled a few turns in the genoa to settle things down a bit. *Audentia* immediately stood up and sprinted away like an eager filly who'd been confined too long in a pasture. The delivery only took about an hour.

At the new slip, I methodically checked all the rigging again to make sure I'd replaced all the cotter pins — we had re-tuned the rig slightly under sail, after giving it a chance to stretch a bit.

The starboard aft lower shroud was strangely loose. I didn't think the wire could have stretched that much. Puzzled, I glanced around the deck. My heart sank when I saw what had happened. The top section of the chainplate, the part exposed on deck, had pulled up about 2 inches, taking with it a portion of the nonskid and leaving a gaping hole. The chainplate had apparently broken off belowdecks. We were lucky the mast didn't go with it.

Uncovering the problem

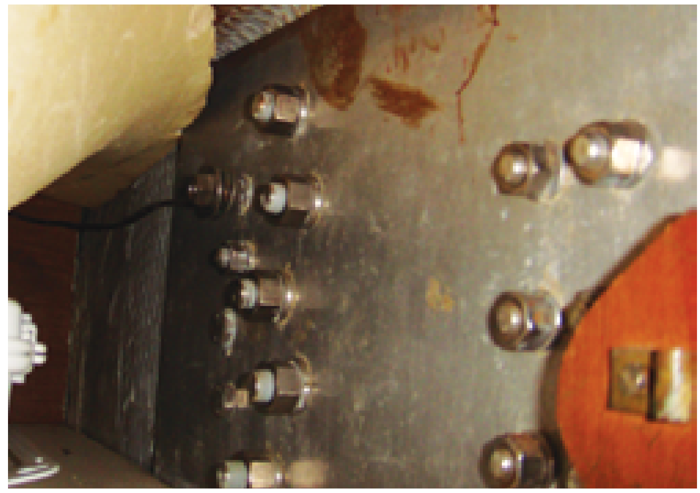
Older Tartan 37s have three chainplates on each side, anchoring the forward and aft lower shrouds and the cap shrouds. The chainplates pass through the deck about midway between the coachroof and the toerail and are attached to bulkheads belowdecks. The culprit was the starboard aft lower chainplate. It made me suspect the integrity of *Audentia*'s remaining five chainplates, as she's an older boat.

At sea, a broken chainplate can be disastrous. With no way of repairing it, save having a spare on board, the rig is severely compromised and, in all likelihood, will come down. We were lucky that we had been sailing on port tack most of the day and that it was the starboard chainplate that broke. After the initial shock, followed by relief that the mast was still standing, my dad and I dove headfirst into the problem.

For a new boatowner, such an event raises a number of worries: fear of not knowing how to fix it, concern that getting professionals involved in the repair is going to cost a fortune, and disappointment that maybe this wasn't the right boat after all. Adam's father, who's sailed with us for years but has never experienced the "joys" of owning and maintaining a boat, had all these thoughts while Dad and I got to work.

Stabilizing the mast

It's absolutely imperative to support the mast before unscrewing any of the rigging. The lower shroud was already loose, obviously, so the cap shroud and the forward lower were supporting the mast. This would have been adequate. However, I anticipated also removing the big chainplate holding the cap shroud, which would have left only



On the starboard side of the Tartan 37, the chainplates for the aft lower shroud and the cap shroud tie into the main bulkhead, at left. The aft lower chainplate, the one that failed on *Audentia,* is the angular fabrication. Just inboard of it is the cap shroud chainplate, which Andy deemed also suspect. The tie rod, by Andy's right hand, carries the rigging loads into the hull structure close to the mast step. The chainplates and the tie rod are connected by a single large backing plate on the forward side of the bulkead, inside a locker, at right.

a forward lower to support the mast. This would be unacceptable.

We led the main halyard outboard and slightly aft, secured it to the outboard genoa track on the toerail as far forward as possible, and cranked down on it with the halyard winch. I also loosened the shrouds on the port side to ease the tension on the entire rig. Just to be safe, I re-attached the cap shroud to one of the lifeline stanchion bases, leaving it snug but not tight. With the mast properly supported, we mentally prepared ourselves for the challenge we'd find belowdecks.

Extracting the chainplates

On the Tartan 37, the chainplates are located inboard and bolted to the bulkheads. The aft lower and cap shroud chainplates are backed up by one enormous aluminum plate to which a beefy tie rod is bolted to transfer the load to the hull. The arrangement is simple, impressive, and appeared to be quite stout. But, of course, removing a chainplate couldn't be as simple as undoing some bolts and removing the plates — this is a boat project.

The broken plate was concealed behind a thin veneer covering the bulkhead. Getting to it entailed removing the pilot berth trim and a bookshelf. Before it was over, we had destroyed the veneer to get at the bolt heads. Once the plates were exposed, however, it was a simple matter to remove the bolts and take them out. We'd already removed the rigging, so once the bolts came out (with a normal set of wrenches), we simply pulled the chainplates down through the deck and part one of the repair was complete. The whole process took about two hours, and the majority of that time was spent removing the trim and the veneer.

Evaluating the damage

As it turned out, the aft lower chainplate didn't really break — it disintegrated. These chainplates on both sides of the boat are fairly complicated triangular affairs with several welds on them. A shortcoming of stainless steel is its susceptibility to crevice corrosion, especially in an environment where it's deprived of oxygen and exposed to water. Where chainplates enter the deck is a common trouble spot on many boats. Welds are particularly vulnerable. After years of water seeping through the deck, crevice corrosion had eaten away most of the weld on the chainplate. The hard sailing we'd experienced was essentially the final straw, but the plate was compromised long before we ever left the dock.

Repair and rebuild

We left *Audentia* that afternoon with one chainplate broken into three pieces, one questionable chainplate, two holes in the deck, makeshift shrouds, and a pilot berth in a shambles down below. I carefully covered the deck holes with plastic bags and lots of duct tape. We straightened out the cabin as best we could and went off in search of a stainless fabricator.

To further complicate matters, Adam was coming home in less than a week for a weekend's leave and was eager to sail his new boat . . . which I had managed to break


The broken chainplate is an object lesson in all the ills that can befall a stainless-steel fabrication that is hidden from view on a boat. Stainless steel is subject to crevice corrosion, especially in a location where it is starved of oxygen and exposed to salt water. Welds, as this example shows, are especially prone to failure. Periodic inspections, and a regime of cleaning out old caulk on a regular basis and replacing it with new, will go a long way toward ensuring a long life for the replacement chainplate.

on her maiden voyage. Just as I'd felt responsible when helping him find the right boat, I now felt I had to put it back together for him so he could actually enjoy it.

I took both stainless-steel plates to Madden Masts & Rigging in Annapolis, where I'd been getting all of the metalwork done for my 1966 Seabreeze yawl and for my dad's 1986 Wauquiez Hood 38. The guys at Madden are consummate professionals; I had the utmost confidence in them.

Rich Krolak took one look at the broken plate and immediately said it would be no problem to fabricate a new one, despite the complicated arrangement. He promised to have it done within a few days.

Insiduous corrosion

Rich polished off the remaining bedding compound from the larger chainplate and carefully inspected it for signs of crevice corrosion. I thought the plate looked OK, but Rich had other ideas. He pointed out several spots on the plate where crevice corrosion had started, noting that to grind down those areas, he would have to bore deep into the plate, severely compromising its structural integrity. He pointed out the difference between harmless surface scratches and the damaging corrosion. The corrosion appeared as slightly graying round splotches that looked like tiny swirls drawn on the metal with a pencil. It was easy to spot once I knew what to look for.

In a few days, Rich had completed a mockup of the lower chainplate. It was unpolished and tack-welded together. These chainplates on the Tartan 37 have a few important angles that needed to be exact — where the plate bolts onto the bulkhead and where the upper leg of the triangle comes to rest under the deck. Rich wanted me to take the mockup to *Audentia* for a test fit before he finished it.

The plate fit precisely. I picked up the finished chainplates the following day. What I received from Rich weren't merely structural pieces of metal. They were more like works of art, polished to a mirror finish with elegantly rounded edges, precise bolt holes, and a confidence-inspiring heft.

I returned to *Audentia* with the new hardware, faced once again with a rigging project only hours before we were to set sail. Adam was returning that night and I had a promise to keep.

Swift reassembly

Putting the pieces back together proved remarkably simple; I had purchased nine new bolts (no sense in having a weak link in an otherwise new system) and had them in place and snugged down in a matter of minutes. After re-attaching and tuning the shrouds, we liberally applied bedding compound around the chainplates where they pass through the deck. Less than a week after what

Not so good old chainplates

Audentia is a 1982 Tartan 37, now 28 years old. Without definitive proof that a previous owner had replaced them, we were forced to assume the chainplates were also of 1980s vintage.

After this experience, it's now glaringly obvious to me that an inspection of the chainplates must be at the top of the list of things to do when buying a good old boat. Adam had four surveys done on the boat before and after he made the purchase: the initial inspection by my father and me, the general yacht survey, the rigging survey (also done by Madden), and the survey I made of the rigging when we replaced the backstay. But nobody discovered the broken chainplate. The problem is access. Chainplates corrode precisely where you can't see them, so you have to unfasten them and pull them completely out of the boat. A yacht surveyor will do this, if asked — at an additional cost, of course — but I learned it's fairly easy to do it yourself and should not be a deal-breaker if you find problems.

Even if you find the chainplates are solid, by way of preventive maintenance you should routinely dig out and replace the caulking around them every five years or so. This will keep the chainplates watertight and inhibit the onset of crevice corrosion.

seemed like a disaster, *Audentia* was ready to sail again.

The entire repair — dismantling the veneer and the pilot berth trim, removing the chainplates, securing the mast, and putting everything back together again — took only about one full day of my labor. The new chainplates were fabricated in about six hours and cost around $800. Rich noted that the cost per chainplate would have diminished considerably had we replaced all six at once. In a bind, the entire project could probably have been completed in one day . . . an amazing thought, considering the doom and gloom we'd felt on discovering the damage.

Adam elected to leave off the veneer that had covered the chainplates. With some elbow grease, the exposed chainplates on a newly varnished bulkhead will look very seaworthy, match the already exposed chainplates on the port side, and be much easier to access in the future. Putting the pilot berth back together was just a matter of re-attaching some trim pieces.

> **"Adam did get the right boat, even if all the chainplates need to be replaced."**

Audentia is all the better

In hindsight, Adam did get the right boat, even if all the chainplates need to be replaced, which I now suspect they do. We did not remove the other four chainplates, though that project will be at the top of Adam's list when he returns from flight school. We did carefully check the deck around the other chainplates looking for wet spots in the core, a sign that crevice corrosion might be present. We then re-bedded them with BoatLife caulk. The experience of removing and rebuilding two of the six was painless and, aside from the moderate cost of fabrication, repeating the procedure on the remaining four should be a simple task. The two starboard chainplates happened to be the only two hidden behind veneer, so removing the other four should be a simple matter of unscrewing the bolts.

Both the backstay replacement and the chainplate replacement have improved *Audentia* considerably and at a very reasonable cost, considering her purchase price. In my estimation, it is well worth it to simply replace all the chainplates on a good old boat at the time of purchase and to accept the cost as part of the overall price. The peace of mind gained, especially if you plan on sailing offshore, is priceless.

Andy Schell is a professional captain, rigger, and freelance writer. He lives aboard his Allied Seabreeze yawl, Arcturus *and runs sail training and navigation workshops with his father, also a captain. Andy and his fiancée, Mia, are fitting out* Arcturus *ahead of sailing her to Sweden, Mia's home country. Contact Andy at <www.fathersonsailing.com>.*

Statement of ownership, management, and circulation

Publication title: Good Old Boat; **Publication number:** 019-327; **Filing date:** 9/1/10; **Issue frequency:** Bimonthly; **Number of issues published annually:** 6; **Annual subscription price:** $39.95; **Location of office of publication and headquarters or general business offices of the publisher:** 7340 Niagara Lane North, Maple Grove, MN 55311-2655; **Publisher:** Michael Facius; **Owner:** Partnership for Excellence, Inc., above address, jointly owned by Karen Larson and Jerry Powlas; **Bondholders, mortgagees, and other security holders owning or holding one percent or more of total amount of bonds, mortgages, or other securities:** None; **Tax status for nonprofit organizations:** N/A; **Number of copies printed/total press run:** 28,917 (30,000) 12-month average (Actual issue published nearest to filing date) • Paid outside county 10,620 (10,843) • Paid in-county 0 (0) • Dealer, vendor, counter, and other sales 6,852 (7,055) • Other classes mailed through the USPS 0 (0); **Total paid and/or requested circulation:** 17,471 (17,898); **Free distribution by mail (samples complimentary, other free):** Outside county 383 (380) • In-county 0 (0) • Other classes mailed through the USPS 0 (0); **Free distribution outside the mail:** 4,481 (4,943); Total free distribution: 4,863 (5,323); **Total distribution:** 22,334 (23,221); **Copies not distributed:** 6,583 (6,779); **Total:** 28,917 (30,000); **Percent paid and/or requested circulation:** 78% (77%); **Publication of statement of ownership:** November/December 2010

This article is an excerpt from Lin and Larry Pardey's Capable Cruiser, *which was published in its third edition earlier this year. The information in this book was extensively revised for this new edition.*

Keeping up with the rigging

Take preventive steps but be prepared for at-sea repairs

by Larry Pardey

Of all the systems on board an offshore cruising vessel, your rigging must be the most reliable, but it is also the simplest to inspect and easiest to maintain. Unlike the parts that keep your engine running, none of the components of your rig are moving at high speed and few are hidden from view. In addition, replacement parts are available at chandleries in many yachting centers and do not have to be ordered from a specific parts supplier. That is why, with a carefully planned and built rig, regular inspections, and timely maintenance, many people, ourselves included, have sailed around the world without experiencing a rigging failure at sea.

On *Seraffyn*, for example, Lin and I covered 47,000 miles with our only rigging problem at sea being a spinnaker halyard that chafed through due to being unfairly led over and across the headstay. On *Taleisin*, during 90,000 miles of sailing, no rigging problems have occurred at sea. But we can think of some that have been prevented by the small maintenance projects instigated by our regular inspections at sea and in port. Because they were done before problems occurred, these projects were truly small — ranging from adding a bit of leather as chafe prevention, to repositioning halyard or sail fairleads.

Today, we still carry the same items for repairing gear failures at sea that we did when we first set off voyaging more than 40 years ago. Many of these items are a regular part of our rigging maintenance gear and have come in handy when we wanted a replacement or a slight change to the rigging in anchorages along our cruising route; others have sat in the same nook year after year, moved only for cleaning and inspecting. You could say they are there as insurance against our ever needing them.

The essential items in our rigging repair kit — items that should be available on any seagoing yacht — include:

- One piece of new rigging wire the length of the longest stay on the boat (in our case, the headstay). If your rigging wire is 1 x 19 stainless, it would be wise to carry one length in 1 x 19 and a second of 7 x 7. When you are at sea, you'll find it easier to bend and put a thimble and splice or cable clamps on the 7 x 7 wire, which is more pliable. *Taleisin* has hand-spliced 7 x 7 rigging, so the wire we carry has one eyesplice with a thimble spliced into it. This way, we can replace any wire on board relatively quickly. I secure the ready-spliced upper end in place, measure the correct wire length to the appropriate turnbuckle, bend the lower end around a thimble, and hold it in position with marline seizing line or plastic tape. Then I use a Molly Hogan (or "hasty eye") splice to secure it. (See pages 310 and 311

Sanding and varnishing *Taleisin*'s mast gives Larry ample opportunity to inspect every part of the rig.

Stainless-steel rigging can succumb to metal fatigue, especially in places such as this, where the weight of a jib-furler caused the forestay to flex at the swaged-on fitting.

in Brion Toss's book *The Complete Rigger's Apprentice*, available at www.briontoss.com, for details of this splice and proper use of bulldog clamps. Brion's chapter on emergency rigging repairs should, in our opinion, be required reading.)

- Spare turnbuckle
- Spare clevis pins
- Assortment of cotter pins
- Selection of thimbles
- End fittings or bulldog clamps (wire rope clamps). If your boat is rigged using swages or other mechanical ends, such as Sta-Lok or Norseman fittings, you need to carry half-a-dozen bulldog clamps for doing replacements at sea, plus spare fittings to upgrade the repair when you reach a quiet anchorage. It is important to carry spare end fittings that are either metric or imperial (inches), to match your wire.
- Swaging tool and copper Nicopress sleeves (called copper stop sleeves in some marine catalogues, or Talurit fittings in the UK) for backup to mechanical end fittings. These can be either metric or imperial.
- Assortment of stainless-steel shackles, both D- and harp-shaped
- Stainless-steel seizing wire
- Selection of soft thin leather and thicker firm leather
- Duct tape
- Plastic tape
- Wire cutter or hacksaw
- Rigging vise (optional, but it has earned us some funds as we cruised)
- Spare blocks with swivels or beckets (at least two to fit the largest line used on board)
- Two lengths of low-stretch Dacron line long enough to replace your longest halyard
- If you have wire halyards, include a suitable length of 7 x 19 (flexible wire) in your spares inventory.

Double-duty rigging

Although we actually use them as part of our everyday sailing, we consider our low-stretch Dacron rope halyard arrangements to be a major part of our at-sea rigging-repair equipment. All of our halyards are external to the mast, with the main and jib halyard rigged through two side-by-side, large-diameter masthead sheaves so either can be used for the mainsail or jib. To supplement this, we carry two spinnaker halyards run through blocks at the very top of the mast. Thus, if any halyard should break, we have another that can work as a substitute, so no one has to go aloft at sea. Should the main halyard break, we can use the tail end of the jib halyard to pull up the main, and a spinnaker halyard to haul up the jib. If your halyards are all led internally, this probably won't work. In that case, you should have at least one spare halyard block aloft and external of the mast with a messenger line permanently rigged to let you haul up a substitute halyard. We know this from personal experience. A halyard chafed through when we were delivering a boat that was fitted out by the factory and then handed over to us to take from Miami to Puerto Rico. We had to find shelter behind a coral reef, where I spent almost an hour aloft working a line through the masthead fittings and across a double-sheave arrangement to create a replacement halyard.

Fatigue failures

The most common rigging failures at sea that we hear about tend to be shrouds or headstays failing due to metal fatigue. The majority of wire failures seem to be the headstays inside roller-furling headsails. The weight of the furling drum, foil, and rolled-up sail swinging around at sea increases the likelihood of metal fatigue in the wire headstay. Tightening up your backstay when you are running will keep the headstay from moving as freely. A twice-yearly inspection of the swages and the wire right where it enters the swages might help prevent failure. Replacement of this headstay every three years would be a wise precaution.

But should a failure occur at sea, immediately head downwind and get a halyard secured to your bow fitting. Next, winch it up securely to serve as a temporary headstay. Then, and only then, should you deal with getting the sail down.

A rig saved

This is exactly what Darren Dzurilla did on his 36-foot cutter, *Mischief*, when his headstay broke 500 miles south of Hawaii. We watched Darren and his partner, Melinda, sail in to anchor near us at Kiritimati, one of the Line Islands 900 miles south of Hawaii, a place that rarely attracts cruising visitors. Darren told us they had been broad-reaching toward Fanning Island. They heard a horrendous bang and, after checking to see whether they had hit something, one of them noticed that the headsail was really baggy. That's when they realized that the headstay inside the furling foil had broken. Darren knew the only thing holding the top of his mast in place was the rope halyard for the roller-furling headsail. So he immediately ran his spare jib halyard forward to the base of the headstay and set it up as tightly as he could. Then he and Melinda set to work getting the jib furled. This maneuver turned his gear failure into a nuisance instead of a dismasting. Once everything was under control, Darren decided to divert to Kiritimati, with its larger population, with the hope that they could find help fixing the headstay.

The last 400 miles of their voyage was accomplished using only a staysail and the mainsail. Soon after they arrived, I helped Darren go aloft to remove his headstay and the roller-furling sail and gear. I was not surprised to find that the nine-year-old wire had broken just where the wire entered the swage.

Preventing fatigue

A very simple lash-up can cut the risk of shroud failure at sea, especially if you will be sailing along on one tack for long periods. To prevent metal fatigue in the leeward shrouds (which will, without fail, slacken off and flop around as the strain is all taken by the windward shrouds), secure a length of nylon line to the forward shrouds (port and starboard) then wrap the line twice around all the leeward shrouds — the lowers, intermediates, and upper shroud. Bring the line back to the forward shroud, snug it up, and secure it tightly. This will keep the shrouds from swinging to the boat's motion and cut the risk of metal fatigue. There is no need to loosen the lash-up when you tack, as the stretchiness of the nylon line will allow the shrouds to straighten out normally.

Learn how to repair

The skills and spare parts you acquire before you set sail will stand you in good stead if you cruise to out-of-the-way places. Riggers are hard to find in the islands of Polynesia and the South Pacific and even harder to locate among the atolls of the western Indian Ocean. Rigging spares are scarce everywhere except in main yachting centers.

There will be some wear and tear on your gear and you will have to replace some bits in anchorages along the way. So before you set off, take the time to practice putting a mechanical end fitting on a piece of wire of the size you use on your boat. Learn how to dismantle and reassemble all the blocks on board.

“Before you set off, take the time to practice putting a mechanical end fitting on a piece of wire.”

Fake a rigging failure and think of how you would support your mast if a headstay or shroud let go. Just thinking through the process could point out ways to simplify or improve your standing and running rigging. With a good collection of rigging supplies and with frequent careful inspections, regular maintenance, and timely replacement of wire rigging, you should never have to repair your rig at sea.

Lin and ***Larry Pardey*** *are sailing* Taleisin *while upgrading a 21-foot trailersailer so they can try brown-water sailing on some of the dozens of river estuaries along New Zealand's west coast.*

Maintenance and repairs are a key part of cruising. It's far easier to address wear and tear in port than deal with a failure at sea.

PART ONE

Where there is no rigger

A rigging repair is a community effort

In this, the first of two parts, authors Leslie Linkkila and Philip DiNuovo describe what happens when rigging fails in paradise, how they kept their mast up, and the choices available to sailors when replacing standing rigging themselves.

by Leslie Linkkila and Philip iNuovo

We were anchored in the ultra-calm anchorage nestled between Isla Del Rey and Isla Espiritu Santo in Islas Las Perlas in the Gulf of Panama, making final preparations for crossing the Pacific in our Mason 33, *Carina*. Before taking off on the 4,000-mile passage to the Galapagos and on to the Marquesas, we wanted to inspect the rig, so Philip donned a climbing harness and I (Leslie) cranked him up to the masthead.

"Uh oh," he called down.

"What?"

"It's bad, very bad."

"You're kidding, right?"

"*No, I am not kidding!* We only have a couple of wire strands left holding up the forestay."

We were roughly 50 miles south of Panama City, where — despite its status as the crossroads of sailing — there is no rigger.

Our standing rigging is made of 1 x 19 stainless-steel wire rope with Sta-Lok mechanical terminals and had been professionally installed in 1999. Since we had been diligent about cleaning and inspections and had replaced *Carina*'s chainplates in 2007, we were (unwisely) confident about our rig's integrity.

Of the many spares we had on board, we had no wire rope, Sta-Lok terminals, or spare wedges for the terminals. In hindsight we had been irresponsible . . . but that was the situation. Getting back to Panama City would be difficult against episodic winter northerlies and short steep seas. These conditions could cause the forestay to part, taking the roller furling unit, and possibly even the mast, with it.

Other cruisers offered us their spare (used) wire, but its age was similar to *Carina*'s failed wire. We decided to motor back to Panama City, where obtaining supplies would be easier than anyplace we had cruised or would be cruising. We used our SSB radio and modem to email a Seattle marine supplier and ordered wire rope and fittings to be shipped to us in Panama City.

Our immediate need was to reduce the tension on the failing forestay. We moved both spinnaker halyards to the bow, secured them to the forward port and starboard cleats, and winched them tight. We then eased the backstay a bit. To reduce weight on the forestay, we dropped the genoa and flaked and stowed it. We returned the Profurl swivel to the top of the extrusion with the genoa halyard so it was tucked under the stop. We moved our two main halyards aft, attached them to pad-eyes, and winched them tight. We set up our running backstays in their working positions and tensioned them. We hoped these steps would be enough to keep the rig intact while we motored to Panama City for 12 to 15 hours under potentially rough conditions.

A better plan

Friends on the other boats in the anchorage conferred, kibitzed, and offered suggestions. Finally, friend Royce, of the schooner *RDreamz*, recommended we take down the forestay while at anchor. His argument was that by lowering and disassembling the furling system on his expansive deck, we could prevent a catastrophic failure that would cause serious damage to the furler and possibly the mast. Luckily, his boat's deck was longer than our forestay.

We assembled and met with crews from *RDreamz*, *Tao 8*, and *Bluebottle* to carefully plan the steps needed to remove the damaged forestay. The following morning dawned breezy but the water in the anchorage remained flat calm. We pulled *Carina*'s anchor and slowly motored up to *RDreamz* and passed a line from our

Leslie and Philip discovered this damage at the upper end of their forestay while anchored in a remote anchorage hundreds of miles from the nearest rigging supplier.

A team of helpers, assembled from cruising boats in a remote anchorage in Panama, watches as Philip prepares to lower *Carina*'s forestay onto the deck of the schooner *RDreamz*.

bow to the stern of *RDreamz*. Once this line was cleated on both vessels, we put *Carina* in reverse at low rpm and locked her wheel.

Philip donned his climbing harness once again and we cranked him to the masthead. Using a rolling hitch, he tied a second halyard to the furling extrusion about 5 feet below the furler wrap stop. After tensioning this halyard, the team on *Carina*'s deck removed the clevis pin from the tack of the roller furler, swung the furling drum and forestay over the bow pulpit, and handed it to the team on *RDreamz*. When ready to lower the forestay, Philip snipped the remaining wires . . . they were so few he only had to use lineman's pliers. Though supported with a halyard and with the backstay eased, there was still enough tension that the wires parted with a sharp "Sproing!"

A team of two managed both halyards, slowly lowering the top of the forestay as the team on *RDreamz* walked forward on deck, carrying the furling drum while supporting the extrusion to clear the stern rail as it came down.

Soon *Carina*'s forestay was resting safely on the deck of *RDreamz*. We then attached the spinnaker halyards to *Carina*'s bow pulpit to support the mast and lowered Philip to the deck along with the upper Sta-Lok terminal and the frayed end of the forestay.

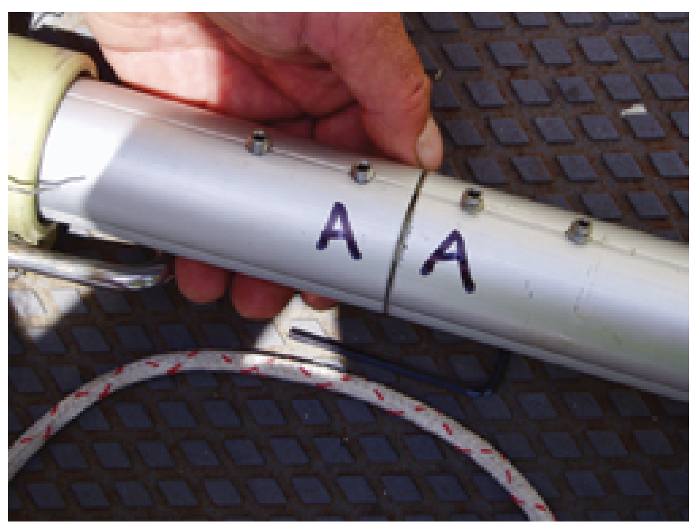
Later, while disassembling the extrusion sections, we cleaned and inspected the furling drum, extrusions, extrusion bearings, and setscrews. We were careful to label where sections intersected. We also took care to measure, to the millimeter, the full length of the original 1 x 19 wire rope.

With the parts of the furling system safely stowed in *Carina*'s main saloon, padded with pillows and tied down, we began our trip to Panama City. There we would meet the shipment of rigging supplies we had ordered by email.

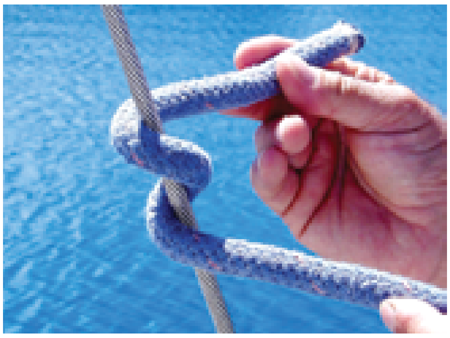
Our original plan had been to bring *Carina* into the marina at Panama City, where we could lay out the new forestay, install the Sta-Lok terminals, and assemble the Profurl extrusions using a stable and relatively clean dock. This option seemed less appealing as we approached the city. The marina was tightly packed with megayachts, the management unfriendly, and the slip cost shocking. The idea of using the parking lot near the anchorage was even worse — it was filthy and served as the staging area for crowds of island-bound ferry passengers. So when friend John of *Nakia* suggested that we might be able to install a new wire and then reassemble the furler directly on the wire as it hung from the masthead, we agreed.

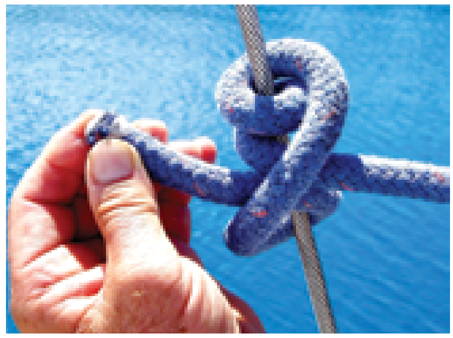
A collaboration of cruisers

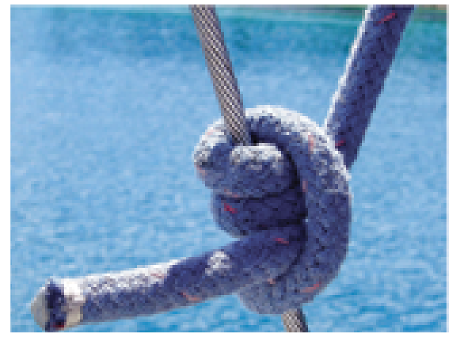
To do this, we would need help. Once we received our parts shipment, we assembled another team of eager volunteer cruisers from the vessels *Susurru*, *Iwa*, and *Nakia*. All the boats involved had rigs with mechanical terminals — either Sta-Lok or Norseman — but none



The team on *RDreamz*, at left, walked forward on deck carrying *Carina*'s furling drum while supporting the extrusion to clear the stern rail as it came down. Leslie and Philip labeled the components as they carefully dismantled and inspected the Profurl furling assembly, at right.







To tie a rolling hitch onto a stay, take two turns around the stay in the direction the load will be applied, at left, cross the end over the standing part, and take another turn, tucking the end under, center and right. Long link plates, bottom right, allow access to the forestay turnbuckle.

of these cruising sailors had actually assembled a terminal. For that matter, neither had we. In addition, most of our team also owned Profurl roller furling, so everyone was interested in that aspect of the project too.

To prepare for reassembling the roller furler, we made sure that the inner-extrusion bearings were at the top of each extrusion section. This would allow us to slide the bitter end of the new wire through the constriction of the bearing, push the extrusion over it, and have the bitter end of the wire emerge at the lower unconstricted end of the extrusion bearing assembly.

We also assembled the Sta-Lok stud terminal fitting to what would be the masthead end of the new forestay wire. We did this in our cockpit the night before our team arrived so we could learn how to assemble a Sta-Lok fitting in privacy. The process seemed pretty straightforward and — on our first try — we assembled a nearly flawless terminal.

When our team was assembled, using the old wire as a measure, we cut the new forestay wire, allowing for the damaged wire we had cut off during disassembly and the fact that the new wire would stretch a bit.

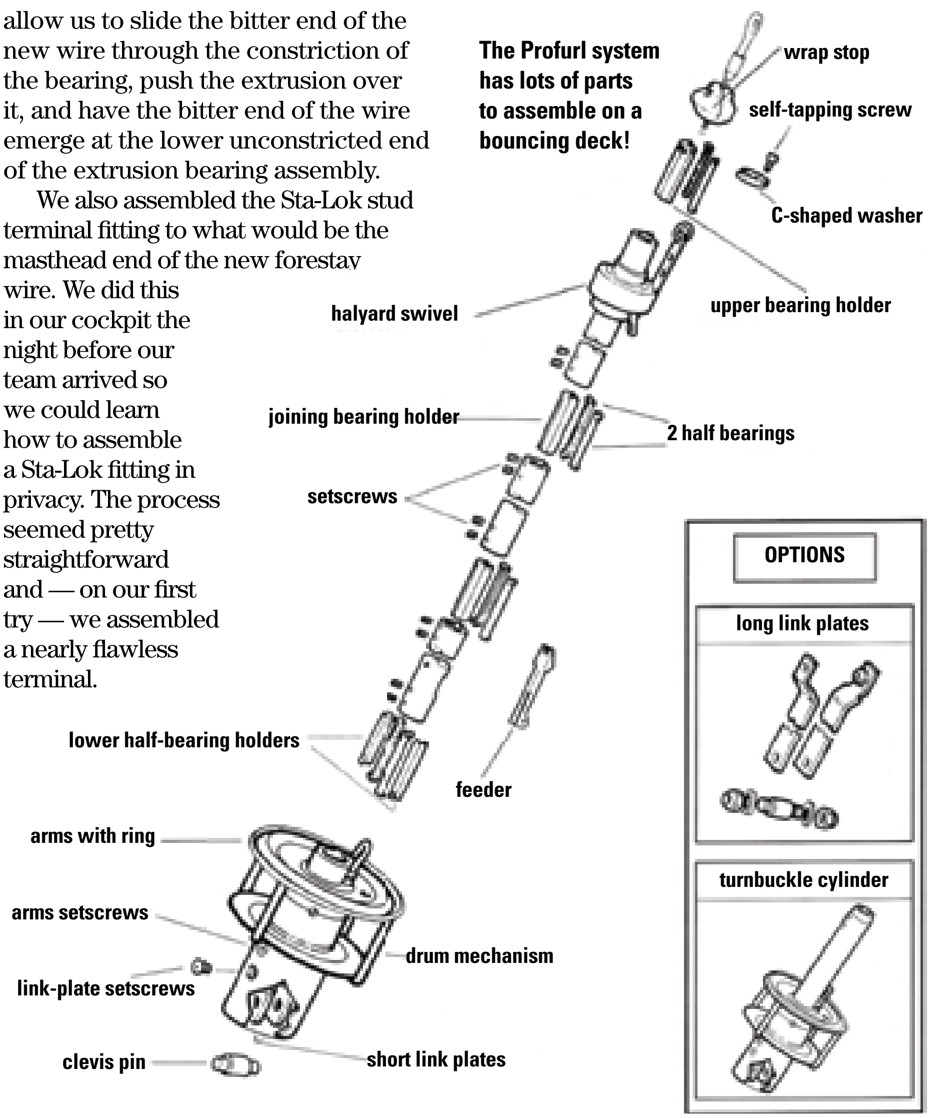
We again winched Philip aloft, where he and the masthead crossed the sky in wide arcs in the rough conditions — we were in the La Playita anchorage amid wakes created by workboats and vessels transiting the Panama Canal, all the while being buffeted by 20- to 25-knot winds. We considered postponing the project, but everyone was enthusiastic and we proceeded.

Using a rolling hitch, the deck team attached a halyard to the new forestay and hoisted the forestay wire fitted with the Sta-Lok eye to Philip, who slipped it onto the masthead tang and secured it with a clevis pin and cotter pin. We then lowered Philip to the deck.

We assembled the Profurl by slipping each section of extrusion onto the forestay in succession, beginning with the top section. The genoa halyard was attached to the swivel and we periodically took up on the halyard to raise the swivel up the foil column. We had a messenger line attached to the swivel so we could retrieve it later.

As each section of extrusion was added to the growing furler foil on the forestay, we pushed the assembly slowly

The Profurl system has lots of parts to assemble on a bouncing deck!



upward. One person was the assembler, sliding each extrusion over the bearing of the adjacent extrusion and securing the setscrews with (red) thread locker. A support person handed him tools and materials when needed. Another team member fetched and aligned the next extrusion section, and the last held the bottom end of our increasingly weighty assembly as it swayed around in the wind, waves, and boat wakes.

The final section was longer than the others, due to the long link plates of our Profurl unit. Reaching as high as possible, grunting and groaning as *Carina* danced around her anchor, the assembler was finally able to get the setscrews in place. In retrospect, we could have made this easier by removing the furler link plates or by hoisting our assembler up the staysail stay to the height of the joint.

With the assembly complete, we attached a halyard to the drum and winched the Profurl assembly as far up the forestay as it would go, to expose the lower end of the 1 x 19 wire. Our team, eager to learn, watched and helped as we assembled the lower Sta-Lok fitting, a stud which fit the turnbuckle.

To complete the assembly, we threaded the stud into the turnbuckle, then secured the tack with the clevis pin and tensioned the forestay. The final touches were to reattach the Profurl link plates at the tack and the wrap stop at the masthead and, lastly, to tune the rig. We were all satisfied with the successful completion of our first do-it-yourself rigging project.

Rig care and inspection

Rigging life expectancy depends on many factors including the grade of the stainless-steel wire, terminal type, the quality of the workmanship used in constructing and installing terminals (swages or mechanical terminals), maintenance, the environment (temperature, humidity, and salinity), rig tuning, and boat usage (frequency and racing versus cruising). We recommend an inspection of all standing rigging components at least annually, preferably more often, but especially before every ocean passage!

Although we don't know the exact cause of our failure, we suspect it was an incident in which a spinnaker halyard that had been stowed at the bow pulpit wrapped the forestay as we attempted to furl the genoa while sailing downwind in fresh conditions.

To clean and inspect our rig, we use WD-40 (a moisture-exclusion agent and lubricant available everywhere we have cruised) along with a fine synthetic scrub pad and a soft cotton rag to remove dirt and surface rust. After cleaning, we carefully scrutinize the full length of our stainless-steel wire-rope stays and shrouds, turnbuckles, tangs, and terminals, looking for corrosion, pitting, cracks, broken strands, and wear. Any questionable areas, we examine more closely by magnification. We have no dye penetrants aboard but these products, when available, are effective in amplifying the visual signs of damage, such as cracks or pitting.

It is also advisable to periodically invert rigging wire and terminals since seawater, dirt, and acidic pollutants run down the wire and accumulate at a wire's lower end, causing corrosive breakdown in the terminal. Internal corrosion in terminals causes the swelling that leads to cracking and failure, a problem more pronounced with swaged terminals. Mechanical (compression) fittings, such as Sta-Lok, provide greater internal space for expansion in the event of internal corrosion.

Also, depending on the age of your boat, pulling and inspecting your chainplates is prudent. Six of *Carina*'s eight chainplates were dangerously cracked, something we discovered during a refit when she was 20 years old. When viewed from above and below, they appeared serviceable. It wasn't until we pulled them that we could see the failures just below deck level. We were very lucky we discovered the problem in time to prevent a catastrophic failure.

Mechanical or swaged?

Mechanical terminals offer the hands-on sailor a distinct advantage over swaged terminals by permitting replacement of rigging wire and terminals without the need for specialized swaging equipment or tools. This is critical to the long-distance cruiser, since a failed fitting will inevitably happen hundreds, if not thousands, of miles from the nearest rigger and rigging supplier.

Recently, we replaced the remaining old wire of *Carina*'s standing rigging

Resources

Blue Wave
Blue Wave A/S
www.bluewave.dk

Hi-Mod
Petersen Stainless Rigging
www.petersen-stainless.co.uk

Hayn Enterprises
www.hayn.com

Norseman
Navtec
www.navtec.net

Quick Attach
Suncor Stainless
www.suncorstainless.com

Sta-Lok
Sta-Lok Terminals, Ltd.
www.stalok.com

Internal corrosion in swaged terminals, caused by the accumulation of seawater, dirt, and acidic pollutants, leads to cracking and failure. Note the small vertical crack at the top of this fitting, at left. Pulling and inspecting chainplates is prudent because, when viewed from above and below, they often appear serviceable, as this upper shroud chainplate did, above. If this crack had remained undiscovered, the rig was destined to suffer a catastrophic failure.

while at anchor in the rural island group of Vava'u in the Kingdom of Tonga. We were able to tackle this project, necessitated by the discovery of corrosion and more broken strands in our rigging wire, because all our stays and shrouds are fitted with Sta-Lok mechanical terminals.

When disassembled, the 11-year-old Sta-Lok terminals appeared to be in very good condition. We cleaned, inspected, and reused them, replacing the old wedges with new ones. Our experience has made us appreciate the Sta-Lok system sold to us by a rigger who also happened to be a former cruiser.

Swaged terminals may be less expensive than mechanical terminals and they have a reputation for superior strength. However, the process of swaging results in work-hardening of the stainless steel, which causes brittleness and susceptibility to stress corrosion, and the specialized equipment needed to form swaged fittings is impossible to find in remote areas anyway.

The extra cost of mechanical terminals is mitigated by the fact that they can be reused when re-rigging, generally with the need to replace only the wedge, a minor expense. Any of the available mechanical systems, if appropriately sized, will be more than adequately strong. All currently marketed brands of mechanical terminal claim operating ranges between 90 and 100 percent of the breaking strength of the wire. At least two brands offer Lloyd's listing or certification.

With mechanical terminals, the same terminal body may be used with an end fitting of a threaded stud, fork, or eye. This universality allows for the wire of a stay to be end-for-ended without the need to change any terminal fitting.

Based on our experience, we would highly recommend using mechanical over swaged rigging terminals.

> **"The extra cost of mechanical terminals is mitigated by the fact that they can be reused."**

Mechanical rigging options

The most common brands of mechanical terminals are made in the UK: Sta-Lok (Sta-Lok Terminals, Ltd.), Norseman (Navtec), and Hi-Mod (Petersen Stainless Rigging, distributed by Hayn Marine in the USA), a relatively new product that is gaining in popularity. Blue Wave terminals (Blue Wave A/S) are made in Denmark and sold through dealers in North America. A previous relationship with Suncor Stainless resulted in the similarly designed product labeled Quick Attach, which seems to be intended primarily for lifeline applications. All these brands are constructed of type 316 stainless steel and are marketed for use with stainless-steel wire rope. Internet prices for the different systems at the time we were researching this article were similar.

All the brands work essentially the same way: a wedge or a cone (based upon wire type) is inserted on the end of the stainless-steel wire rope and then the wedge-wire assembly is compressed onto the wire as the two sections of the terminal are threaded together using hand tools. Wedge design for all systems varies with wire type, except in the case of the Blue Wave and Quick Attach systems, which have a universal wedge (that they call a "jaw") for each wire diameter.

One design distinction of note: the Sta-Lok wedge is compressed inside the male-threaded terminal section (called the socket), such that when the terminal is assembled, the wedge is internal to the walls of both the male- and female-threaded terminal sections (called the former), doubling the wall thickness securing the wedge. The Norseman, Hi-Mod, and Blue Wave wedges are internal to the wall of only the female-threaded body section of the fitting. What this doubling means in terms of breaking strength we cannot say, as little objective testing data is available.

Sta-Lok and Hi-Mod both claim to hold to the full breaking strength of the wire, though only Sta-Lok offers certification of this specification by Lloyds of London. Norseman literature makes no specific claims regarding strength and there have been reports of failure under testing (see *Good Old Boat*, March 2000). The Blue Wave product carries Lloyds certification of its breaking strength specification at 90 percent of the wire's breaking strength, though there is a note in their literature that indicates that wire breaking strength may be "decreased by 0 to 15 percent" when using these terminals. Most owners we interviewed seem happy with the performance of their fittings, regardless of which brand they own.

Philip DiNuovo and Leslie Linkkila came to cruising and boat ownership as adults and quickly developed a passion for small-boat travel. In 2003, they quit their professions and left the Pacific Northwest behind. Now in the South Pacific, Philip and Leslie have had to learn to service nearly every system aboard Carina, *their Mason 33.*

In the second part of this article, to be published in the September issue, Leslie and Philip will discuss lessons learned and the specific steps involved in replacing their rigging.

Where there is no rigger

Replacing standing rigging, step by step

by Leslie Linkkila and Philip DiNuovo

When our headstay almost parted in Panama, where there is no professional rigging service, we had to replace it ourselves. Since the standing rigging on our Mason 33, *Carina*, had been installed with Sta-Lok mechanical terminals, we used the same terminals on our new headstay. We found them easy to assemble using common hand tools, and that gave us the confidence to go ahead later and replace all the standing rigging, which we did while at anchor in Vava'u, Tonga. We hope our experience will be helpful to others who might wish or need to do the same.

PART TWO

In this article, the second of two, Leslie Linkkila and Philip DiNuovo describe the step-by-step process by which to renew stays and shrouds while the mast is in the boat. In the July issue, they described how they removed and replaced their headstay while at anchor in Panama.

One stay at a time

Plan on replacing only one wire rope at a time and make sure that throughout the rerigging procedure your mast is well braced with spare halyards.

When replacing an upper shroud, ease the tension on the port and starboard shrouds uniformly to avoid bending the mast. Although the mast should remain standing securely with just the lower shrouds, we always used halyards as guy lines for added security. Lubricate turnbuckle threads to avoid galling or other damage. We used Tri-Flow, which contains P.T.F.E. and is available as a liquid, since it leaves little residue that can later collect dirt.

Loosen the turnbuckle on the stay that is to be replaced until the stay is loose, but do not disconnect it completely. This will stabilize the bottom of the stay while you disconnect the top and lower the stay.

At the top of the stay, before removing the cotter and clevis pins, tie a line securely to the wire below the terminal using a rolling hitch (see Part One, in the July issue). Then slowly lower the stay to the deck.

At deck level, tie a line between the stay and the boat before detaching the lower end of the stay. This will prevent the stay from "snaking" over the side and into the deep blue while you're manipulating it. If you're at a dock, move the stay to the dock and lay it flat. If at anchor, bring both ends of the stay to your work area; we used our cockpit.

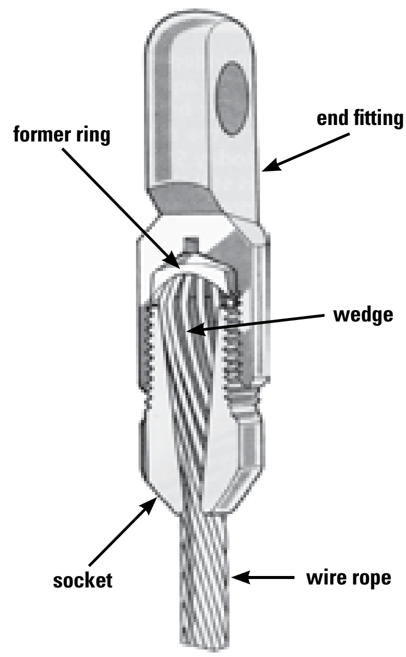
Removing an installed terminal

Our standing rigging was assembled with Sta-Lok terminals. The steps that follow will be similar in principle with other brands of mechanical terminals.

Unscrew the female portion of the terminal by holding the male portion with a box wrench and using a large

The first step in disassembling a terminal is to unscrew the two parts.

Inspect the female thread for signs of rust and traces of thread sealant.



This cutaway diagram shows the component parts of a Sta-Lok terminal

Clean the threads inside the fitting. A strand of wire works well for this.

If sealant was used in assembling the terminal, soften it with a little heat.

Select a long socket that will just fit over the end of the terminal.

The socket should rest up against the hex end of the terminal socket.

Tap the end of the socket with a hammer to loosen it from the wedge.

The terminal socket slides up the wire revealing the sealant inside.

screwdriver (for an eye) or second box wrench (for a stud).

Inside the female half of the Sta-Lok is a “former,” a dome-shaped part that can be re-used if undamaged. The former may be difficult or impossible to remove from a used fitting, and you might damage it in attempting to remove it, so be sure to have spares.

If the terminal was assembled using silicone sealant and a thread-locking compound, clean the fitting of the residual material. A single strand of 1 x 19 wire works well for removing residual sealant from the threads and former. Periodic spritzing with WD-40 and wiping by twisting a rag into the threads also helps to remove old thread compound and sealant.

Disassembling the socket (male section) takes a little bit more effort, but only if the terminal was assembled with sealant. To avoid damage to the threads during disassembly, we used a long socket from our socket-wrench set. The socket should have a diameter smaller than the terminal cap but just large enough to pass freely over the threads.

Secure the wire in a vise or clamp it with locking pliers, such as Vise-Grip. Next, heat the fitting with a heat gun or propane torch just long enough to soften the sealant (approximately 1 minute with a heat gun on low setting). Slip the socket over the threads and use a hammer to dislodge the fitting from the wire.

We found no rust inside our disassembled 11-year-old fittings, only silicone sealant and red thread-locking compound.

Once you have loosened the male terminal sections at both ends of the wire, and before cutting the old wire, measure for the new wire against the old wire. This is the time to consider whether the new wire should be a trifle longer or shorter than the old wire.

To measure accurately, tape the old and new wires together every few feet along their lengths to prevent the two wires from “walking.” Bracket, with duct tape, the location on the new wire where it will be cut, and carefully cut the end as square as possible.

This can be done with a cable cutter, hacksaw (tape either side of the cut and secure the wire in a vise), or a high-speed rotary tool such as a Dremel.

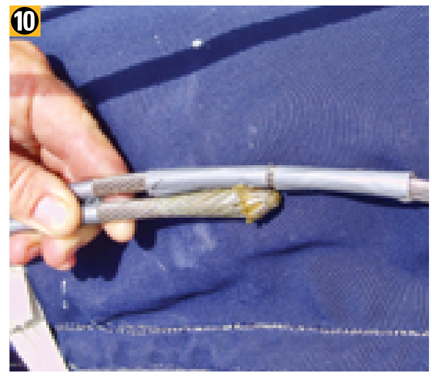
Now remove the male Sta-Lok terminal section from the old wire.

Installing a terminal

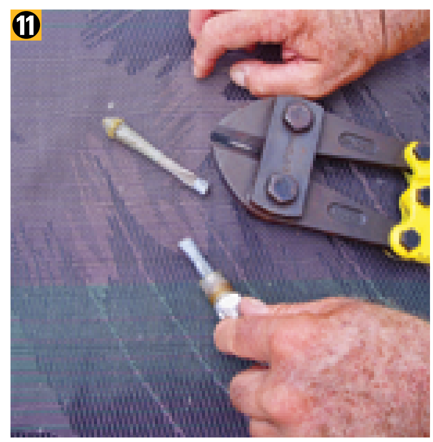
Before reassembling the terminal on the new wire, clean the male and female parts thoroughly with WD-40 or a similar solvent and a synthetic scouring pad, such as Scotch-Brite.

Ensure the threads are clean and that you can thread the terminal easily by hand. Inspect each piece carefully for corrosion or cracks.

Tape the old wire, with the wedge still in place, to the new wire.



At the other end, wrap tape around the new wire and mark for the cut.

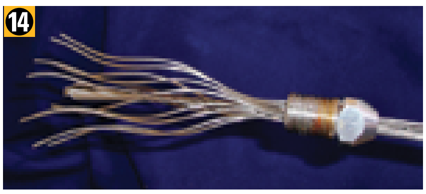


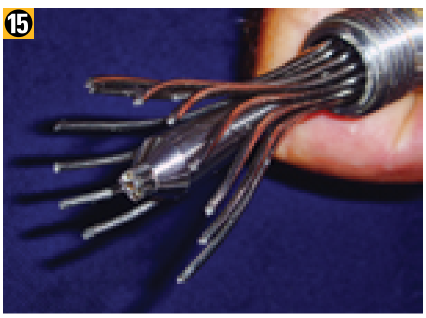
To remove the terminal socket from the old stay, cut the wire.

Slide the terminal socket off the cut end of the old wire.

13

Clean both threaded parts of the terminal before reusing them.

14

Slip the socket over the end of the new wire and unlay the strands.

15

Slide the wedge over the wire core and carefully re-lay the strands.

16

In this poor assembly, a strand is lodged in the slit in the wedge.

17

Properly assembled, the strands lie uniformly around the wedge.

Inspect the cut end of the new wire. The cut should be reasonably clean and none of the individual wire strands should vary in length more than 1 mm. Use a wire snipper to trim individual wires if necessary.

Slide the male terminal piece (socket) over the new wire (an important step). Using a small slotted screwdriver, begin to uniformly unlay the wire approximately 2 to 4 inches from the end. If you want, you can apply a wrap of thread or tape a few inches from the end of the wire to prevent the wire from unlaying beyond this point and to prevent the socket from sliding down the wire.

Slide the new wedge over the seven core wires until 2 to 4 mm (about ⅛ inch) of wire extends beyond the wedge (this distance depends on the wire diameter and is specified in the Sta-Lok instructions). Do not reuse old wedges unless no other option exists.

Re-lay the wire. Push the male terminal fitting up the wire and rotate it with the lay of the wire to gently re-lay individual strands.

Take care that the wedge does not slide out of position (off the end of the wire), that strands are uniformly spaced around the wedge, and that no individual strand is lodged in the wedge slot. If the pre-assembly is poor, pull back the male terminal piece and use a small slotted screwdriver to gently push the wedge back into position and realign individual strands. A good tip for Sta-Lok fittings: hold the male terminal piece snugly against the wedge and rotate the male terminal in the direction of the lay of the wire rope as you align the individual strands. This helps to keep individual strands out of the wedge slot.

Once you have the wedge, wire strands, and male component assembled satisfactorily, thread the female terminal section on until you feel some resistance. Some riggers recommend using a thread-locking compound at this point to lubricate the threads and to avoid galling.

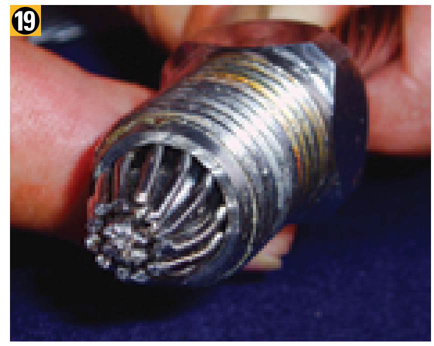
Using a vise and box wrench, or two box wrenches, slowly tighten the terminal, but just hand tight. You will hear a disconcerting "scritching" sound as the wires bend and lay with the former inside the terminal. Immediately disassemble the terminal fitting to check the quality of the assembly; the wire strands should be bent and lie neatly and uniformly around the end of the wedge.

Complete the assembly by applying a "grape-sized" dollop of sealant to the female terminal section. If you didn't do this during your test assembly, now's the time to apply Loctite or another thread-locking compound to the threads of the male terminal section.

Reassemble the terminal, tightening to hand tight with box wrenches. *Do not overtighten!*

18

Thread the female terminal end onto the socket and draw it up hand tight.

19

Unscrew the terminal end and examine the assembly for uniformity.

20

Make the final assembly with sealant and thread-locking compound.

21

The corroded wedge (left) indicates water ingress into a terminal.

To seal or not to seal?

There are arguments for and against applying sealant to mechanical terminals. Hi-Mod discourages the use of a sealant while Norseman endorses its use but advises against silicone sealants. Sta-Lok indicates sealant is not needed but, if used, it should be a polysulfide. Blue Wave recommends Sikaflex 221. Upon replacing our failing 11-year-old wire rope, every terminal we disassembled revealed a wedge that looked nearly perfect. These terminals had been sealed by our rigger with marine silicone sealant.

Alternative products

Norseman (Navtec) —
The Norseman system design has changed little with time. The company was purchased by Navtec, which is part of Lewmar. Lately, availability of Norseman fittings seems to be an issue with U.S. rigging suppliers. In our opinion, the industrial design of the Norseman is less refined and its finish compares poorly to the machining and brilliant polish of the other brands.

The wedge is similar in design to that in the Sta-Lok but a bit shorter and of slightly larger diameter. The wedge is inserted significantly deeper into the unlaid wire — 1.5 times the wire rope diameter — than with other designs. The terminal consists of three components: the body (female thread); the cone; and the end fitting (male thread) with its integral former machined to compress the end of the wire when the terminal is assembled.

Norseman terminals have similar components to Sta-Lok products but the threaded parts are reversed.

Hi-Mod (Petersen Stainless) —
The Hi-Mod system is the latest introduction into the market and has little history yet, though its manufacturer has a reputation for high-quality products and these cleverly designed terminals are rapidly gaining in popularity.

The industrial design and finish quality seems superior to the Norseman, though the form is similar. The Hi-Mod design is differentiated by its aluminum-bronze crown ring that sits on the wedge. This ring keeps the individual wire strands evenly spaced around the wedge and prevents the outer wire strands from bending, making all system

Resources

References

The Complete Rigger's Apprentice by Brion Toss; International Marine, 1998

Understanding Rigs and Rigging by Richard Henderson; International Marine, 1991

Rigging Services Guidelines published by Navtec Rigging Solutions

Inspection of Sail Rigging and Masts on Inspected Small Passenger Vessels, USCG Inspection Note #13, October 2008

"New Swageless Fitting Shows Promise" by Bill Sandifer; *Good Old Boat*, March 2000

Manufacturers

Blue Wave
www.bluewave.dk

Hi-Mod
www.petersen-stainless.co.uk

Norseman
www.navtec.net

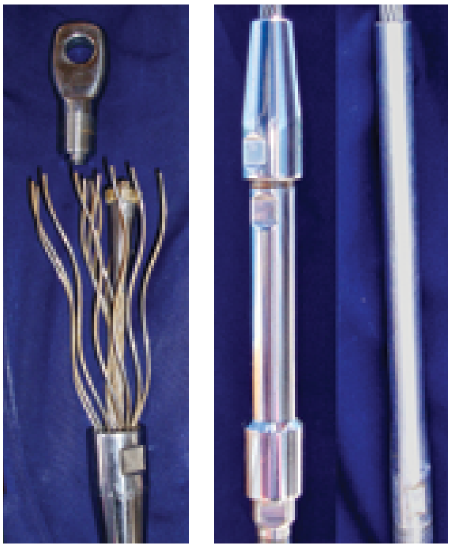
Quick Attach
www.suncorstainless.com

Sta-Lok
www.stalok.com

Tri-Flow Superior Lubricant
www.triflowlubricants.com

components reusable. The crown and the end fitting also help to ensure a flawless assembly by holding the position of the wedge to a precise depth.

Blue Wave (Blue Wave A/S) — The design of the terminal body components of the Blue Wave are similar to those of the Norseman and Hi-Mod, though their terminology is slightly different. The key differentiating design element is a jaw (called by others a wedge or cone) that slides over and compresses onto the full diameter of the wire rope, making it universal for a given wire diameter irrespective of wire construction (7 x 7, 7 x 19, 1 x 19, or Dyform). In addition, the system includes a compression ring that slides onto the bitter end of the wire and a locknut on the head that secures the assembled terminal. The design and construction are of high quality but the product's popularity (at least in the U.S.) seems limited.



Hi-Mod terminals use a "crown ring," far left. An assembled Hi-Mod alongside a swaged fitting, at left. In the Quick Attach (and the similar Blue Wave) terminals, above, the wedge fits over the entire wire.

Quick Attach (Suncor Stainless) — These terminals are of the same design as the Blue Wave terminals, although the installation instructions contain minor variations. They appear to be marketed primarily for lifeline applications by Suncor Stainless and for railings by Atlantis Rail.

Design note

Sta-Lok terminals have a design feature that distinguishes them from the other products listed above. In Sta-Lok fittings, the wedge is compressed inside the male-threaded socket and the female-threaded former. This doubles the wall thickness securing the wedge.

Proactive with rigging

When we left our home port on our open-ended cruise, we didn't give much thought to replacing our standing rigging. Our rig was new when we launched *Carina*, we had sought advice from professional riggers just before departure, and we cleaned and inspected our rigging regularly. Though we were proficient at most maintenance tasks aboard *Carina*, we had not given enough thought to the possibility we would need to become do-it-yourself riggers.

Our experience taught us valuable lessons and we feel that others can benefit from them:

- Know your rig and how to service and install every component.
- Clean and inspect rigging at least annually but preferably more frequently. Inspect your rig before departing on any ocean passage.
- End-for-end stays and shrouds when they have reached approximately half their expected life.
- Don't neglect to inspect chainplates, as cracks are usually well hidden.
- Be comfortable in your bosun's chair or climbing harness. Work out safety procedures with your crew and always use a safety line.
- When cruising, carry spare wire rope in all sizes represented in your rig, of a length and diameter suitable for replacing any stay.
- When cruising aboard a vessel outfitted with swaged terminals, carry enough mechanical fittings and suitable extensions or long studs to permit any swage to be replaced using the existing wire. For rigs already fitted with mechanical terminals, carry at least one representation of each fitting and terminal in the rig and possibly a connector that could be used to repair a section of wire in situ.
- Replace any rigging component — wire, terminal or chainplate — that shows any sign of degradation.

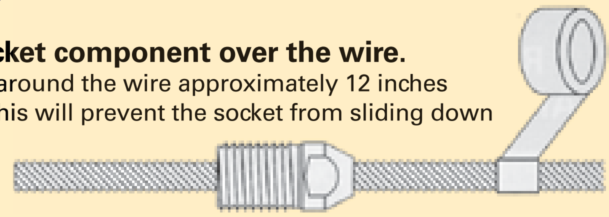
After learning by necessity while replacing first one part, and then all, of *Carina*'s rig without the help of professionals, we have become proponents of mechanical (compression or swageless) fittings. These systems are not difficult to master and working with them is certainly within the capabilities of most sailors. For offshore cruising, using them seems imperative, in case a rigging failure is discovered hundreds or thousands of miles from professional rigging services.

Philip DiNuovo and Leslie Linkkila came to cruising and boat ownership as adults and quickly developed a passion for small-boat travel. In 2003, they quit their professional jobs and left the Pacific Northwest behind. Now in the South Pacific, far from marine professionals, Philip and Leslie have had to learn to service nearly every system aboard Carina*, their Mason 33.*

Assembling a Sta-Lok terminal

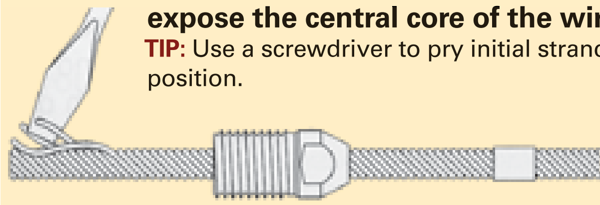
STEP 1
Slide the socket component over the wire.

TIP: Wind tape around the wire approximately 12 inches from the end. This will prevent the socket from sliding down the wire.

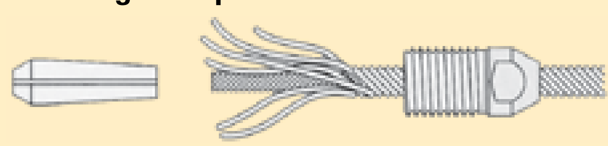


STEP 2
Unravel the outer strands 2 to 3 inches to expose the central core of the wire.

TIP: Use a screwdriver to pry initial strands out of position.



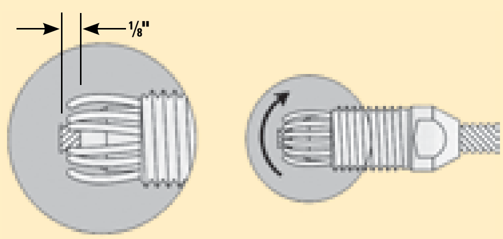
STEP 3
Slide the wedge component over the core.



STEP 4
Reposition the outer strands.

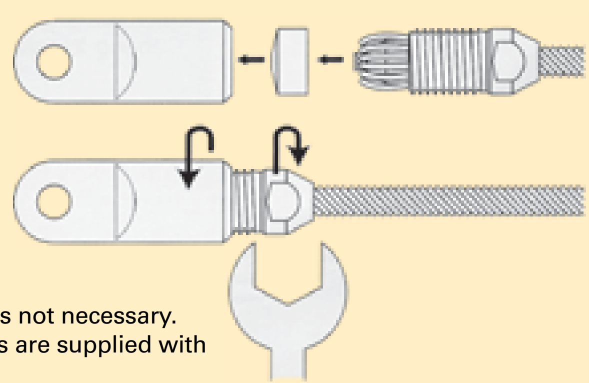
Turn the outer strands around the wedge, clockwise or counterclockwise according to the lay of the wire. Ensure approximately ⅛ inch of the core protrudes from the end of the wedge. Take care to ensure that a strand does not slip into the slit in the wedge.

TIP: While repositioning the outer strands, push the socket toward the end of the wire. This will help control them. When the wire strands are in position, push the socket firmly down to hold them in place.



STEP 5
Final assembly

Place the former cup in the bottom of the end fitting. Screw the socket assembly into the end fitting and tighten it with wrenches. The assembly is now complete.



TIP: Undue force is not necessary. Fitting instructions are supplied with each terminal.

Rebedding chainplates

Damp skivvies provoke an impromtu pit stop

by Fred Bagley

Extracting the chainplate revealed an oval hole and little caulking, above. Fred used a Dremel tool to grind the old caulk out of the holes, at right.

We put up with many inconveniences when sailing because we like to go where cell phones don't ring. But wet underwear? That forced our hands.

We sail a 21-year-old Caliber and have never had structural issues. Sails got old, engines needed overhauling, things like that . . . but water getting into the boat? Oh sure, there had been clues: the rumpled book that lay against one of the chainplates over the winter (condensation, right?) and the time we found water on a shelf after a hard sail (maybe just a porthole not fully shut?).

Then a surveyor put his moisture meter on the deck while the boat was still in her cradle. The starboard deck between our upper and aft lower chainplates was damp (the underwear lives on a starboard shelf), but he said, "The deck is solid so just rebed 'em. Piece of cake." He gave a final thump of his hammer and clambered down the ladder.

One thing we *are* good at is procrastinating so, assuring ourselves we would get the chainplates tended to soon, we set sail for the summer. Then the underwear got wet. We had stuck our heads in the sand long enough. It was time to go to work.

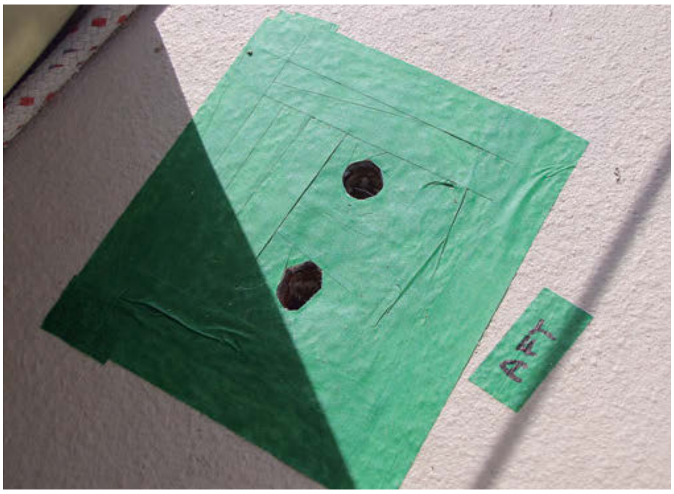
We needed just three things: supplies, a dock, and expertise. We had a tube of caulk on board. There were no docks to be found, but we cruise Lake Huron's North Channel so there were plenty of protected anchorages. Expertise was the biggest problem. We had never tackled a job like this. Ever.

Extraction and inspection

Our shrouds attach to ½-inch square U-bolts with shoulders that compress a plate to the deck. The U-bolts pass through the deck and then through heavy L-brackets that are bolted to bulkheads.

On a flat-calm day we tackled the starboard upper shroud first. After securing our main and spinnaker halyards to the starboard toerail to support the mast, we lined the toerail with cockpit cushions to keep all dropped items on the boat. We marked the number of turns on the turnbuckle and then loosened it. After removing the nuts under the deck, we levered out the U-bolt. It came out hard. We decided that was a good sign.

While there was residual caulk in the holes through the deck, there was none under the deck plate, which in fact had a smidge of dirt and rust under it. After digging and grinding out the old caulk (never set sail without a Dremel tool!), we discovered the wood of the deck core was rock solid. (Thank you, Mr. Surveyor.) We also discovered that the original deck holes had been over-drilled by 3⁄16 inch and the aft hole was significantly oval in shape. We were puzzled about what might have caused that. Sloppy workmanship by the builder? Crummy repair job by a previous owner? The U-bolt working itself back and forth within



A generous application of tape ensured epoxy went only where it was wanted, at left. Using what was on hand, Fred "waxed" ½-inch bolts so the epoxy would not stick to them, at right.

the over-drilled hole? We decided the oval-shaped hole was a bad sign.

So, we wondered, do we just put in some sealant and bolt her back together or go for it?

We went for it.

A proper repair

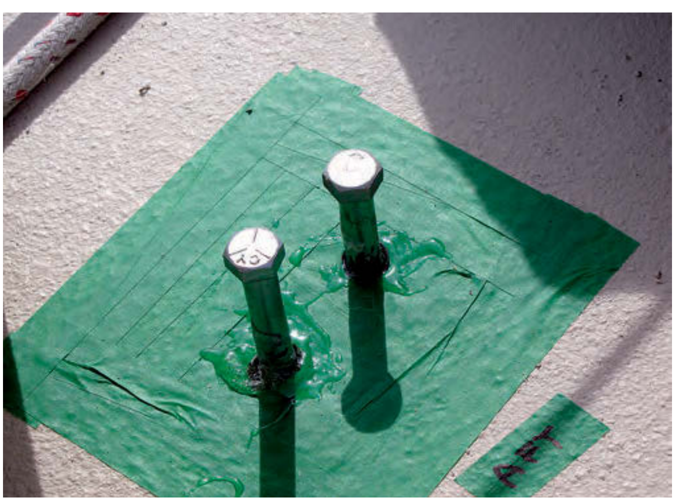
Fortunately, we had some hardware-store fast-set epoxy and plenty of painters tape. Our goal was to create an epoxy cylinder from the outer skin of the deck to the inner skin. We were hopeful this would prevent any future leaks from penetrating the deck core and at most only soak underwear inside the boat. In the process, we would convert the oval deck hole to circular. We assumed there were better ideas out there, but we were on our own.

We blocked a piece of wood enclosed in a plastic bag under the L-bracket inside (epoxy won't stick to plastic bags) and taped around the deck holes with the painters tape (another thing we are good at is spilling stuff). We prepped the holes with acetone, mixed the epoxy, and poured it into the holes, filling each hole about halfway.

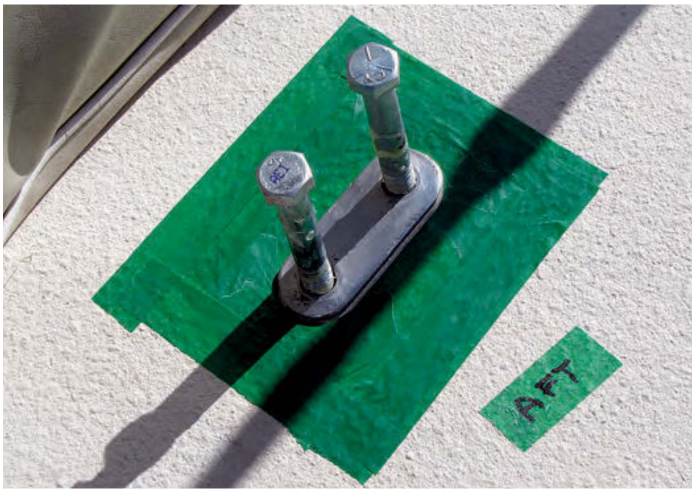
To be sure our new holes would align with the L-bracket beneath, we inserted ½-inch-diameter bolts through the epoxy-filled holes, pushing

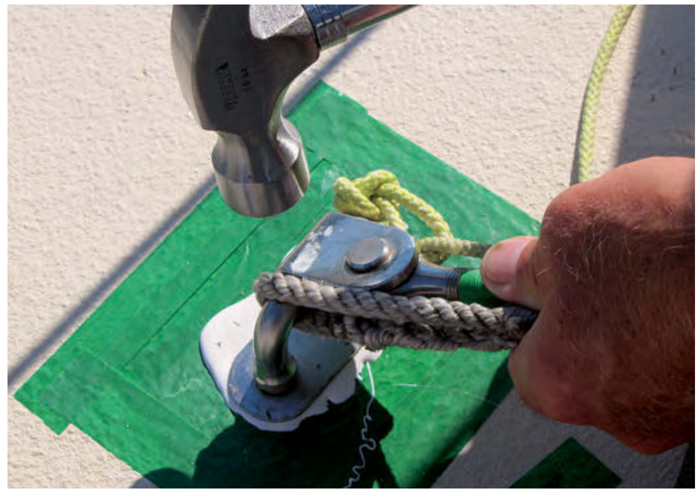
each one into a hole in the L-bracket. (We first coated the bolts with lip balm to keep the epoxy from gluing them there forever.) The bolts also served as plungers, pushing the epoxy into all the recesses of the oval holes and the core. We topped up the holes with a tad more epoxy, waited several minutes until the epoxy was firm but not solid, then very slowly rotated the bolts counter-clockwise until they were out. Then we opened a bottle of chardonnay.

The next day, we ground off the excess epoxy, removed the painters tape, and touched up the holes with a drill. We decided to bevel the upper edges of the holes a tad to allow the sealant to form a good barrier around the U-bolts. Then we retaped the deck around the outline of the deck plate and applied the caulk. To our astonishment, the U-bolt went back into place perfectly. We gratefully put on the washers and nuts and tightened everything. Removing the tape removed most of the excess caulking and a little acetone cleaned up the rest. Then we finished the bottle of chardonnay.



A wooden block wrapped in plastic and wedged against the interior chainplate bracket, above, stemmed epoxy drips. After filling the holes with epoxy, Fred threaded the bolts into the chainplate bracket, at left. Bolts withdrawn and epoxy set, Fred "countersunk" the holes, at right.





Mission accomplished

In turn, we finished the other two starboard and all three port chainplates. Every chainplate had at least one deck hole that was significantly oval; one huge oval hole had been filled with an enormous amount of caulking. There was no evidence the oval holes themselves had been ever been addressed.

Around the starboard aft plate, the one over the underwear, we found some soft wood in the core. (What's with that, Mr. Surveyor?) We cleaned out the soft wood with a variety of tools before letting that area dry overnight and doing the epoxy the next day. We planned to drill holes in the deck from underneath and let it dry completely over the winter. That plan collapsed when the job of repairing the headliner looked too formidable.

We invited the surveyor with the moisture meter to come back in the spring to see where we stood. The highest readings in the area around the chainplates were 18 to 19 percent and the surveyor said it sounded good when he tapped on it. We did find some slightly higher readings just aft of the chainlates where the pump-out and water fill penetrate the deck but, overall, we were pretty happy.

Our project was strung out over several days, all at anchor, and nary a single item was lost overboard. Taping the deck minimized any unsightly residue of either epoxy or sealant. The lip-balm-covered bolts inserted into the wet epoxy guaranteed accurate access for the U-bolts to the L-brackets inside. The total cost of the repair was $19 and a bottle of chardonnay.

And yes, the underwear stayed dry the rest of the summer.

Fred Bagley and his wife, Jennifer, live in Vermont but sail the upper Great Lakes out of Penetanguishene, Ontario, in southern Georgian Bay. They primarily cruise Georgian Bay, the North Channel, and Lake Superior on their Caliber 38, Catamount.

Fred used the bolts to locate the deck plate while he taped around it prior to caulking, at left above. With the caulk applied under the plate, Fred tapped the U-bolt into the holes, at right above. When everything was finally reassembled, at left, it was time to break out the wine.

Making new lifelines

Low-stretch Dyneema has advantages over wire

Our Liberty 458, *Nine of Cups*, just celebrated her 25th birthday. We replaced the lifelines the first year we owned her, using vinyl-coated 7 x 7 wire. It looked great for a few years but began showing rust spots. In year four, we replaced them again using uncoated 7 x 7 stainless-steel wire. Five years later, they were beginning to show a few broken strands and "meathooks" here and there; it was time to replace them once again.

This time we considered the new fiber technologies for our lifelines. Ropes made with these new fibers have a number of properties that make them good candidates for lifelines: high strength, low weight, high resistance to chafe, resistance to flex fatigue, good resistance to UV, and very low stretch. They are also easy to splice, so I can make them myself without having to order pre-made sections with swaged fittings. Before making the decision, however, we did a bit more research. They're called "lifelines" for good reason and, before we trusted our lives to them, we needed more than the rope manufacturer's assurance that they would live up to expectations.

After spending hours perusing the nautical discussion boards (where someone asks a question and then 24 "experts" with varying amounts of actual knowledge provide conflicting answers, all stated with authority, and then argue among themselves), we found one very good paper by US Sailing (see "References" on page 34). Their conclusion after considerable research was that, with a few caveats, the new Ultra-High Molecular Weight Polyethylene (UHMWPE) fibers were acceptable for use as lifelines. These UHMWPE fibers are sold under the brand names Dyneema (by DSM) and Spectra (by Honeywell). We decided to go ahead with the project.

Splicing aids

Tools and supplies needed to make the eye-splices:

- Fid or splicing wand in the correct size for the line you are splicing
- Tape measure
- Adhesive tape (masking, electrical, or plastic)
- Sharp scissors or knife
- Magic Marker with a fine point
- Needle with an eye large enough to accommodate one strand of the line if using the Bury technique

We narrowed our choices down to Amsteel (Samson) or STS-12-75 (New England Ropes). Both are 12-strand single-braid Dyneema with extremely low stretch, high strength, and easy splicing characteristics; both can be ordered in a gray that looks remarkably like steel wire when installed; and both have strength equal to or greater than wire of the same diameter. We based our final decision on price and availability. The Amsteel won out.

Our old lifelines incorporated turnbuckles in the fixed sections and pelican hooks at each of the gate sections. These fittings could be reused. To convert to rope, the only hardware we needed to purchase was a small shackle for one end of each section and a new threaded toggle jaw for each pelican hook or turnbuckle. The initial cost for converting to rope would be less than replacing the lifelines with wire. In the future, the replacement cost would be significantly less since we would need to purchase only the rope.

One drawback to using rope is UV degradation of the fiber in a sunny environment. While the rope has a UV-resistant coating, it is still susceptible to degradation. Testing has shown that the line will retain 60 percent of its tensile strength after five years of exposure. You can compensate for this by using the next larger size line. For example, if you have ¼-inch lifelines, use 5⁄16-inch Dyneema.

Measuring and splicing

Two recommended methods exist for eye-splicing Dyneema. New England Ropes recommends the locked Brummel and Samson recommends the Bury. These methods can be found on the respective companies' websites. The locked Brummel is more complicated than the Bury. On the other hand, while the Bury is simpler, it must be lock-stitched. I opted to use the Bury, but either technique will work. One important caveat, if using the locked Brummel technique: recent testing has shown the amount of tail that must be buried should be at least 72 times the diameter.

To calculate the amount of line required, I measured the line needed for each section and added the listed amount from the table to allow for the eye-splices (see "Splicing Allowances" on page 33). You need another couple of feet to use as twine for lock-stitching each eye-splice if you use the Bury splice.

Nine of Cups has 12 sections including the gates. Our wire was ¼-inch, so I used 5⁄16-inch rope with a breaking strength of 10,500 pounds to replace our old wire. I measured the amount of rope needed

by David Lynn

(136 feet), then added 51 inches x 12 sections (51 feet) to allow for the Bury-type eye-splices and 2 feet for the lock-stitching for a total of 189 feet.

In the old wire version, each of the lifeline sections on *Nine of Cups* had a threaded stud on one end and a toggle jaw on the other. These were swaged fittings and could not be used with the new system. We replaced them with a shackle on one end and a threaded toggle jaw with clevis pin on the other. Be sure to purchase the threaded toggle jaw with the correct thread (right hand or left hand) for your turnbuckle or pelican hook.

Alternatively, you can do without the turnbuckles and use only shackles. Even the shackles are an option, as the lifeline sections can be lashed to their respective endpoints using Dyneema. After several years of use now, however, I recommend using turnbuckles for the reasons discussed below.

You will want to make the longest lifeline section first. That way, if you make a mistake and it is the wrong length, you can cut it shorter and use it for a shorter lifeline section. Before cutting the line, make the first eye-splice. Use the procedure for making the splices provided by either New England Ropes or Samson (see “References” on page 34). The directions on the New England Ropes site for the Brummel should be modified to note that the length of tail to be buried should be 72 times the diameter.

Attach this eye-splice to something secure, like a stanchion, and use a winch to tension the line. The length of line being tensioned should be at least as long as the lifeline section you are making. Keep the tension on the line for a minute or two, then release it. Repeat this pre-tensioning process four more times. What you are doing is removing the constructional elongation from the line. Next comes the tricky part. When you make an eye-splice, the line becomes shorter because the cover bunches up when the tail is buried. Add 2 inches to the line length, then measure, cut, and make the second eyesplice. You will get an idea of the chafe-resistance of this line

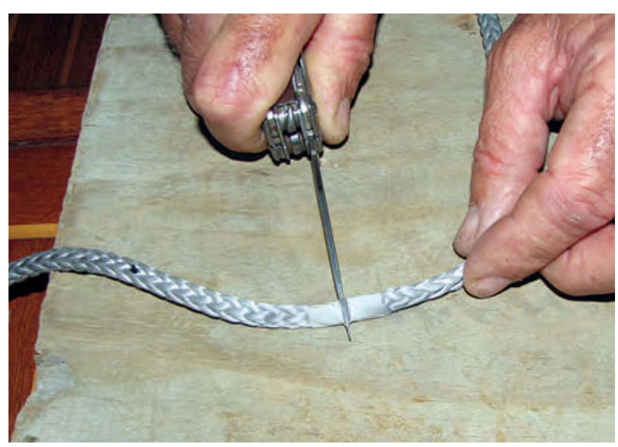
Splicing allowances

Line size	Breaking strength	Allowance for 2 eye-splices Bury	Allowance for 2 eye-splices Brummel
3/16 inch	5,000 pounds	33 inches	31 inches
¼ inch	7,400 pounds	42 inches	40 inches
5/16 inch	10,500 pounds	51 inches	49 inches

It’s important to allow about two inches extra length for the bunching at the eye-splice where the rope has to expand to cover the inserted tail.

This eye-splice is connected to a turnbuckle toggle by means of a clevis pin. The turnbuckle is used to tension the lifeline.

The lifeline gate has a threaded toggle to fit the pelican hook on one end and a shackle on the other.



Dyneema is very tough. A very sharp knife is needed to cut it and the blade will need to be sharpened often. A wrap of tape holds the strands together.

“After a little practice, the eye-splices became quite easy to make.”

By replacing the swaged studs of the wire lifelines with toggle studs, David reused the original turnbuckles with the new Dyneema lifelines.

when you try to cut it. It is not easy to saw through the line even with a sharp knife, and the knife will become dull after only a few cuts.

At this point, the lifeline section will probably be slightly too short. Repeat the pre-tensioning process, and it should fit. It is difficult to end up with precisely the right length, and one reason to use turnbuckles is to allow you to take up any slack at this stage.

After a little practice, the eye-splices became quite easy to make. Once I got past the learning curve, each section took about a half-hour to complete. All together, it took about 10 hours to complete the project once everything was on hand. The total cost for our boat was about $450, versus $620 for replacing the lifelines with new wire. Had I not already had the turnbuckles and pelican hooks, my total cost would have been about $630. In the future, replacing the line will cost about $315 once every five years.

Further discussion

Our new lifelines have now been in place for almost three years. We have since learned there is one more rope characteristic called “creep” that should be discussed. Stretch is the increase in length a rope undergoes when it is subjected to a given load, for example, 0.70 percent at 20 percent of breaking strength. Stretch is the ability to give but return to the previous size, like an elastic band. Creep, however, is a permanent increase in length that results from a material being under tension over a long period of time. Dyneema and Spectra have very low stretch properties but do exhibit creep.

Lifelines that are under tension will become slack over time and will need to be re-tightened periodically. On *Nine of Cups*, we hang our headsail sheets and furling lines from the lifelines when not in use. As a result, we have needed to tighten these sections every six months or so. Having turnbuckles in each section makes this an easy task. If you use only shackles to attach each section of lifeline, it’s not possible to take up the slack due to creep.

An alternative to using turnbuckles is to lash the end of each section to the stanchion. This allows you to re-tighten each section as needed and is less expensive than turnbuckles. As a friend recently pointed out, it has another advantage as well. If ever anyone goes overboard while attached by a tether, you can quickly cut the lashing so that you don’t have to lift the person over the lifelines to get him or her back aboard. Just make sure your lashing is at least as strong as the lifelines and check regularly for chafe.

Since we made our lifelines, there has been some controversy as to whether attaching an eye-splice to a small-radius shackle reduces the strength of the line, and some people recommend using a thimble in the eye-splice. I have not been able to find anything supporting this from the manufacturers but, other than the cost of the thimbles, I can’t see any reason not to add them.

Overall, we have been quite happy with our lifelines. Marcie likes to hang the occasional towel or swimsuit over them and there is never an issue with rust stains. Rope requires no polishing or waxing like stainless steel. I intend to continue using Dyneema when it’s time to replace the lifelines on their five-year anniversary.

David and Marcie Lynn have lived aboard Nine of Cups*, their 1986 Liberty 458 cutter, since purchasing her in Kemah, Texas, in 2000. Since that time, they have sailed her more than 70,000 nautical miles in their ever-so-slow world circumnavigation and at press time were cruising Tasmania. Find them on their website at <www.nineofcups.com> or their daily blog at <www.justalittlefurther.com>.*

References

Samson Ropes splicing website
www.samsonrope.com/splicing-instructions.cfm

New England Ropes splicing website
www.neropes.com/splicingguidechoice.aspx

Dyneema/Spectra Single Braid Line, Properties and Recommendations for its use; Glenn T. McCarthy and Evans Starzinger, U.S. Sailing, http://offshore.ussailing.org/Assets/Offshore/SAS/PDF/Dyneema+Article.pdf

G-10 steps up

A mast gets a new foot to stand on

BY CLIFF MOORE

I've always been in the habit of pulling my mast when I lay my boat up each fall. It adds to the annual cost, but it's better in the long run. For one thing, it makes it easier to cover the boat, a 1981 Paceship PY 26, and there's less risk of the boat being damaged by winter storms.

Pulling the mast also allows me to inspect the masthead and rigging up close without worrying about falling out of a bosun's chair. Occasionally, I find something at the masthead in need of repair, such as frayed rigging wire or a bad anchor light, and addressing it is easier on the hard. But a few years ago, the trouble lay at the base of the mast.

As I was cleaning out the boat, I found a crack running from side to side at the after end of the all-aluminum step . . . right under one of the big nuts that held it in place on the keel. I wiggled it with my fingers and it came apart in my hand. The step had been secured to the keel with the stainless-steel keel bolts that fasten the cast-iron keel to the boat. It was a textbook recipe for electrolysis and that, I knew, is never good.

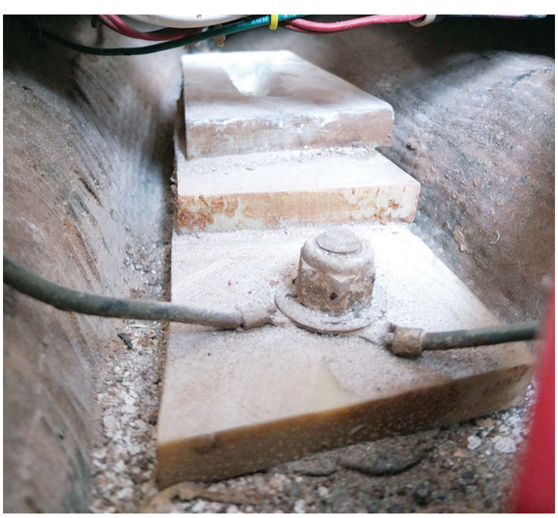
A not very close inspection showed that the mast foot, another aluminum casting, also showed signs of severe corrosion, as did the lower edge of the mast itself, where it fit around the foot. Fortunately, I had all winter to find out how to fix it.

A link on a website devoted to Paceship owners led me to a source — Rig-Rite — for a replacement mast shoe. If memory serves me correctly, it was somewhere north of $100, but not by much. I was happy they had one at any price for a 30-year-old boat.

A non-corroding substitute

The remaining problem was how to deal with the corroded mast step. One of the boating magazines had an article about G-10 and how it could be used for backing plates under cleats and other deck hardware. It could even be used, in larger sizes, for engine mounts. Although it sounds like the name of a group of economists, G-10 is a composite of fiberglass and epoxy, and it's available in a wide variety of dimensions and shapes.

I'm an empirical armchair engineer with no formal training, but it seemed to me that a material with a compression strength of 60,000 psi, a modulus of elasticity of 2,700,000 psi, a Rockwell hardness of 110, and a specific gravity of 1.82 should be plenty tough, plenty hard, and plenty heavy. Also, it had the qualities of being impervious to water, essentially non-absorbent, and non-conductive to electricity, thus would shield the mast from further corrosion due to contact with stainless steel in bilge water. It sounded ideal.



The original mast step was in dire shape, top of page, as the result of years in contact with stainless-steel keel bolts. The G-10 replacement, while not pretty after two years in the bilge, is still intact, at left.

A little research indicated that G-10 could be milled, drilled, cut, and shaped like a hard piece of metal, but that any tools used with it should be carbide-tipped. I found it available online in flat sheets of various thicknesses, as well as in different shapes, such as tubes, bars, rods, and angled pieces. In fact, not too far from my home in New Jersey, McMaster-Carr had a warehouse with an amazing variety of thicknesses and sizes. It's also available from Jamestown Distributors, one of my favorite suppliers for stainless-steel and bronze hardware.

I found carbide jigsaw blades at my local hardware store and used only two of them for the entire job, plus a couple of carbide drill bits and an ordinary tap for a 5⁄16-inch bolt. However, the G-10 was so hard, and its position in the bilge is of "out of sight, out of mind," that I left it pretty rough, except for softening the edges with a sander. There was no way I was going to make this pretty, with nicely rounded edges, as I might have if I had used wood. I advise wearing protective gear when cutting, drilling, or sanding this stuff, as it will produce a lot of fiberglass dust. Don't breathe it.

Plan and execution

My plan was to remove the old mast shoe and cut away enough of the mast (about ¾ inch) with a hacksaw to remove the corroded part. I did that, then built a new mast step from G-10. The old step was 2 inches tall. The new one would have to be taller to offset the slightly shorter mast.

Referring to the old mast step as a model for its replacement, I ordered a 24 x 24-inch piece of ¾-inch-thick G-10 from McMaster-Carr for $311.

Using an ordinary jigsaw with a carbide blade, I cut a piece of G-10 the length of the original step (about 18 inches) and roughly the width of the bilge (6 inches), leaving space for any water in the bilge to wash along its sides. This was to be the base and, at ¾-inch thick, it allowed the tops of the keel bolts to be exposed.

I cut a second piece as a spacer to make up for the shortened mast. Then, using the new mast shoe as a guide, I cut a third piece big enough

The old mast foot was severely corroded, as was the base of the mast around it.

to fit directly under the mast and cut a beveled slot in it to hold the tenon at the bottom of the mast shoe.

Once I had the upper section of G-10 cut out and properly shaped, I drilled and tapped holes to hold four 5⁄16-inch bolts. I then glued the three pieces of G-10 with epoxy and tightened the stainless-steel bolts to secure them together. The bolts were isolated so they would not touch either the keel bolts or the mast. It seemed like belts and suspenders, but this way, I felt the pieces wouldn't be likely to slip or slide under the tremendous sideways pressure the mast would exert when the boat was under sail.

Once I felt confident about the location of the upper portion of the new step, I used the original step, what was left of it, as a guide to cut holes for the two keel bolts holding it in place.

I tightened the keel-bolt nuts with a torque wrench to the builder's specifications (about 90 foot pounds), and used 3M 5200 sealant around the bolt holes. When the mast went in, the rigging wire fit well enough. Even though the step was, in effect, about ¼ inch lower than it had been before, enough threads were showing on the

The tenon that sat in the mast step was also white with oxide.

turnbuckles that I could easily take up any slack in the shrouds.

My boat had been struck by lightning in the recent past, so I used a commercial electrician's connector, a small rectangle of aluminum with a short foot (about $8), to connect a heavy copper ground strap from the keel bolt to the mast without corroding the mast. The connector has a hole drilled to take the wire, which is secured with a bolt. All I had to do was drill a small hole into the mast several inches above the cabin sole, for a #6 stainless-steel sheet metal screw, to fasten the connector with, and lightly sand bare the aluminum surface to ensure a good electrical connection.

Over the past three years the mast step has held up very well and shows no sign of loosening or slipping. With luck, it should last another 30 or so years.

Ciff Moore's first boat was a Kool Cigarettes foam dinghy with no rudder or sail. Many years and many boats later, he's sailing a 26-foot AMF Paceship 26 he acquired and rebuilt after Hurricane Bob trashed it in 1991. He is the editor of a community newspaper.

Resources

Mast foot for the PY26:
www.rigrite.com

G-10 material in a variety of shapes:
www.mcmaster.com
www.jamestowndistributors.com

The Paceship Website has a wealth of information for owners of all models of Paceships:
www.Paceship.org

A mast boot for all sea

Rubber roofing out of a can does the trick

Over the years I have tried several methods to create a watertight mast boot. As a temporary fix, I once used duct tape. It was inexpensive and actually lasted about 10 months before it started to leak. I tried using a couple of rolls of mast-boot tape, a wide self-bonding tape. It was quite a bit more expensive and lasted only a year and a half before it started leaking. I also tried Spartite, a two-part liquid that forms both a mast wedge and mast boot. It worked well, but is expensive and, if not applied properly, can permanently bond the mast to the boat.

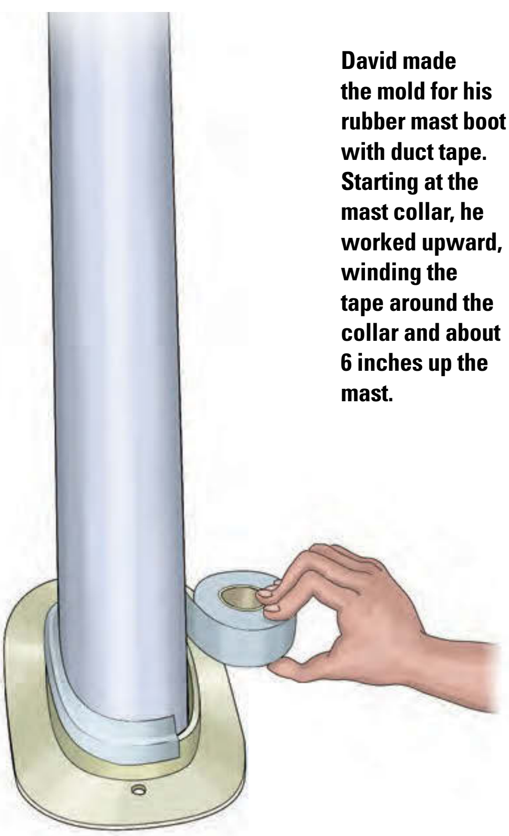
While we were in New Zealand last year, we pulled the mast for a refit. When we re-stepped the mast, we could not reuse the Spartite boot and I began looking for another solution. At the suggestion of a local rigger, I decided to try a one-part waterproofing compound that's marketed for roof and gutter repairs. This is a thick rubbery substance about the consistency of honey that can be applied with a brush. It will adhere to metal and painted surfaces and, once it dries, it remains flexible and is UV-resistant. It seemed ideal for my application.

A quick-and-easy mold

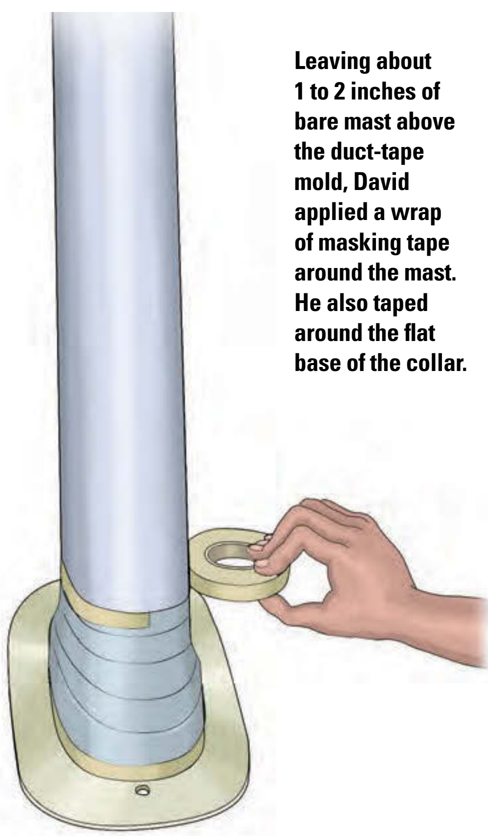
My first step in making the mast boot was to create a form, or male mold, to support the waterproofing compound until it could set. I used my ever-present duct tape to make the mold, but any wide adhesive-backed tape would work. I started by making a wrap around the deck collar and continued to make wraps upward until I had a cone-shaped form reaching from the deck collar to the mast. Next, I put a wrap of masking tape around the mast 1 to 2 inches above the top of the mold and applied masking tape to the deck below the mast collar.

I found the waterproofing compound at a local building-supply store. The product itself is not hard to find (and several brands will do the job), but it is difficult to find in a small quantity. For *Nine of Cups*, our 45-foot cutter, I needed less than a quart, and the products were usually available only in 1- and 5-gallon containers. See the Resources box (facing page) for sources I've located that will sell and ship the waterproofing compound in 1-gallon or smaller quantities if you cannot find it locally.

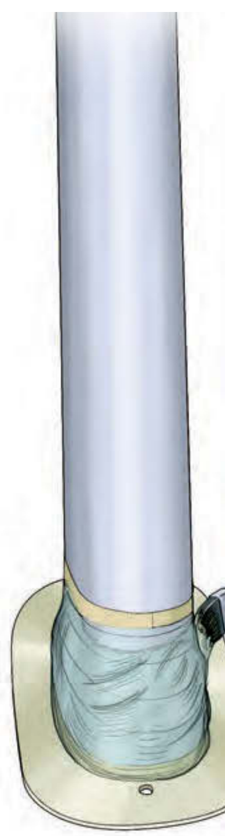
ILLUSTRATIONS BY FRITZ SEEGERS



David made the mold for his rubber mast boot with duct tape. Starting at the mast collar, he worked upward, winding the tape around the collar and about 6 inches up the mast.



Leaving about 1 to 2 inches of bare mast above the duct-tape mold, David applied a wrap of masking tape around the mast. He also taped around the flat base of the collar.



sons

by David Lynn

Laying down rubber

Using disposable chip brushes, I applied three thick coats following the manufacturer's re-coat schedule. For the product I used, I was able to apply a new coat after eight hours of drying time, so I applied two coats the first day and the last coat on the second day. After it dried beyond the tacky stage, I carefully removed the masking tape, using a razor blade as necessary. I then let the waterproofing compound cure for a couple of days.

Since the waterproofing is UV-resistant, the mast boot was now functionally complete, but it didn't look finished. I decided to make a cover from Sunbrella, using a small piece left over from our Bimini project.

The cover-up

The shape of the cover is a bit odd — it's the base of a cone. After a bit of trial and error, I came up with a simple formula that can be used to make the pattern.

First, I measured the circumference of the mast, $C1$, and the circumference of the mast collar, $C2$.

I estimated how high on the mast I wanted the cover to reach and put a pencil mark on the mast at that point. Then I measured the distance from the base of the mast collar to the pencil mark on the mast, which is Ht in the formula. You can calculate the two radii, $R1$ and $R2$, using the formulas below.

$$R1 = (C1 \times Ht) \div (C2 - C1)$$
$$R2 = R1 + Ht$$

David applied three coats of waterproofing compound over the mold and the mast up to the masking tape, waiting the appropriate length of time between coats.

For example, on *Cups* the mast has a circumference of 26 inches and the mast collar has a circumference of 31 inches. The distance from the bottom of the mast collar to the top of the cover is 7 inches. Plugging these values into the formulas:

$$R1 = (26 \times 7) \div (31-26) = 182 \div 5 = 36.4 \text{ inches}$$
$$R2 = 36.4 + 7 = 43.4 \text{ inches}$$

Before marking and cutting the fabric, I made a paper template to check my calculations. Once I was convinced the template was accurate, I used it to draw the pattern onto the fabric. I added an extra inch to one end of the pattern to allow for an overlap, then added ½ inch to the entire outline to allow for hemming the edges. Next I folded the ½-inch of material along the outline and hand-stitched it. Marcie keeps a roll of basting tape on hand. It's narrow double-sided adhesive tape and works well to hold the material in place while stitching it. The last step in the fabrication process was to hand-stitch mating pieces of Velcro onto the ends of the fabric where it overlaps.

I installed the cover by wrapping it tightly around the mast and collar and pressing the Velcro strips together. I wanted to add a whipping with ⅛-inch white nylon line to the top and bottom to give it a finished look. In previous versions, I used a French spiral hitch and once I even finished it with a Turk's head. It was a lot of work and I don't think anyone but me ever noticed. This time I used an easier method. I used a hot-melt glue gun to attach one end of the small line to the cover about ½ inch from the top, then made 12 wraps of line tightly and neatly around the mast working upward. I put a small dab of glue on each revolution and secured the end to the mast and the

Since the rubber boot didn't look "finished," David covered it with a dress boot made of Sunbrella, then added whippings top and bottom.

Resources

Kool Seal Elastomeric Roof Coating
www.koolseal.com for data sheet;
www.amazon.com to purchase

Liquid Rubber Highbuild S-200 Waterproofing
www.liquidrubber.ca

Duram 195 Waterproofing Membrane
www.duram.com.au

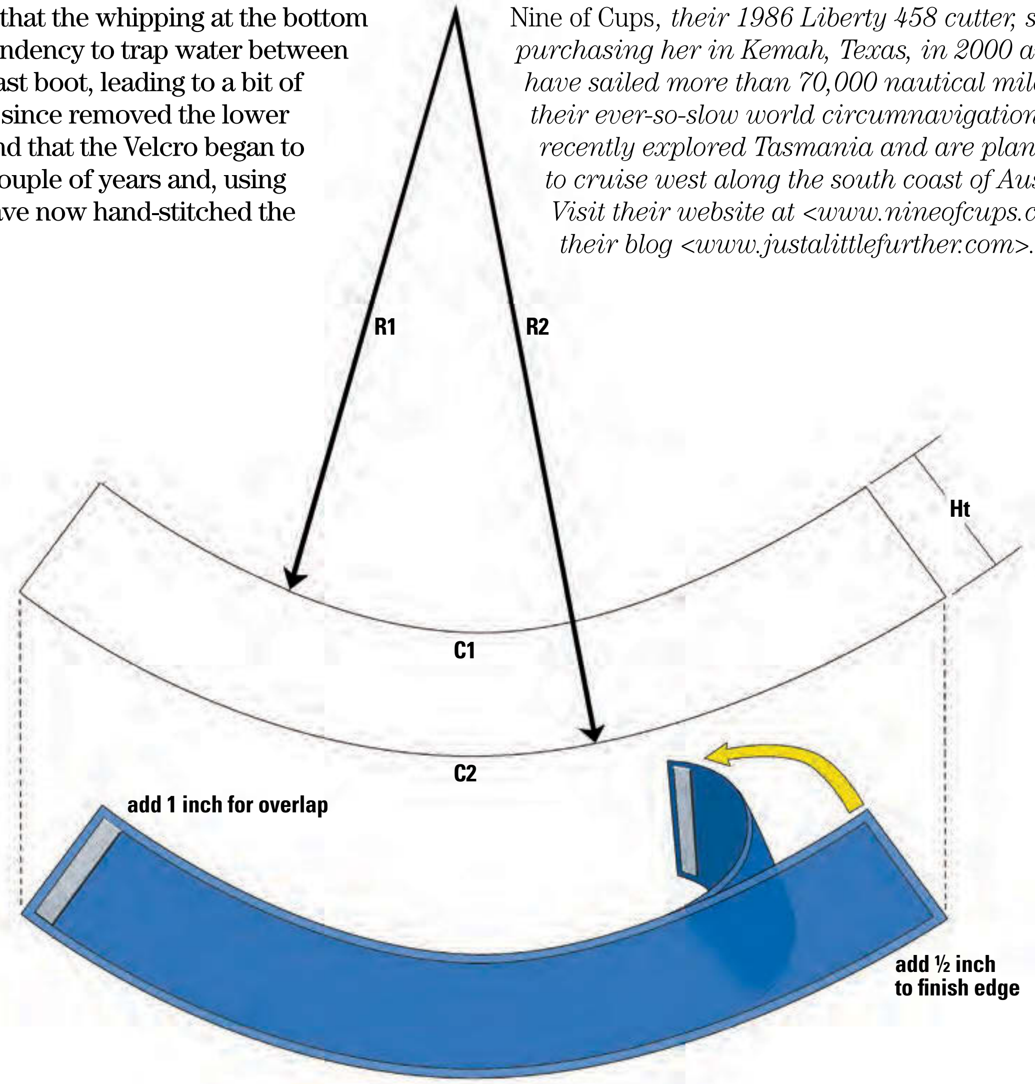
Liquid Rubber EPDM
www.liquid-roof.com

wrap just below it with another dab of glue. Using the same process, I also added a whipping at the bottom around the mast collar. The end result looks nice and I can remove it quite easily when necessary.

This mast boot has been in place for more than two years. It has been exposed to heavy seas and cold temperatures in the waters of southern New Zealand and Tasmania as well as the more tropical temperatures of Vanuatu and Fiji. So far it has shown no sign of leaking. I did find that the whipping at the bottom of the cover had a tendency to trap water between the cover and the mast boot, leading to a bit of mold growth. I have since removed the lower whipping. I also found that the Velcro began to lose its grip after a couple of years and, using a curved needle, I have now hand-stitched the Sunbrella in place.

I have also learned that the manufacturers of some of these products do not recommend its use on stainless steel because it will not adhere well. This should not be a problem in this application. If the mast collar is stainless steel, the membrane will form a tight flexible boot over it, shedding water downward.

David Lynn is Good Old Boat's *newest contributing editor. He and his wife, Marcie, have lived aboard* Nine of Cups*, their 1986 Liberty 458 cutter, since purchasing her in Kemah, Texas, in 2000 and have sailed more than 70,000 nautical miles in their ever-so-slow world circumnavigation. They recently explored Tasmania and are planning to cruise west along the south coast of Australia. Visit their website at <www.nineofcups.com> or their blog <www.justalittlefurther.com>.*



The taper from the mast collar to the top of the mast boot means that the canvas cover must be made as the base of a cone. David used this simple way to calculate the dimensions (see the formulas on page 37).

Mast-raising magic

Persistence pays off with a solo solution

by Rob Mazza

Almost every boat manufacturer eventually tries its hand at designing a mast-raising system, with varying degrees of success. While I was with C&C, I was project manager on the Mega 30 and, while with Hunter, I headed the design team under Warren Luhrs that produced the Hunter 23.5 and 26 water-ballasted trailerables. All three of these boats were built with self-contained mast-raising systems.

The goal of every deck-stepped mast-raising operation is that it be self-contained, safe, and easily operated by a small number of people.

These operations always involve two components. One is the mechanism for raising and lowering the mast and the other is a system for stabilizing the mast to prevent it from oscillating from side to side during the process.

As it's being raised or lowered, the mast rotates around a pin in the mast step or tabernacle. Leverage is provided by a gin pole or by an A-frame pivoting at the deck at a point in line with the mast step or chainplates. Either of these systems is operated by a block and tackle (often the mainsheet tackle) attached at the bow or a line led forward around a block at the stemhead and aft to a cockpit winch. The connection from the gin pole or A-frame to the masthead is inevitably the jib halyard.

Because the pivot point at the mast step is almost always higher than the chainplate pins — due either to the crown of the deck or the mast being stepped on a deckhouse top — the shrouds themselves cannot be used to provide the required transverse support unless the chainplate pins are raised to be perfectly in line with, and on the same axis as, the mast-heel pivot pin. Some boat owners have actually added stainless-steel chainplate structures to achieve this, but the most common solution is to mount lifeline stanchions in line with the mast-heel pivot pin and weld eyes to those stanchions in line with the pivot-pin axis. To these eyes are attached the bottom ends of transverse support wires led to attachment points on the lower section of the spar at a height easily reached from deck once the mast is raised so that it can be disconnected and removed.

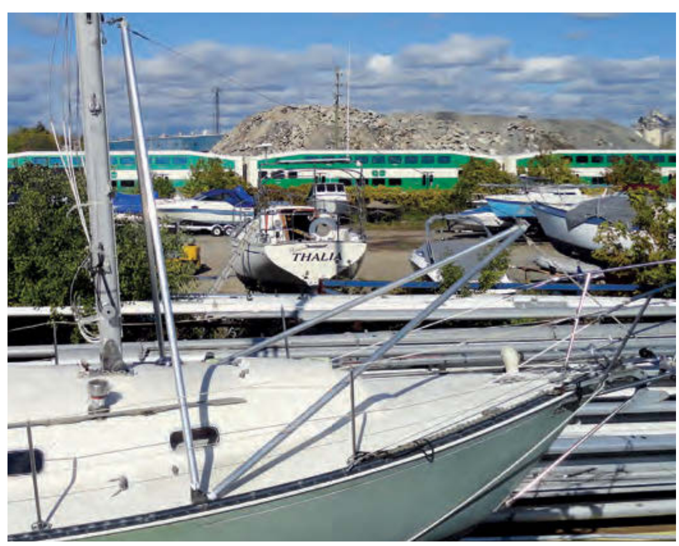
When visiting my old friend Danny Klacko at Klacko Spars in Oakville, Ontario, recently, I was intrigued when he said, "While you're here, I want to show you something on my C&C 27. I've been working on mast-raising systems for more than 40 years, and I think I've finally developed the absolute best solution for any existing boat with a deck-stepped mast of virtually any size."

Resources

Danny Klacko will quote on systems for non-DIY boat owners:
klackospars@bellnet.ca
www.klackospars.com

Two A-frames share common pivot points at the deck and are connected by a wire between their apexes. The forward one provides the raising lever and the after one lateral support for the mast.

The pivot point of the A-frames is not level with that of the mast, but the apex of the after A-frame, attached to the spinnaker-pole car, accommodates the offset by rising up the mast as the mast is being raised.



When the mast reaches its fully vertical position, it remains supported by the A-frame while the shrouds are connected to the chainplates.

The apex of the after A-frame attaches to the ring on the spinnaker-pole car with a snapshackle. The stainless-steel wire leading forward connects it to the forward A-frame.

After the mast has been lowered and the after A-frame disconnected from the mast, both frames can be rotated forward so they can be stowed on deck or removed. Once disconnected from the deck, the A-frames "scissor" together for ease of storage.

A custom-made stainless-steel tabernacle allows the mast to pivot and also serves as the mast step.

The deck pivot is designed to allow the A-frames to stow one on top of the other when folded down. The toggle connections allow freedom of movement. The bracket is bolted to the toerail so it can be easily removed when not needed.

"The key to this system is the use of a spinnaker-pole track with a freely moving car."

His boat was sitting behind the shop on her trailer with the mast lowered. At the word from Danny, the young man on board started cranking on the cockpit winch and the mast rose from the horizontal to the vertical in less than a minute. At a nod from Danny, the line on the winch was eased, and the mast reversed its trajectory. At all times the mast was completely under control with no evidence of sideways oscillation as it went through its arc.

Articulating A-frames

The unique feature of the Klacko system is the use of two connected A-frames mounted on common deckplates port and starboard, with the apex of the aft pair attached to the car on the spinnaker-pole track with a snapshackle.

The aft A-frame supports the spar laterally, independently of the shrouds. The apex of the forward A-frame is connected to the apex of the aft frame with a stainless-steel wire. The lifting force is applied with a line led through a block on the stemhead and directly aft to a cockpit winch. When the mast is down, the aft frame is almost horizontal and the forward frame is vertical. As the mast is raised, the frames rotate as well, with the forward frame becoming horizontal and the aft frame vertical when the mast is up.

Once the mast has been raised and the forestay hooked up, the the aft A-frame can be quickly disconnected from the spinnaker pole car and the A-frames folded for storage.

The key to this system is the use of a spinnaker-pole track with a freely moving car. Since the mast and the aft A-frame rotate around different pivot points, the car must be able to move along the track as the mast rotates about its pivot. For sailors who don't have a spinnaker-pole track and don't want to install one, a bridle around the mast or even a 12-inch-long link plate between the apex of the A-frame and the fixed point on the mast would work, but neither system offers the same amount of transverse fixity that the spinnaker-pole track and car provide. Mounting a short length of track and a car, even if the boat is not equipped with a spinnaker, is still the best solution.

Danny Klacko, after 40 years of development, freely shares this concept with anyone who would like to copy it.

Rob Mazza is a Good Old Boat *contributing editor. A sailor by passion and yacht designer by vocation, his long career around sailboats began at C&C Yachts back when now good old C&Cs were cutting-edge new.*

Replacing lifelines

Hand-crimped terminals make for easy DIY

BY GARY PARDUN

Gary eliminated the gate and attached his new lifelines to the pushpit with pelican hooks. By releasing the lifelines, he can make a temporary gate anywhere he wants on that side of the boat.

Rust stains on the vinyl cover indicate a corroded lifeline cable inside — it's time to replace it. The old-style pelican hook was difficult to open and close because the tension was on the lever.

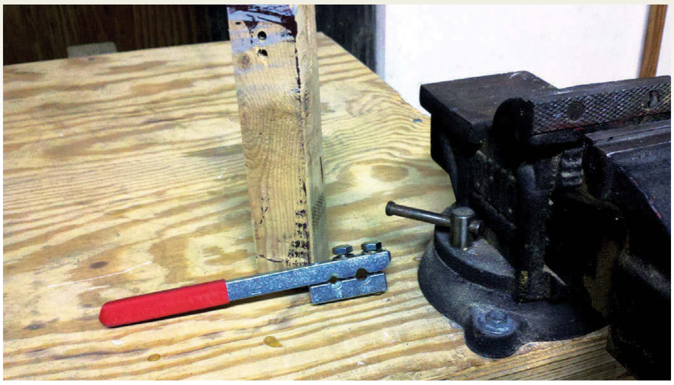
Rust-colored stains in the cracked vinyl-coated lifelines on *Galilean*, our 1984 Islander 30, signaled corrosion at work. Vinyl-coated lifelines are smooth to the touch and nice to lean against, but moisture becomes trapped between the cable and the vinyl and the cable corrodes underneath and out of sight. By the time the brown stains appear, the cable is already compromised.(See also, "Maintain Your Perimeter" by Don Casey, November 2009.) Given that our lifelines probably dated to 1984, it was clearly time to replace them.

Our boat was built with gates in the lifelines, but the Bimini frame that had been added later made it impossible to use them. The pelican hooks, being of the "classic" design, were difficult to open because the tension of the lifeline was on the moving lever rather than the fixed hook.

I had read about sailors who dispensed with the gate entirely. Some connect the pelican hook to the pushpit and run a continuous cable all the way to the pulpit. This way, releasing the pelican hook lets the lifeline droop the length of the boat and you can make a temporary gate wherever you want it. Reconnect the pelican hook from the comfort of the cockpit and you're back in business. This design also eliminates much of the (expensive) hardware for making a traditional lifeline gate as well as the labor of installing it. Dispensing with the gates was an easy decision. While I was at it, I decided to replace the old pelican hooks with the newer "over the center" design that takes the stress off the lever.

Lifeline anatomy

Lifelines have three basic components: the cable, the connectors at the ends, and the fittings. The connector is called a terminal because it terminates the cable and provides a way to attach it to the fittings.



A wooden block with a hole and a kerf makes an excellent jig for sawing stainless-steel cable with an ordinary hacksaw, and the red-handled crimping tool is essential for stainless-steel terminals, at left. The crimping tool must be held securely in a vise, at right, while the bolts are tightened little by little on alternate sides of the terminal. The signal to stop tightening is when the jaws of the tool touch on both sides. (Fittings, such as the pelican hook in the picture, do not need to be attached while crimping.)

Cable comes in a choice of diameters (⅛ inch and 3⁄16 inch are the most common for lifelines) and wire patterns, which include 1 x 19 (one group of 19 wires), 7 x 7 (seven groups of seven wires), and 7 x 19 (seven groups of 19 wires). I also had a choice of vinyl-coated or bare. The consensus for our 30-foot sloop was to use 3⁄16-inch 1 x 19 Type-316 stainless-steel uncoated cable.

The most common terminal is a stud, a threaded bolt with a hollow end just big enough for the cable. After the stud is attached to the cable it will still fit through the holes in the stanchions.

Fittings connect the stud to the boat. This is where both the variety and expense increase. Common types of fittings include turnbuckles, gate (or pelican) hooks, toggle jaws, gate eyes, and deck toggles. These fittings screw onto the stud and then fasten to a stanchion, pulpit, pushpit, or the deck. (These parts are illustrated in "Lifelines 101," May 2010).

Since a turnbuckle has screws on both ends that turn in opposite directions, I had to make sure that if the stud on a cable had a right-handed thread, the stud on the other side of the turnbuckle had a left-handed thread, and vice-versa.

Terminal attachments

Friction keeps the cable from sliding out of the terminal, and that friction can be achieved in three ways: machine swaging, mechanical terminals, and hand crimping.

In machine swaging, the cable is inserted into the terminal (stud) and a hydraulic press squeezes the living daylights out of the assembly, forming a nice tight bond between the terminal and the cable. The surface of the terminal is left smooth and shiny but smaller in diameter. This is not a do-it-yourself option. You have to buy the completed swaged lifelines from a rigging dealer. A well-known marine retailer quoted a price of $700 for the four lifelines (without gates).

Several manufacturers, such as Sta-Lock, offer mechanical fasteners you assemble using wrenches after you unravel the end of the cable and insert a metal cone (see "Where There is no Rigger," September 2011). You have to assemble these terminals after passing the cable through the stanchions. This is the most expensive option.

Hand crimping uses a special hand tool to pinch the terminal against the cable in a series of indentations about ⅛ inch apart. This is the least expensive option. Being a die-hard do-it-yourselfer, I chose hand crimping.

Measure once, but order extra

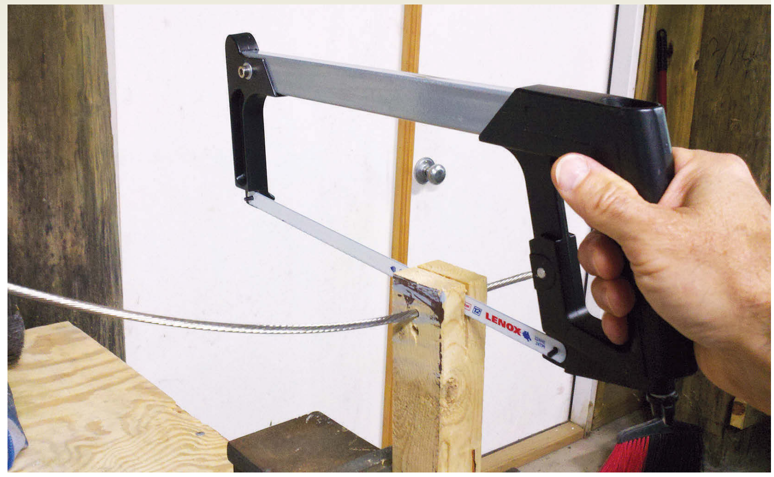
While the old lifelines were still in place on the boat, I measured each one from the tip of one terminal to the tip of the terminal on the other end by pinching a tape measure against the lifeline every foot or so as I shuffled my hands along the cable. Since I was just looking for an estimate of how much new cable I needed, I didn't bother to subtract the length of the threads of both terminals. I didn't see any point in trying to cut it too close just to save a buck.

Since studs are not reusable, I needed two for each of the four new lines. My new pelican hooks came with their own studs, so I ordered only four new studs along with the cable and crimping tool. The studs for hand crimping differ from those used for machine swaging; I had to be sure to order the right ones. When the parts arrived, I removed the old lifelines and labeled each one, e.g., "port upper," so I could match them to their new counterparts when measuring the new cable for length. This would be particularly helpful if I had different fittings for different lifelines, but in my case everything was symmetrical.

Tools and techniques

To hand crimp lifelines, I needed a few common tools and one I didn't have: a hand crimper for stainless steel. The manufacturer made it abundantly clear that crimpers for other materials, such as aluminum or copper, simply won't work. Stainless steel is very hard to crimp and requires a tool built specifically for that purpose.

C. S. Johnson makes a lever-type model and a bolt-type model. I chose the bolt-type hand crimper (part number 53-210) that runs about $50. I used a ½-inch socket wrench to tighten the bolts. The crimping tool has an opening for ⅛-inch terminals and one for 3⁄16-inch terminals. It comes with the bolts straddling the 3⁄16-inch side. To crimp ⅛-inch terminals, you will



Each terminal requires five crimps, above. The jig made sawing the cable easy, at right, and the result was a clean square cut.

need to move the outside bolt to the other side.

I could have bought a special tool for cutting the cable. Instead, I used an ordinary hacksaw. A bolt cutter will not work. (Don't ask me how I know.)

Sawing stainless-steel cable presents a couple of challenges. The first is that the sawed ends tend to fray just like a rope cut with a dull knife. The individual wires bend and don't spring back and the frayed ends that result don't fit well into tight-fitting terminals. The second problem is that the cable flexes back and forth as you try to saw it, making it difficult to cut it cleanly.

People typically suggest wrapping electrician's tape around the cable where it is to be cut. This will reduce, but not eliminate, fraying but does absolutely nothing to keep the cable from bending and rolling as it's being sawn. I couldn't figure out how to put the cable in a vice or clamp it down close enough to the cut on both sides to hold it firmly, so I made a simple jig that solved both problems.

I found a piece of wood about 2 x 2 x 6 inches and drilled a 7/32-inch hole all the way through one of the shorter dimensions about 1 inch from the end and centered. I wanted the hole slightly larger than the 3/16-inch cable so it would allow the cable to slide through easily but hold it tightly once it was inside. I stood the block in the vise with the hole parallel to a long wall so I'd have plenty of room to stretch out the cable. Using an ordinary hacksaw, I made a cut perpendicular to the hole and deep enough to pass through the hole.

The hole in the jig holds both sides of the cable firmly so they don't move or fray while the pre-cut slot, or kerf, guides the hacksaw as it does its work. The jig doubles as an extra pair of hands to tame the cable, which is inclined to coil up. (***Note:*** *While it is possible to cut stranded wire with a hacksaw, another way is to use a Dremel or other rotary tool with a cutoff wheel. Tape the wire and cut through the tape. The cut will be clean, with no burrs or distortion to the strands.* ***–Eds.***)

I used a handsaw and drill to make the sawing jig. A vise or clamp is essential for holding the crimping tool and the sawing jig.

Rather than cutting all the lengths of cable at once, I found it easier to work on each lifeline one at time. That way I didn't have unruly pieces of cable getting in my way while I was crimping on the terminals. As insurance against a measurement error, I started with one of the longer lifelines so, if I cut the cable too short, I could turn it into one of the shorter lifelines.

Crimp, measure, cut, crimp

My basic procedure was to crimp on a terminal, mark the new cable for length, saw it, and crimp on the other terminal. A friend told me to lubricate the bolt threads of the hand crimper to make it easier to tighten and loosen the bolts. This was helpful advice, since I had a lot of cranking to do on those bolts.

First, I passed a couple of feet of cable through the jig and set the jig aside. Then I put the lower (smaller) jaw of the hand crimper in the vise with the upper jaw (with the handle and the bolt heads) on top and free to move up and down. I loosened the bolts enough to accommodate the stud terminal, inserted the terminal from the back until it was flush with the front side of the tool, and gently tightened the bolts with my fingers until it held the terminal in place. I then inserted the cable into the terminal as far as it would go and held it in place with one hand while tightening the bolts with the socket wrench. Switching back and forth between the bolts, I tightened each one about a half a turn.

How tight is tight enough? I read about one guy who wanted to make sure the crimps would really hold so he just kept tightening the bolts. He ended up stripping the threads and the manufacturer had to send him a new tool. The rule is to stop tightening the bolts when you can't see a gap between the jaws of the tool. The crimp can't get any tighter than when the jaws touch.

After making the first crimp, I loosened both bolts, again alternating between them, enough to slip the terminal out a little more, so the back edge of the crimp I had just made was even with the front side of the tool, and finger-tightened the bolts to hold it. As I started tightening the bolts on the second crimp, I tried to hold the cable perpendicular to the crimp tool so the crimps would be straight and parallel.

After crimping the terminal the recommended five times, I removed the completed terminal from the crimper tool and removed the crimper tool from the vise. With the cable still through the hole, I put the sawing jig back in the vise.

To determine where to cut the new cable, I pulled it through the jig for the approximate length of the lifeline I was

Resources

Lifeline components
C. S. Johnson
www.csjohnson.com
Use the Marine Dealer search tab to find retail outlets.

> “Normally, the carpenter’s adage to “measure twice and cut once” is good advice . . . I measured four times.”

replacing. With the end of the new terminal matched up with the end of the terminal on the old lifeline, I taped the ends together. I used the pinch-and-shuffle method to keep the cables parallel until I reached the end of the old lifeline.

Normally, the carpenter’s adage to “measure twice and cut once” is good advice, but in this case, due to a minor bout of paranoia, I measured four times. Holding the end of the new terminal even with the end of the old terminal — the old and new terminals were different lengths — I used a Sharpie pen to mark where the cable would end inside the new terminal.

Since the cutting mark would be hidden inside the sawing jig, I needed another reference mark. The cutting slot in my jig was ¾ inch from the edge, so I made a large mark on the cable ¾ inch from where I actually wanted to cut it. Aligning this mark with the edge of the jig put the cutting mark directly in the kerf for the hacksaw.

Several light strokes of the hacksaw made a clean cut through the cable. After pulling the cut piece out of the jig and to prepare for the next one, I shoved another couple of feet of new cable through the jig before removing the jig from the vise.

I put the crimping tool back in the vise and crimped the terminal for the pelican hook on the end of the cable I had just cut to length. I loosely coiled the completed lifeline and marked it as an upper lifeline.

I followed the same procedure for the other lifelines. Each took about an hour to complete. My concentration and vision tended to falter after a couple of hours, so I took a break each time I finished two lifelines. I didn’t want to zone out and start crimping with the cable only halfway in the terminal or make shallow crimps because I didn’t feel like bending over to see if the jaws were touching.

I threaded the completed lifelines through the stanchions and screwed on the fittings. The old lifelines couldn’t be tightened all the way because the studs had been screwed unevenly into the turnbuckle bodies and one stud would hit the center post of a turnbuckle while the other was only partway in. Not wanting to make the same mistake, I detached each turnbuckle from the boat so I could thread the body evenly onto both studs before reattaching the turnbuckle to the boat. By holding the cable terminal while tightening the turnbuckle, I was able to prevent the cable from twisting.

The bottom line

The new “gateless” lifelines look great and function better with the new pelican hooks. The uncoated cables permit easy inspection and promote worry-free sailing. Hand crimping the lifelines was about half the cost ($380) of sending them out to be machine swaged and twice as rewarding. I might even recover some of the cost of the crimping tool by posting it for sale on a certain well-known auction site.

Part of the joy in owning a good old boat is fixing it yourself and making it a better old boat. Whether repairing something broken, improving the boat’s seaworthiness, or enhancing safety, doing the work yourself brings a great sense of accomplishment. Achieving all three in one project is a good old boat grand slam.

Gary Pardun and his wife, Carol, after 10 years of the pleasures of fickle-wind lake sailing, now navigate the tidal waters near Beaufort, South Carolina. Since Carol is at heart a “big boat” girl, they have also enjoyed chartering in the Mediterranean around Italy and Greece. Their boat provides plenty of opportunities for Gary to meet his goal in life: “Make everything better.”

BY ART HALL

Watertight chainplates

A long-term problem cured

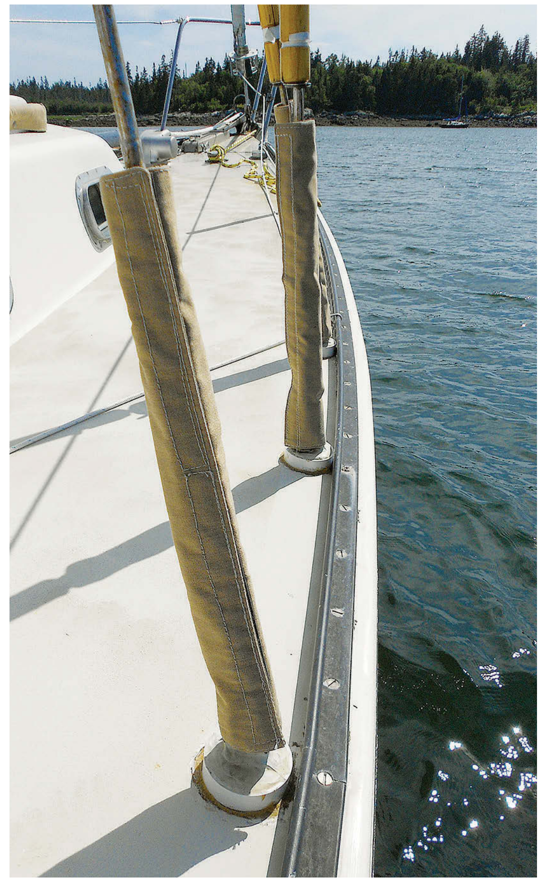
Secret Water is an aging and much-loved 1965 Allied Seabreeze 35. During my stint as owner (1996 until present), she has had her share of annoying deck leaks, mostly minor in nature. I've managed to stem the ingress of water everywhere except around the chainplates. After many years of struggling with this problem, it was time to come up with a fix once and for all.

Leaks at chainplates are not only a nuisance, they are dangerously destructive. Many boat sales have been rejected after a competent marine surveyor appraised the chainplates. Salt water entering next to and remaining in contact with the stainless steel can lead to crevice corrosion and eventual failure. This puts the rig and the safety of the crew in jeopardy, to say nothing of water-damaged bulkheads and interior cabinets, along with sodden bedding, books, and food stores. Except as garnish for a late-afternoon margarita, salt on the rim of the glassware is not welcome!

Secret Water's construction is pretty typical. Chainplates made of stainless-steel flat bar pass through the deck and are bolted below to bulkheads or gussets. Fortunately, Allied Boat Company had the foresight to build with a generous deck flange, so the chainplates, which are well outboard, do not pass through balsa core. I'd tried sealing them with all the usual products with varying degrees of success. But sooner or later I would detect a drip (or worse, a puddle) indicating that, once again, I had lost the battle.

It was time to get creative. Once more, I removed the chainplates from the boat. This allowed me to inspect them properly and really clean up the remains of past sealants that had failed.

The Sunbrella turnbuckle cover hides some of Art's chainplate mod, upper photo on facing page. His technique for thwarting leaks was to wrap the chainplate with heat-shrink tubing and fill a PVC-pipe dam with sealant, lower photo. His chainplates, at right are high — and dry.



Coffer dams

My newest approach was to place a "perimeter collar" around the deck opening. Cutting a 2-inch PVC pipe coupling in half gave me a collar about ¾ inch high. While keeping the chainplate centered, I epoxied the collar to the deck. This has the obvious advantage of ensuring any standing water is below the sealed joint. It also makes a large cavity to fill with sealant to obtain more contact with the chainplate.

Now for the really innovative part of my approach. I'm convinced past failures can be attributed to the sealant not bonding well to the stainless steel. This time, I encapsulated the chainplate, in the appropriate region, with heavy-wall heat-shrink tubing. I used the type that's lined with heat-sensitive adhesive — the material the electrical tradespeople use to ensure a weather-tight seal for cables. Using a heat gun (a hair dryer isn't up to this job), I shrank the material onto the chainplate until I could see the adhesive ooze out both ends. No way will water migrate down along the metal.

The trick now was to find a sealant that would bond to the heat-shrink tubing, the PVC, and the gelcoat deck. I experimented with several of the popular marine brands with limited success. Then I discovered the heat-shrink tubing is made of polyolefin, a plastic that is notoriously resistant to adhesives.

I found the answer in Bond & Fill Flex PVC joint adhesive. This is used in the building trades for installing PVC exterior trim and is available in lumberyards for about $10 a tube. I filled the dam with the sealant and it cured in about 24 hours. After two years of service, the material has remained as flexible as the day it cured. It claims to be highly resistant to UV and I anticipate a long service life.

The chainplates have remained bone dry. Not a drop has entered the boat. The only downside is the somewhat less than "proper yacht" appearance on deck. But sometimes form follows function. It seems a small price to pay for a dry interior. My talented wife created Sunbrella turnbuckle covers that do an adequate job of concealing the deck collars.

Art and ***Sandy Hall*** *and their not-so-inclined-to-sail Pekingese, Kitri, can be found sailing their Allied Seabreeze 35,* Secret Water, *on Penobscot Bay, Maine. Occasionally they'll push way Down East for some solitude. A significant enjoyment while cruising is exploring "eel ruts" in their Peapod dinghy that is set up with two rowing stations.*

Resources

Heat-shrink tubing sources:
www.mcmaster.com
Local electrical supply company

Bond & Fill Flex sources:
www.bondfill.com
Local lumberyard

Lifeline security

Make inspection and maintenance your watchwords

BY FRANK LANIER

During the golden age of sail, old salts greeted new crewmembers with the advice, "One hand for the ship and one hand for yourself." One trip to the yardarm during a howling gale to reef a flapping mass of wet, frozen canvas was all it took to validate this bit of wisdom. As Ol' Jack Tar was often forced to hold on with his eyelids while manning the decks or working aloft, it's little wonder a right good tar was said to possess a hand with "every hair a rope yarn, every finger a fishhook."

Today's sailor has it better with regard to staying on board but still has to contend with rough seas, wet decks, and bad weather. Modern safety gear — PLBs, handheld VHF radios, and personal flares — make it easier to find crewmembers once they're overboard, but it's the old-school stuff — harnesses, jacklines, and lifelines — that keeps them on board in the first place. Of this fundamental safety gear, none plays a more vital role than a vessel's lifelines. It's important to keep your lifelines ready, willing, and able.

Lifelines "just don't get no respect." Their condition and upkeep can be a matter of life and death, yet they're often burdened with numerous unrelated tasks and used as clotheslines and all-purpose tie-down anchor points for fenders and lines. They serve as impromptu grab holds when boarding, fending off, or coming alongside. Even sailors who are aware of the role lifelines play in keeping them on board while under way often fail to realize their value at the dock (where vigilance is more relaxed) or while the vessel is hauled out, where a failure can result in a long fall and a hard landing.

The system as a whole

Mention lifelines and most sailors think of the wire running along the perimeter of a vessel's deck, but that's only half the story. In addition to lifeline wire and its associated hardware (pins, shackles, swages, and so on), it's imperative to view the role played by stanchions, bow pulpits, and stern rails.

Stanchions keep lifeline wires at the correct height, provide rigidity to

A bent toggle bolt, at top, will prevent the lifeline from being tightened and is a potential point of failure. Any damaged hardware item, such as this broken stanchion mounting bolt, at left, should be replaced immediately. Stern rails are often burdened with solar panels, outboard engines, wind generators, davits, barbecues, and man-overboard poles that make inspecting them difficult and add stress to the lifeline system, at right.

the system, and help absorb the initial impact of a potential crew-overboard situation. Bow pulpits and stern rails are able to absorb the force of a flying body and they add strength to their associated stanchions.

Lifelines are commonly constructed of 300 series 7 x 7, 7 x 19, or 1 x 19 stainless-steel wire rope, but high-tech, low-stretch synthetic rope is increasingly being used. The first decision one faces with wire is whether to use vinyl-coated or bare wire.

Coated wire looks nice and is easier on sails. Because it's slightly thicker, it is also easier on hands. When the coating is worn or damaged, however, it can trap water that wicks along the wire and accelerates corrosion. As this corrosion is often beneath the coating, it remains undiscovered until a failure occurs. For this reason, vinyl-coated wire is not recommended and is actually prohibited by many offshore racing organizations.

Uncoated wire lifelines allow you to visually inspect their condition at all times. As the diameter of uncoated wire is smaller than the same-sized coated wire, you can enhance safety by increasing the wire size. In a pinch, larger diameter lifeline wires can even be used to fabricate emergency stays and shrouds. (*See Don Casey's argument for uncoated lifelines, November 2009. –Eds.*)

For coated wire, the general recommendation is that lifelines be replaced every five years, regardless of how good they look. Inspect the plastic coating regularly for damage due to chafe or cracking from UV exposure or old age. Pay particular attention to the ends (often the first place corrosion occurs as the coating has to be cut back to install terminal fittings) and never tape over damaged spots that can trap water, as that makes matters even worse.

> "... rope has the added attractions that it's lighter and doesn't corrode."

Rope lifelines

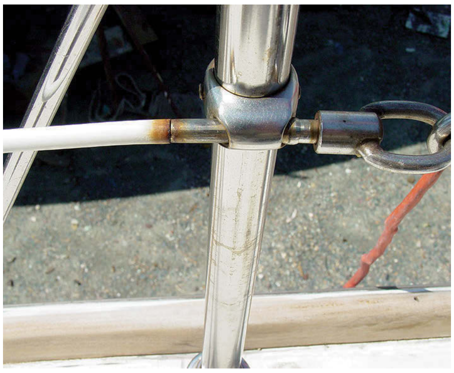
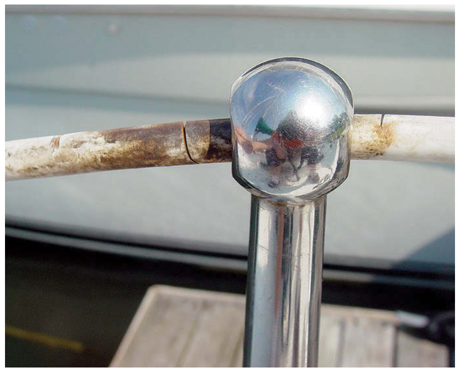
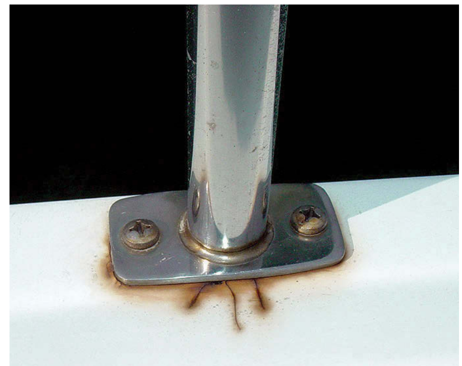
The use of Spectra, Dyneema, and other high-tech, low-stretch rope in lieu of wire has become increasingly popular. *(See David Lynn's report on installing Dyneema lifelines, March 2013. –Eds)* The cost of rope is similar to that of stainless-steel wire, and rope has the added attractions that it's lighter and doesn't corrode. The disadvantages of rope lifelines are a greater susceptibility to chafe and UV damage that is more difficult to detect than wire corrosion. As a result, rope lifelines should probably be replaced more frequently than bare stainless-steel lifelines.

Inspecting lifelines

Lifelines epitomize the expression "as strong as its weakest link," as failure of just one component can lead to someone taking an unplanned swim. When inspecting lifelines, take your time and be thorough:

- Make sure all clevis pins are pinned and all turnbuckle barrels are properly secured with turnbuckle nuts (and pins if possible).
- Clean and polish fittings, swages, and other hardware, then inspect each with a magnifying glass for stress cracks and corrosion.
- Inspect vinyl-coated wire closely for damaged coating and signs of rust.

A stress crack and some corrosion are visible at the base of the lifeline-attachment eye where it's welded to the pulpit, at left. Also, the cotter pin looks loose and could fall out if the clevis pin it's securing rotates over time due to vibration. Where a vinyl-coated lifeline passes through a stanchion, the coating can chafe away, at right, creating a path for water to enter the wire and initiate corrosion.

Even when a vinyl coating is undamaged, water can wick between it and the terminal fitting and penetrate the wire, at left . A vinyl coating can crack due to age, especially at a stress point, such as this stanchion, at center, allowing moisture to enter and corrosion to begin. The "running rust" stain extending from beneath this stanchion base, at right is a sure sign the mounting hardware (or the stanchion itself) is corroding. It might also indicate that water has penetrated the deck laminate. The stress cracks in the gelcoat are another sign of trouble.

Replace the wire if you see chafe, cracking, or wear on the coating.

- To check uncoated wire for broken strands, take a handful of tissue paper, encircle the wire and lightly drag the tissue paper its entire length. Broken stands or "meathooks" will snag the paper. Don't hold the paper too tightly or they may snag a little meat as well.
- Remove all lifelines annually and inspect them for kinks, wear, damage, or corrosion, paying particular attention to the wire at end fittings and where it passes through stanchions.
- If you use end lashings (a multi-purchase lanyard of small-diameter low-stretch line) rather than turnbuckles to attach and tension the lifelines to bow pulpit or stern rail, replace them annually. Lashings should be no more than 4 inches in length (with lifelines fully tensioned) and as strong as the wire they attach. Line strength is reduced at each bend of the line around a lifeline terminal eye and the corresponding pulpit attachment point. When calculating lashing strength, throw in a couple of extra turns for an additional safety margin. Some sailors use lashings so they can cut them to quickly lower the lifelines should they ever need to retrieve a crewmember who has fallen overboard.
- Check all lifeline hardware (gates, turnbuckles, and so on) to ensure that each is in good condition and adequately sized. It's also a good idea to tape pelican hooks and similar gate hardware closed to prevent accidental opening.
- Verify the height of your upper and lower lifelines. The American Boat and Yacht Council (ABYC) recommends a minimum stanchion and top lifeline height of 24 inches, although heights of 36 to 42 inches are preferred. The recommended maximum height for lower lifelines is 9 inches above the deck. This is intended to keep an adult from rolling beneath the lifelines (consider fitting netting if there are children or pets on board). Rigging temporary chest-high lifelines of low-stretch line is also a good idea when heading offshore.
- Lifelines should be tight, but not to the point of bending stanchions or deforming the pulpit or stern rail. If, by using the muscles of your arm only, you can deflect a lifeline more than 2 inches by pressing down with your thumb at mid-span between two stanchions, it's probably too loose and should be adjusted.

Stanchions

The condition of any single stanchion may not seem significant, but as each provides strength to the system as a whole, all must be maintained in top condition. Put off replacing that bent stanchion now and it may fail completely if it's heavily loaded, such as when a crewmember falls against the lifelines in heavy weather.

Stanchion bases must be strongly constructed and through-bolted to the deck with properly sized hardware and backing plates. In some cases, the stanchion and base is a one-piece unit; in others, the stanchion slides into a socket in the base and is held in place with a setscrew or machine screw.

The best setup has the stanchion secured with a transverse bolt that passes through both stanchion and base with an additional setscrew to tighten the stanchion in the socket itself. Through-bolts (with locknuts or lock washers) or machine screws are preferable to Allen screws. If Allen screws are used, there should be at least two, with both threaded through the base and set into dimples in the stanchion.

An easy safety upgrade is to replace the lower setscrew with a machine screw. Drill a hole in the stanchion slightly larger than the screw (so it threads through one side of the stanchion) and use a lock washer to secure it in place.

Stanchion inspection

- Release the tension on lifeline wires and give each stanchion a good wiggle. If loose, determine if the cause is a sloppy stanchion-to-base fit (possibly due to a loose setscrew) or flex in the deck itself. Slight play due to the former is acceptable, but flexing due to a weak deck is a different story and must be addressed. Verify that the mounting hardware and backing plates for each stanchion base are of adequate size and strength. Backing plates should be two to three times larger than the stanchion base and constructed of $\frac{1}{8}$-inch stainless steel or aluminum. Fiberglass or other composites (StarBoard, for example) should be between $\frac{3}{16}$ to $\frac{1}{4}$ inch thick.

- Gelcoat cracks around stanchion bases (often an indication of point loading or thin, poorly reinforced decks) should be inspected thoroughly, even if seemingly cosmetic in nature. Installing larger backing plates or top plates can help reduce point loading by distributing stanchion base loads over a larger area.
- Inspect stanchions and their bases for bends, cracks, broken welds, looseness, and corrosion. Bent stanchions, as well as fractures in the stanchion or its base, are often the result of passengers or crew using stanchions to hoist themselves on board, but fractures can also occur if water enters the base socket and freezes.
- Combining dissimilar metallic components (a stainless-steel stanchion coupled with an aluminum base, for example) promotes corrosion and one or the other should be replaced.
- Tighten stanchion screws and all base-mounting bolts and hardware regularly, and replace any that are stripped or damaged.

Bow pulpits and stern rails

Sailors have an uncanny knack for finding a gadget or doohickey to occupy almost every bit of available space. As a result, stern rails (whose primary job is anchoring the lifelines) are often burdened with solar panels, outboard engines, wind generators, davits, barbecues, man-overboard poles, and more.

It's almost impossible for designers to factor in the additional loads imposed by these aftermarket add-ons, but they can degrade the entire lifeline system. The best way to maintain structural integrity is to install arches, davits, and equipment independently of the lifeline system. If a stern pulpit is used as a mounting platform, additional supports may be needed. In some cases, the best solution may be to fabricate a new stern rail of larger-diameter tubing, with larger base supports or stiffening struts.

If any part of your lifeline system seems inadequate or fails to meet generally recognized standards, don't hesitate to upgrade it — just make sure those retrofits are properly engineered and robust enough to get the job done.

Pulpit and stern rail inspection

Many of the inspection points for stanchions apply to pulpits and stern rails as well.

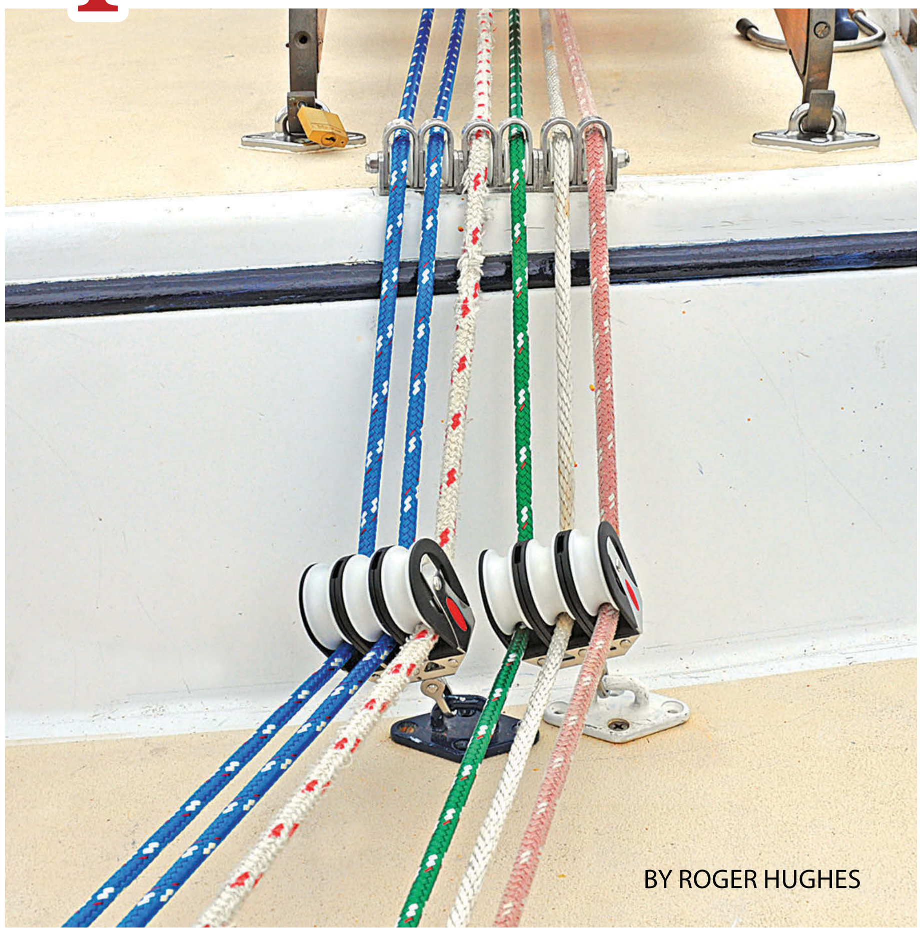
- Check that each base is properly through-bolted and verify the presence of properly sized backing plates.
- Ensure that all mounting hardware is in good condition, tight, and secured with lock washers or Nyloc nuts.
- Unlike stanchions, bow pulpits and stern rails typically use welded bases rather than retaining hardware. This means you don't have to worry about loose through-bolts or setscrews. However, you will need to check all the welds closely for hairline cracks and corrosion.
- Inspect all lifeline attachment points (welded eyes and so on) for distortion, corrosion, and cracked welds. Clean and polish welds and hardware and inspect them for cracks with a magnifying glass.

Your lifeline system is one of your vessel's most aptly named components. Life jackets, harnesses, and tethers are one line of defense, but nothing matches the 24/7 security blanket provided by a lifeline system — as long as it's well-designed and properly installed and maintained. The time to make sure your system is up to the task is before it's needed.

Frank Lanier is an accredited marine surveyor with more than 30 years of experience in the marine and diving industry. He has captained and maintained vessels from dive boats to passenger ferries in the Atlantic, Caribbean, and South Pacific. He's also an avid writer, public speaker, and award-winning journalist whose articles appear regularly in marine publications worldwide. Frank sails his good old boat, Melelu, *a 1978 Union 36, on Chesapeake Bay, although she's currently in Marsh Harbour, Abaco, Bahamas. Find him at www.captfklanier.com.*

Over-the-top blocks . . .

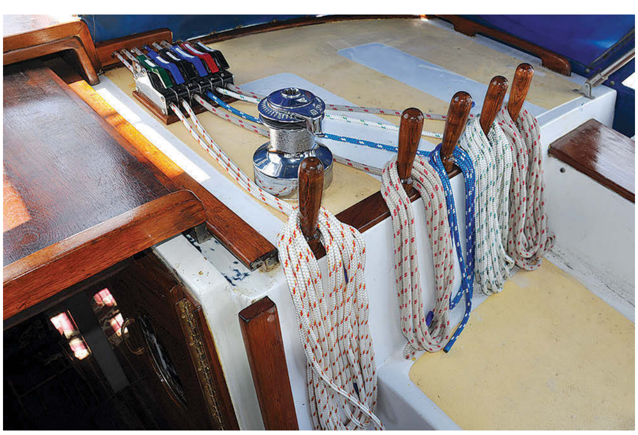
. . . solve line-leading issues on a multilevel deck



BY ROGER HUGHES

Even in our younger days, my wife and I tried to make living and working aboard our cruising boats as easy as possible. This is even more important as we grow older. To make sail handling easier on our Down East 45 brigantine schooner, *Britannia*, I changed all five sails to roller furling. I also wanted to route all the control lines — furling lines, sheets, and outhauls — to our center cockpit so we wouldn't have to go forward to furl or reef in inclement weather or rough seas. This resulted in 12 lines passing along the deck into the cockpit, in two rows of six, not counting the five sheets that route to cockpit winches in the normal way.

By any standard, that's a lot of lines, but I knew how I would handle them once the lines arrived in the cockpit. I made wooden fairleads to guide them through the dodger to two banks of rope clutches with six rope clutches in each. I bought clutches with color-coded levers from Garhauer Marine and taped the names of the lines on the individual clutch levers. The lines pass into the cockpit on either side of the companionway where it's easy to reach and operate the clutches. Then they feed to two Lewmar 30 self-tailing winches and are coiled around a row of belaying pins to prevent tangles. This is now called "the rope deck."



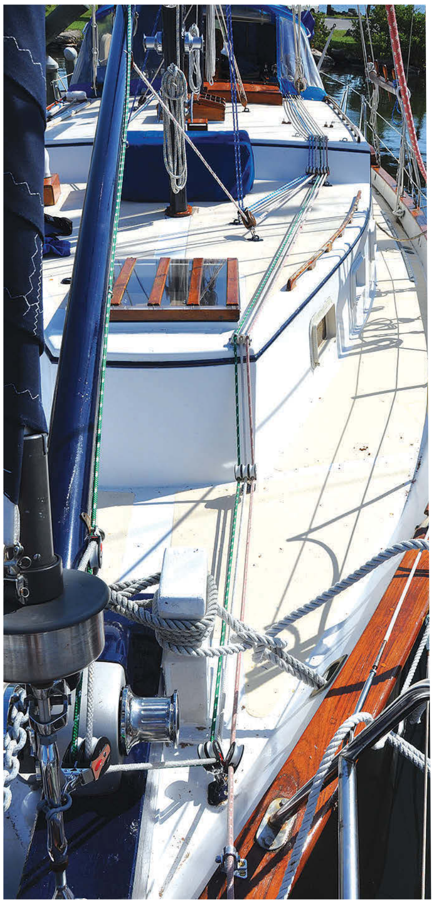
Six lines lead through fairleads to rope clutches and a winch on the starboard-side rope deck, where a pinrail keeps them tidy.

None of this was difficult to plan, and the fairleads, clutches, winches, and pinrails were not difficult to make and install, but one significant problem remained. The Down East 45 has three deck levels: the foredeck, the forward coachroof deck, and the saloon coachroof deck. To reach the cockpit, lines had to be brought up from one level to the next. The jib and forestaysail furling lines and the staysail outhaul were the longest. These had to lead down to the foredeck then over both coachroof levels to the cockpit.

Up and over

Bringing lines down from aloft and along a deck is easily done using blocks anchored to the deck along with line organizers. But routing lines up and over the edge of a coachroof requires what is commonly called an "over-the-top block."

Over-the-top blocks are available from a few suppliers, including Garhauer and West Marine, for about $55 for a single sheave and $85 for a double. Nobody seems to make more



The deck on the Down East 45 has three levels: the foredeck, forward coachroof, and saloon coachroof, at left, presenting an obstacle course for running rigging that needs to be led aft to the cockpit. On the port side, three lines lead up from the foredeck onto the forward coachroof, where they meet three more lines and go up and over the saloon coachroof, on facing page. Despite the many direction changes, the lines run smoothly through Roger's over-the-top blocks.

than a double-sheave combination and if you have 12 lines, that works out to be an expensive exercise.

In any case, all the over-the-top blocks I could find used sheaves with diameters of 2 inches or larger. This results in the lines running about 3 inches clear of the deck and the very serious possibility of someone (me!) tripping over them. I wanted my lines as close to the deck as possible. I tried using bulls-eye fairleads with stainless-steel inserts. These are about $6 each but are only intended to deflect lines through small angles. They're often used to route roller-furling lines from one lifeline stanchion to the next. Still, I decided to give them a try and screwed six to my deck, but the nearly 90-degree up-and-over angle resulted in a lot of friction with a good chance of rapid chafe, especially for those lines that must rise up two deck levels.

Then I discovered that Ronstan made an acetal sheave only 1³⁄₃₂ inch in diameter, yet wide enough to handle up to a ½-inch line, for $3.95 (part number RF128). As three of my lines are ½ inch and the rest are ⅜ inch, this small sheave would work with all my lines.

I decided to make my own over-the-top blocks. They are very simple in design. The sheaves are held in a short length of channel and arches over the sheaves prevent slack lines from jumping off.

Tools and material

I made my over-the-top blocks by hand, using hand tools that most do-it-yourself boaters probably have. It's not rocket science, but some of the operations do require careful measurement and accurate drilling. It was not difficult to do this, and it's gratifying to see the finished product working so well on my boat, especially considering the cost savings over commercial over-the-top blocks.

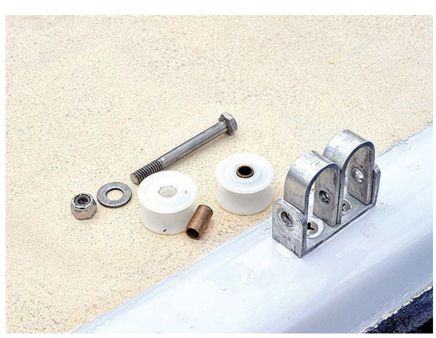
The tools I used were a caliper gauge for accurate measuring, a sharp scribe for marking, a strong vise with aluminum soft jaws, three Vise-Grips, and a ⅝-inch-diameter mandrel that I bent the strips around to form the arches. (In my box of ½-inch sockets, I found a socket that was exactly ⅝ inch diameter, but any ⅝-inch round stock would work.)

Using a drill press beats trying to drill holes accurately by hand. The more precise the marking and drilling, the better chance the sheaves will turn smoothly. It's therefore worth investing in a new sharp ¼-inch drill bit, preferably the type with a pilot point. These drills are easier to center by eye and they leave an almost burr-free exit hole. A countersink bit is another important tool for this work, and a deburring tool and a file are essential for cleaning up raw edges after drilling and sawing.

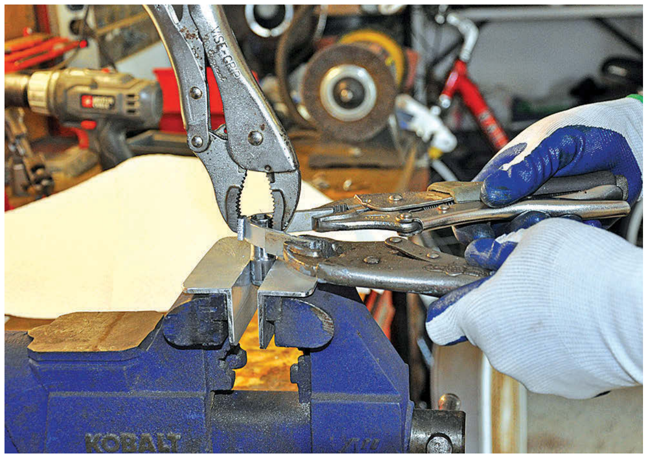
I would have preferred to have made the blocks of stainless steel, but cutting and accurately bending and drilling even ⅛-inch stainless steel was beyond my capability with the equipment I have. Instead, I used aluminum, and it proved quite satisfactory.

I made the bottom channels from a 12-inch length of ⅛-inch aluminum channel that's 2 inches wide and has 1-inch-high sides. I made the line-retaining arches from a 48-inch length of ½-inch x ⅛-inch aluminum strip I obtained from my local aluminum supply shop for $15. I needed one row of six sheaves, a row of three, one of two, and a single, but most sailboats won't need that many and would therefore require less material.

Aluminum can be hand-sawn easily with a hacksaw blade with 24 teeth per inch, but I also used a miter saw with a 10-inch-diameter 60-tooth carbide-tipped blade that cuts through aluminum like butter and leaves a very straight clean cut.



A two-sheave block illustrates the components Roger used for his over-the-top blocks, at left. He bolted the channel to the turn of the coachroof, then assembled the parts, at right.



To make the arches, Roger clamped the aluminum strip to a ⅝-inch mandrel and bent it with Vise-Grips.

Making the bottom channels

The channel was wide enough to hold two sheaves and their arches. I needed five of these two-sheave blocks, so I cut five 1-inch-wide pieces of channel to form their bases.

Accuracy when drilling the holes in the uprights, or legs, of the channel for the axle was critical. It might be possible to use a hand-held electric drill, but it was much easier and more accurate with a drill press. I marked both legs of the channel ¾ inch from the bottom outside of the leg and centered. I drilled a ¼-inch hole at these marks from both sides of the legs. This hole position allows the sheaves to rotate clear of the bottom of the channel by 1⁄16 inch, so the lines exit the tops of the sheaves at the very lowest point, about 1 inch off the deck.

Next, I drilled and countersunk two ¼-inch holes in the bottom of the channel on the centerline and ⅝ inch in from each side. These were for the attachment screws beneath the sheaves. As a final finish to the channels, I rounded the square sharp corners of the legs with a flat file.

Line-retaining arches

To form the arches, I cut the ½-inch aluminum strip into 5-inch lengths. This is longer than needed, but the extra length gave me leverage when bending them around the mandrel. I clamped the mandrel hard in the vise, marked the center of a strip, centered it on the socket, and clamped it to the socket with a Vise-Grip. This was to ensure that the aluminum strip would bend evenly around the mandrel in a perfect half circle — unclamped it would bow upward and not form correctly. I also cut some lengths of strip to clamp between the Vise-Grips and the material to prevent them from cutting into the aluminum and to keep the legs of the arches straight.

I then carefully pulled both legs around the mandrel. It was quite easy with Vise-Grips clamped to the legs to extend the leverage. I could only bend them so far before the Vise-Grips came together, after which point I squeezed the two sides further with just one Vise-Grip until they were parallel and formed a perfect arch. Then I sawed the legs of the arch off square, 1⅝ inch from the top of the arch. Using a round file and sandpaper, I rounded the top inside edges of the arches a little to prevent chafe on the line. A Dremel tool with a round sanding drum would also be good for this purpose.

Each arch was now ⅞ inch wide, so two were a perfect snug fit in the 1¾-inch inside width of the channel.

With both arches centered in the channel, I clamped the assembly in the vice and, with an electric drill, *carefully and dead level*, drilled either side of the arches through the hole in the channel leg. I then reversed the arches and, making sure they were centered in exactly the same position, re-clamped them in the vise and drilled through the other side. At this point, it was possible to push a 2½-inch-long ¼-inch bolt straight through the channel and both arches, pinning them together.

Here, I have a couple of tips for anyone making these blocks. First, don't be tempted to try to drill straight through both arches — it is very unlikely you will be level using a hand drill. If your measuring or drilling has not been accurate enough to make it possible to push a bolt through, ream the holes level by carefully running a ¼-inch drill through. I discovered some unevenness when assembling my row of three channels to make the six-sheave block, but I ran a ¼-inch drill through the whole lot and they worked perfectly when bolted together.

Sheaves and bushings

The Ronstan sheave has a 5⁄16-inch center hole and no ball or roller bearings. I therefore bought some small 5⁄16-inch bronze bushings from Ace Hardware for $3 each. Lowes and Home Depot also sell them. These fit perfectly inside the sheaves and reduce the hole diameter to ¼ inch. Unfortunately, they're only available in lengths of ¾ inch, so I had to carefully saw and file ⅛ inch off one end to make them ⅝ inch long to fit snugly inside the arches. The sheaves rotate on the bushings and the bushings rotate on the bolt, giving an almost friction-free roller-bearing surface for the sheaves. If a sheave didn't rotate completely freely, it meant the bushing had become distorted while being shortened or needed to be deburred.

Assembly and attachment

To fix the channels to my fiberglass deck, I used ¾-inch-long #12 flathead self-tapping screws that finished flush with the bottom of the channel in the countersunk hole. I screwed these directly into the deck and bedded them with 3M 4000 adhesive sealant. It did not seem necessary to bolt these blocks through the deck as you would for a deck eye, because when the lines are

Material costs

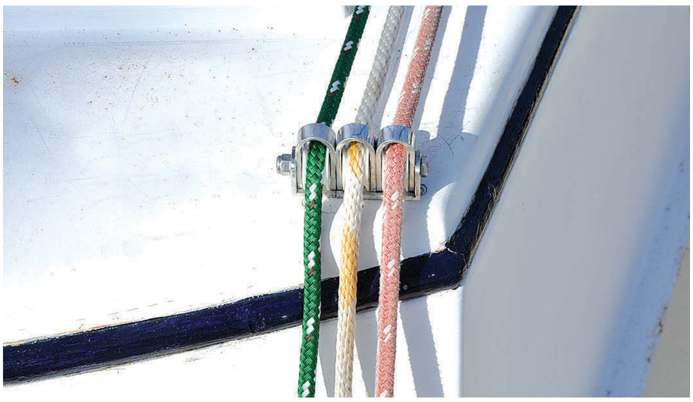
Aluminum:	$15
12 sheaves:	$48
12 bushings:	$36
4 bolts and nuts:	$12
12 deck fasteners:	$4
Total:	$115

Resources

Rope clutches: http://garhauermarine.com

Sheaves: www.ronstan.com/marine

Roger's basic unit fits two sheaves into one piece of aluminum channel, at left. Where he needed to run six lines over the top of the saloon coachroof, at right, he connected three two-sheave blocks with a single through-bolt as a common axle.



A three-sheave block carries the jib furling line, the staysail furling line, and the staysail outhaul over the top of the forward coachroof, at left. A single-sheave block, at right, routes the jib furling line to the deck. This is a one-off made in a slightly different way from the other blocks.

under load they press the assembly down to the deck, rather than pulling it upward. It was, of course, necessary to fix the channel to the deck before assembling the sheaves, then assemble the rest *in situ*.

Just before this final assembly, I put a dab of winch grease on the bolt and bushings, but not on the bushing-to-sheave surface. I positioned the sheaves and bushings inside their arches, pushed the arches into the channel, then passed the bolt through the whole lot and secured it with a thin washer and Nyloc nut. I found it best not to tighten the bolt too much but allow some play in the bearing surfaces so everything rolls freely.

Combinations

Joining three two-block assemblies to make a neat row of six was just a matter of passing a 6-inch bolt through all three assemblies. To make a multi-sheave combination, I found it was best to bolt them all together without the sheaves or arches, position them where I wanted them on the deck, mark the centers of the attachment holes, and then drill the holes for the fasteners.

I also needed a three-sheave block and a single-sheave block. To make the three-sheave block, I cut one leg off a channel, then made a corresponding half channel to butt against it. A 3½-inch bolt goes straight through all three sheaves, locking them together, then a fastener beneath each secures them to the deck.

The single sheave leads the jib furling line down to the foredeck so it can be routed up and over the forward coachroof and the saloon coachroof. This block was also made using half a channel, but it has a different shape so I could screw it to the toerail. I secured a small half channel with one of the screws to fix it to the toerail. A 1¼-inch bolt fastens the assembly together.

These combinations demonstrate the versatility of this method of making over-the-top blocks. There's no reason why the blocks could not be assembled in larger combinations as needed. To give them a really professional-looking finish, the individual pieces can be polished on a bench grinder with a large polishing wheel and a graphite applicator. The aluminum will shine up like chrome.

Practical and inexpensive

My over-the-top blocks work marvelously and with considerably less friction than the bullseye fairleads I tried in my first experiment. The lines look very neat running close to the deck, and there is much less risk of tripping over them.

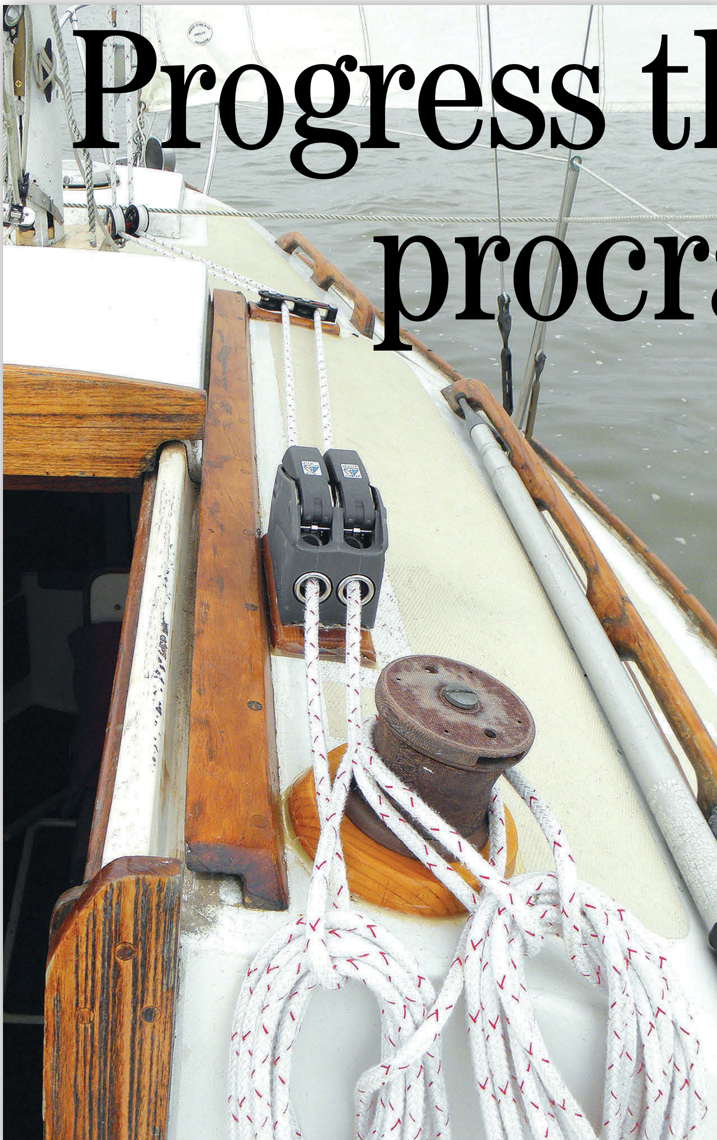
The total cost in materials was under $120 for 12 blocks, or about $10 for each control line. This is quite a savings compared to buying commercial units for about $500. This does not count my labor, of course, but on boats that's supposed to be a pleasure . . .

Roger Hughes has been sailing for nearly half a century as a professional skipper, charterer, restorer, and frequent imbiber aboard lots of boats, including square-riggers. His latest project is refurbishing a rundown Down East 45 and re-rigging it as a brigantine schooner with a beautiful unique roller-furling square sail on the foremast and a few other "inventions," like his over-the-top blocks and a hot tub in the owner's head. See more of the projects Roger has been doing at www.schooner-britannia.com.

Progress through procrastination

Fear of holes redirects energy in a refit

BY STEVE WEIN



I agonized for months over what to do. I really did have a choice. I could either do nothing, which in my now-established senior years means the situation would get worse, or I could "bite the bullet" and cut into it. I'm not referring to a looming medical condition. I'm talking about running my boat's halyards aft to the cockpit so I wouldn't have to run to the mast every time I needed to do something, an activity that was getting more dangerous for me as a singlehander.

The cabin of my 1970 Irwin 23, *ShaBoat Shalom*, was tight and leak-free. The mere thought of cutting holes in my cabintop to facilitate the installation of a winch, clutch, and blocks was creating anxiety to no end. After all, the best way to doom a fiberglass sailboat is to let water enter the core. Furthermore, I realized that, until I drilled the first hole, I wouldn't know the thickness of the cabintop and whether there was dead space between that and the headliner.

But once I drilled that first hole, I would be committed.

Even after I purchased the deck organizer and the clutch from West Marine and resurrected a used winch from a classic old boat, I was anxious. I stalled while creating mounting pads for it all in my workshop, temporarily putting it all together, and making trips to the boat to make adjustments. Once it all would theoretically work, I reached the point where it was time to suck it up and place the drill bit to the already marked spots on the cabintop and go for it.

A "rescue boat"

This was part of the seemingly continuous series of renovations I've been doing on my good old boat since I rescued her from "dead-boat row" at a nearby marina five years ago. I've painted her, replaced the lifelines, and totally rigged the mast and boom, both of which were stripped when I got her.

Steve eventually bit the bullet and installed his winch and clutches, but not until he'd procrastinated long enough to make much of the boat look like new.



Measure twice and cut once isn't enough for Steve. After marking where he thought the organizer, clutches, and winch should be fitted, at left, he finished other projects before making a final check, at center and at right, before finally drilling holes in the cabintop, below.

I then replaced the port and starboard bulkheads, which were suffering from rot, stained and varnished the embossed cabin sole to make it look like wood, and put ceiling along the cabin sides.

But this year's projects were going to be different. First of all, hanging on the wall of our home was the wooden boom from my old 1960 Schock 22 that is now a "fish condo." The boom was a beautiful honey maple color with ancient bronze fittings at either end. I thought it would look fabulous along with the rest of the wooden trim on *ShaBoat Shalom*.

That took some doing. I had to take a foot off the length. I thought that would be easy. Just cut and scarf. No big deal. Ha!

Project creep

As we who do projects realize from experience, there are simple truths we cannot ignore. Any estimate of cost and time should be multiplied by at least two to be more realistic. And once a project begins, all kinds of unanticipated hidden issues will pop up.

When I cut what I thought was a solid piece of wood, I quickly discovered that the boom was very hollow — four ¾-inch-thick sides around a very large air space. What to do? I ended up shaping a 2-foot length of wood to

insert into the space and epoxied the segments together. Once that was done, sanding and varnishing made the seam disappear. It looked as if it had never been shortened.

I ordered bronze C-track to fit the gooseneck and installed it on the mast, then brought the boom and the gooseneck to the boat to make sure it would all work. After checking the fit, I attached the gooseneck to the boom and installed it on the boat before launch. She looked great.

Before she could be splashed, I purchased everything I'd need to run the halyards aft, brought it all to the boat for some fitting tests, and marked the locations. But not knowing the construction and thickness of the cabintop and how much space was between that and the headliner caused continued anxiety.

More diversions

While trying to motivate myself to drill through the cabintop, I worked on other projects. The exterior wood trim needed to be stripped, sanded, and revarnished. After taping off the wood, I did still more fitting tests while trying to get my courage up to make that first hole. Chicken!

I procrastinated by adding non-skid to the deck using Interlux Interdeck paint. After 44 years, the original non-skid was losing its "non" and becoming more "skid." I taped it all off and painted a section at a time, starting at the bow and working my way aft. Once it dried, I noticed the difference right away.

At that point, with a big black sharpie, I outlined where the pads would go on the cabintop, then found a way to procrastinate once again by painting the hull, bootstripe, bottom, and cove stripe.

> "I put the mainsail on the boom and raised it using the new hardware . . . It worked like a charm!"

She was splashed in and I couldn't put it off any longer. It was either do it . . . or not do it and continue to run to the mast for everything.

Time to drill

With much trepidation, I put the bit in the drill, placed the bit on the cabintop, took a big breath, and slowly drilled into the fiberglass. The holes I drilled were much larger than the bolt size so I could strip out a bit of the core, fill it with epoxy to seal it, and finally drill the proper-sized holes.

I was surprised to find that most of the holes went through solid fiberglass, probably because I mounted everything right alongside the starboard companionway hatch guide and Irwin overbuilt the cabintop there for strength.

Once everything was drilled, I filled the holes with epoxy, then drilled again to the size of the bolts I used to mount the hardware. I test-fitted the bolts in the wood bases, the cabintop, and backing plates. Everything fit. I was ready to make it all permanent.

I sanded the areas, then permanently mounted the bases with thickened epoxy, taking care to line up all the bolt holes. After redrilling the bolt holes, I installed the clutch, deck organizer, and winch with liberal applications of 3M 5200.

I should admit that I almost made a fatal mistake. I first mounted the clutch wrong! Luckily, I have a tendency to check, then recheck, and recheck some more. Just before applying the 5200 and bolting it together, I ran some line through the clutch to be sure everything worked as expected. That's when I noticed I had placed it on the cabintop backward! I turned it around and mounted it properly.

I had to drop the mast to replace my wind indicator and run the new halyards through the sheaves. Then after raising it again, I put the mainsail on the boom and raised it using the new hardware for the first time. I then tried it with the jib. It worked like a charm! I popped the clutch free and they both dropped easily. All that was left to complete this project was to adjust the lazy-jacks, add the outhaul and slab reefing, and rig a downhaul for the hanked-on jib. Done!

Much yet to do

What next? I want to build a bowsprit or anchor platform to make anchoring less of a chore and stop the anchor from taking chunks out of my bow on the way up. I'd like to add tracks with cars to give me the ability to control the shape of my jib. I could use a traveler for the mainsheet. Another big project that fills me with trepidation is the creation of cockpit lockers. The Irwin 23 has no lockers in its 7-foot-long cockpit. There's a huge volume of unused space under the cockpit but I have no way to store stuff there and have quick access to it.

Maybe next year. Right now, it's time to go *sailing*!

Steve Wein began sailing in 1974. During his 25 years in Southwest Florida, he sailed the Florida Gulf Coast, the Keys, and the Bahamas. His radio career took him north to Cleveland, then Chicagoland, cruising Lake Erie, then Lake Michigan. Now living in metro St. Louis, he sails his Irwin 23, ShaBoat Shalom, *on Carlyle Lake, Illinois.*

All the deck woodwork received several coats of varnish while Steve worried about drilling holes, at left. Installed at last, above, the organizer and clutches handle the halyards for the mainsail and jib. Note the boom and gooseneck.

When halyard sheaves go bad

Make the switch from wire to rope

BY ED LOUCHARD

Not long ago a fellow named Sean brought his masthead sheaves to my shop. They were made from phenolic resin, known also as Micarta or Bakelite. One sheave was barely serviceable, the groove worn deep by the halyard wire and the bushing loose on its pin. The other was split and chipped with big chunks missing. Sean told me he couldn't find sheaves to fit his good old boat. Before long, out came the full story.

Sean was cruising alone in the Gulf Islands on the eastern coast of Vancouver Island in his Gulf 32. One day as he prepared to set out, hoisting the main seemed difficult, but he got it up and everything appeared to be fine. While cruising north, he encountered some weather and dodged into a small bay to lay over. He kept the main up while dropping anchor, then loosed the halyard to drop the sail. Nothing doing. Sean had recently installed a Strong Track with some matching slides to ease the effort of hauling the main up and down, so he knew his sail slides and track weren't the problem. He figured the problem must be aloft. He was able to hoist himself to the masthead using the jib halyard.

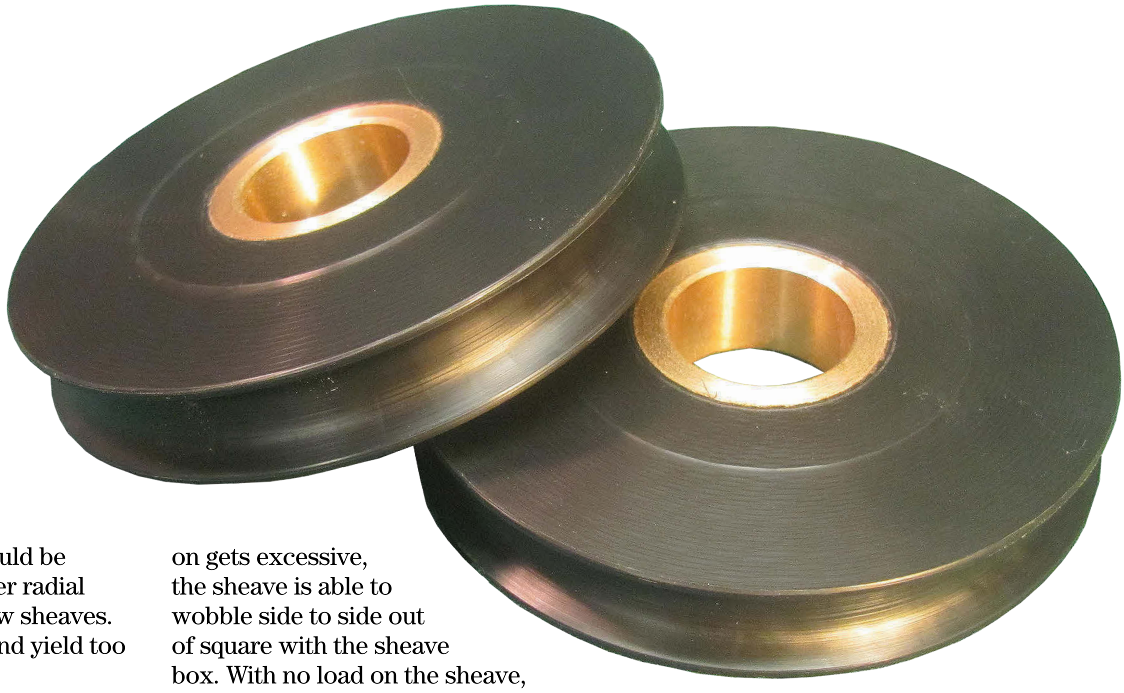
An exposed anchorage was not his location of choice to go aloft single-handed, but there he was nonetheless: main up, weather getting worse, and nothing else for it. At the top of the mast he found the wire halyard thoroughly jammed between the sheave and the wall of the sheave box. The wire had jumped the sheave and worked its way all the way down to the pin. It was not possible to get the wire out with the limited tools he had with him at the top of the mast while swaying back and forth in an exposed anchorage. Sean worked the halyard shackle loose, but as the shackle pin came out, the weight of the sail jammed the shackle. When he finally worked the headboard free of the shackle, the main dropped like a shot all over the house and deck and began to flog in the wind.

Sean was glad to reach the deck once more, but unhappy that his main halyard was out of action. Having a masthead rig meant he was able to use his jib halyard sheave for the main but then, of course, he had no jib. After a truncated cruise, he returned to his home port and hired his rigger to sort things out.

Change to rope

The first part of the solution to a problem like Sean's is to switch out old-style wire halyards for modern, low-stretch rope. The stretch factor is the reason wire came into use in the first place. But wire is no longer necessary now that modern halyards stretch so little. A rigger can advise you on the correct halyard material for you and your boat. I installed 5⁄16-inch Sta-Set X on my 34-foot, 13,000-pound Abeking & Rasmussen cruiser. This did not stretch enough for me to notice. The sheave box on my 1937 boat was only 3⁄8-inch wide, as the boat was designed for a wire-only sheave, hence the need for a small diameter halyard.

The second part of the solution is to install new sheaves at the masthead. The groove in the new sheave should be cut for a rope-only halyard instead of being shaped for wire or wire and rope. The pins



that the sheaves run on should be checked for wear and proper radial clearance relative to the new sheaves. Many pins are undersized and yield too much clearance.

Often, no changes are necessary at the deck level, as many older halyards are wire-to-rope, meaning a tail of rope is spliced to the wire and is led to a rope winch. Some older boats with all-wire halyards need to switch out the wire halyard winch for a rope-only winch and add the necessary cleats.

Some sailors opt to use their old sheaves, but these sheaves are often wobbly on their pins and loose in their slots. This brings me to the second story I have to tell.

A masthead mystery

The first masthead sheave I serviced was on a friend's Folkboat. As I had done a lot of work on the rest of the boat, I was invested in the outcome of the refit. As the boat headed out of the shop and back to the water, everything looked good, but I didn't feel right about that masthead sheave. I knew the bushing was worn, but hey, it spun freely. What could go wrong? When it came time to raise the main, the owner complained that the sail was just as hard to raise as before. I was puzzled and dismayed. The fix would require going aloft and doing I knew not what.

As the boat had a fractional rig, the jib halyard was not going to get me very high up on the mast, so I had to go up on the main halyard. Once up, I had to shift my weight off the halyard to investigate the problem. I could tell that the sheave spun freely.

I did not fix that sheave that summer. It took me a while to figure out what was going on. When I did, it was simple. I have seen it many times since.

When the clearance between the sheave bore and the axle pin it rides on gets excessive, the sheave is able to wobble side to side out of square with the sheave box. With no load on the sheave, things look sort of OK, as the observer can spin the sheave by hand without encountering any resistance. However, when a load is on it, the sheave can tilt and jam against the side of the sheave box. That was happening to the Folkboat halyard sheave, as I eventually learned.

Clearance is crucial

Good clearance between the sheave bushing and pin requires a close initial fit and good lubrication. Proper initial clearance keeps wear to a minimum. The sintered-bronze "sleeve bearings" I use are porous as manufactured and subsequently filled with 30-weight oil. When the bushings are under pressure or become heated, the oil moves to the surface and lubricates the interface. I use thick-walled bushings so more oil is available over the life of the bushing, thereby extending its life.

There are two clearance measurements for each sheave: radial clearance and axial clearance.

Radial clearance – I measure pins, or axles, with a set of digital calipers. This yields a measurement in thousandths of an inch. On a ½-inch pin, I shoot for .003-inch radial clearance. The pins I supply are .500 inch, and the bushings after finish reaming are .503 inch.

Axial clearance – The side-to-side, or axial, clearance should be enough for the sheave to spin freely and to move side to side about 1⁄32 to 1⁄16 inch.

I usually cut side reliefs on my sheaves, leaving just the ½ inch closest to the bushing on each side in contact with the inside of the sheave box, minimizing friction. If we are working with wire halyards, we do not cut side reliefs so there is no gap between sheave and sheave box for the wire to sneak into.

Side reliefs provide another plus. If the sheave pin is slightly out of square with the box, the relief will provide sufficient clearance so the sheave's outer edge does not contact the sheave box first, which creates maximum friction. Not long ago I cut a set of sheaves with taper from the hub outward. Just the hub, the very inner part of the sheave next to the bushing, was permitted to bear on the wall. The friction was reduced dramatically.

Inspection time

The off-season is the time to inspect and refit your masthead sheaves and halyards, either aloft at the dock or when the mast is down. Check your boom sheaves as well. This is an easy way to save a good deal of trouble and expense during the sailing season, when you want to be sailing and not tied to a dock or anchored out in a faraway place with a main or jib that refuses to come down.

Ed Louchard runs Zephyrwerks. He makes custom-sized sheaves and rollers for sailboats and other applications, as well as rope-stropped block kits. Ed's business was born out of the realization that very few sizes of sheave are commercially available. He works out of his home shop in Port Townsend, Washington. Check out his website at www.zephyrwerks.com.