GOOD OLD BOAT™

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Issue 102 May/June 2015

$8.00 (Canada $8.00 CDN)
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GOOD OLD BOAT

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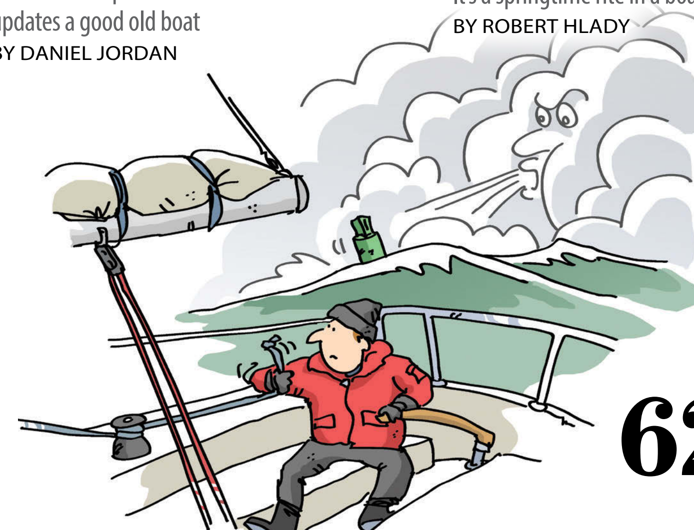
What's more

On the cover . . .
Mike Hinton caught this shot from the deck of Butch Weinberg's Hallberg-Rassy while crewing in the Texoma Sailing Club's Lakefest Regatta. Bill and Mary Nichols squeeze every quarter knot out of *Trust*, their J/30. Over the years, *Trust* has rewarded their efforts with many trophies in the cruising class.



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Electrical soldering

Basic steps for making reliable connections

BY DAVID LYNN

If you own an older boat, an important skill to master is the proper technique for soldering electrical connections. At some point, you'll undoubtedly want to repair, replace, or update an electrical circuit. You may want to replace a bilge pump or windlass or add an electrical switch. While many connections can be made using crimp terminals, a good solder connection is often preferable.

Before contemplating any soldering work, you'll need to assemble a few tools and supplies (see "Soldering Tools and Supplies" on page 36). None of this is particularly expensive.

Soldering is messy, so you need a suitable work area. Excess solder will drip and hot components, soldering irons, and heat guns will often burn the work surface. I do most of my soldering at the nav station using an old cutting board as my workbench.

As with any boat project, success depends to a large degree on preparation and understanding the tools.

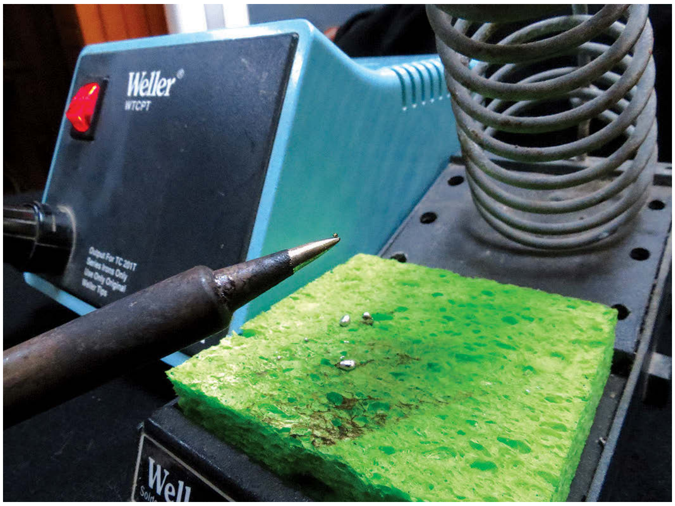
Tinning a soldering tip

Before the soldering iron can be used, the tip must be tinned. I plug in the soldering iron and let it heat up to temperature. If it's a new tip, I let it continue heating for about 10 minutes to allow any coating to burn off. I apply solder to the entire tip. A lot of solder will drip off the tip during this process. After the entire tip has been coated, I wipe it off using a damp sponge or a damp rag. If the tip is now uniformly shiny, the prep work is done. If it is a new tip, especially a ceramic tip, I may have to repeat these steps three or four times. It is quite important that the entire tip is shiny and bright, otherwise the surface of the tip will oxidize and it will have difficulty making good solder connections. It may need to be re-tinned periodically, when you're working with the soldering iron, especially when the iron is not temperature-controlled.

The soldering iron tip should never be sanded or filed. The surface plating is quite thin, and the tip will be ruined if it is filed through to the copper.

Preparing the connections

First, I strip the insulation off the wires, being careful not to nick the conductors in the process. The amount of insulation to be stripped depends on the wire size and the type of connection. If joining two wires, 1 inch is usually enough for wire sizes AWG 18 or smaller, while 1½ inches of insulation should be stripped from the ends of wire sizes AWG 12 to AWG 16. If a wire is to be soldered to a terminal, stripping half this amount of insulation will usually be adequate.



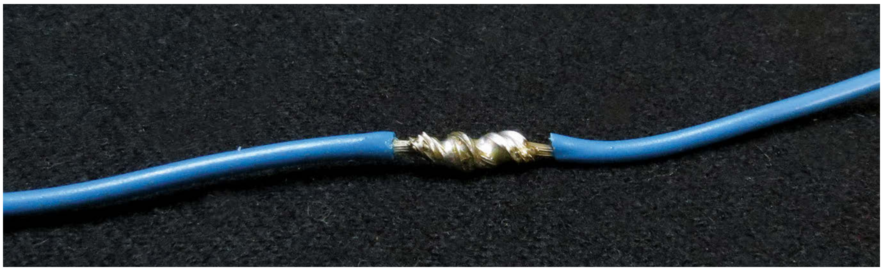
Tinning the tip of the soldering iron is crucial to making good solder joints. The sponge, kept damp, is used for cleaning the tip.

All the components that are to be soldered together should be clean and shiny. If the wires and/or terminals are all marine-grade tinned copper and in good shape, it will be easy to make a good solder connection. If the wires are not tinned and appear dull due to oxidation but are otherwise in good condition, it might be possible to clean them using a mild acid followed by a neutralizer (see "Corrosion Cleanup" on page 37). Wires showing signs of deterioration are green or have a powdery residue and should be replaced. It is difficult, if not impossible, to make a good solder joint with badly oxidized wire. The result will be a bad connection that may overheat and/or will surely fail at an inopportune time.

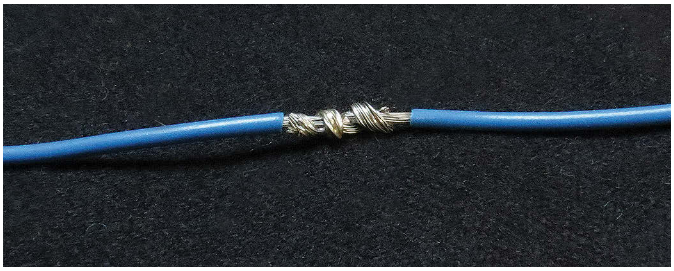
Before making the connection, I slide a suitable length of heat-shrink tubing onto one of the wires. It should be long enough to cover the entire solder joint and have enough extra length to overlap the wire insulation by a minimum of ¼ inch. The diameter of the tubing should be large enough to slide over the completed solder joint but small enough to fit tightly over the wire insulation after it's heated. Most good heat-shrink tubing has at least a 3:1 shrink ratio.

A good solder connection begins with a good mechanical connection. If soldering two wires together, they should be twisted together in line. The wires should not be wrapped together side-by-side; the resulting connection will be larger and weaker than if done properly.

When attaching a wire to a terminal, I wrap the wire tightly around the terminal. I make sure the wrap is tight



A good solder joint has a smooth surface that closely follows the contours of the wires.



A joint with too much solder looks bulky, above. If the joint has too little solder, the strands of the wire are clearly visible, above right. Both joints need to be redone.

A "cold" solder joint, at left, is a poor connection. It can result from insufficient or uneven heat applied to the joint, a poorly tinned soldering iron, or corroded conductors.

enough to hold the wire in place before I apply the solder.

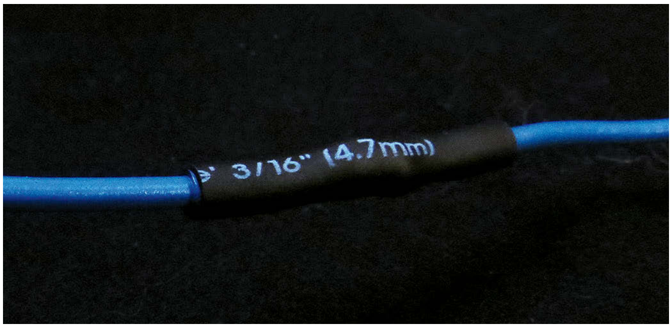
Making a good solder joint

First, I slide the heat-shrink tubing as far from the solder joint as I can. I don't want the heat of the soldering iron to shrink the tubing before it's time.

Next, I turn on the soldering iron and allow it to heat up. I unroll a foot or two of solder, tin the tip, and place the iron against the connection. After a few seconds, the connection will get hot enough to melt the solder. I touch the end of the solder against the wire connection, *not* against the soldering iron tip. When the connection reaches the right temperature, solder will begin to flow into the joint. I keep the connection hot and continue feeding solder until the joint is evenly filled with solder. The photos show a good solder joint as well as joints with too much and too little solder and a "cold" joint. If the solder joint has too much solder, I heat it up again and give it a good rap against the table. The excess solder will usually fall off.

Sealing the joint

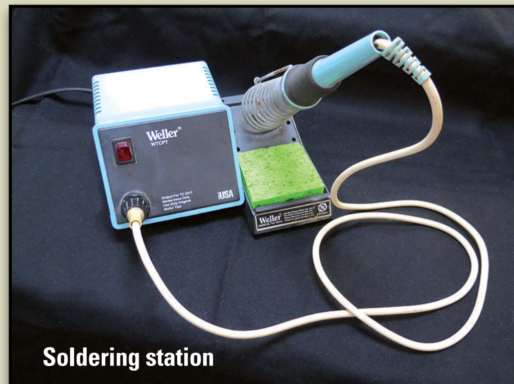
The last step in the process is to seal the unprotected wires. I allow the connection to cool, then slide the heat-shrink tubing over the solder joint. I use a heat gun to evenly heat the tubing until it shrinks tightly around the connection and wires. A small amount of adhesive will usually ooze out the end of the tubing. The heat gun requires a lot of power. If we are on the hook, I sometimes use a lighter, a stove burner, or a gas-heated iron to heat the shrink tubing. If using an open flame, of course, take care to ensure the flame does not come into direct contact with the tubing or insulation.



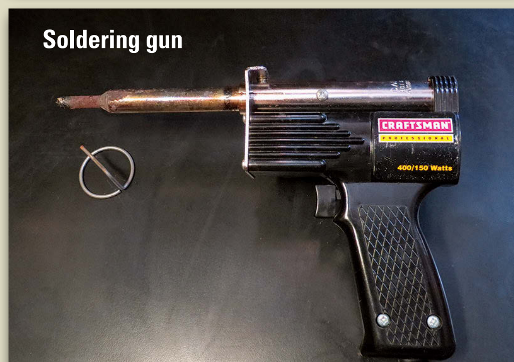
To ensure a waterproof seal on the insulation, the heat-shrink tubing should extend at least ¼ inch either side of the bare wires.

David Lynn is a Good Old Boat *contributing editor. He was an electronics technician in the U.S. Navy for six years before getting his BS and MS in electrical engineering. He and his wife, Marcie, have lived aboard* Nine of Cups, *their 1986 Liberty 458 cutter, since purchasing her in Kemah, Texas, in 2000. They have sailed her more than 80,000 nautical miles in their ever-so-slow world circumnavigation. Recently, they crossed the Indian Ocean and spent some time in Durban, South Africa. Find them on their website at www.nineofcups.com or read their daily blog at www.justalittlefurther.com.*

Soldering tools and supplies



Soldering station



Soldering gun

Gas soldering gun

Soldering irons –The type of soldering job to be done and the wire size will determine the type of soldering iron needed. For most onboard soldering, I prefer a low-wattage soldering pencil with a round-cross-section tip. A 40-watt iron is perfect. This will solder most connections for wire sizes from AWG 12 to AWG 30. Choose a 0.125-inch-or-so sharp or conical solder tip. The least expensive soldering irons cost less than $20, but I recommend spending a few dollars more to get one that incorporates a sponge and holder and is temperature-controlled. I found soldering stations of reasonable quality online for $40 to $120. I also found a good quality used Weller soldering station on eBay for $50.

If you'll be soldering heavier wire than AWG 12, you'll need a higher-wattage soldering gun. A trigger-operated 100/140-watt soldering gun is ideal and should cost between $30 and $40.

Another option is a gas-heated soldering iron. These are refillable butane irons with different heat settings and tip sizes. A gas-heated iron is a good option when AC power isn't convenient, as when you need to solder a connection at the masthead or when you're on the hook and trying to conserve battery power. A gas-heated iron of reasonable quality will cost between $30 and $50.

Solder –You need tin/lead, rosin-core solder with a tin/lead ratio of either 60/40 or 63/37. Do *not* use acid-core solder. A diameter of .040 inches is a good all-around size. If you're doing only one or two projects, a small roll will be fine, otherwise buy a 1-pound roll.

Hand tools –You will need a few basic hand tools: needle-nose pliers, wire strippers, and wire cutters. I have a couple different sizes of each. As a minimum, I recommend:

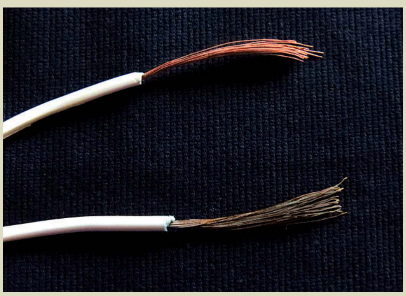
- **Needle nose pliers** – 6- to 8-inch
- **Wire stripper** – 8-inch combination crimper, bolt cutter, and wire stripper
- **Wire cutter** – 6- to 8-inch diagonal wire cutter

These are available for around $8 to $15 each.

Heat-shrink tubing – Once the solder connection is made, it must be protected from the elements. I highly recommend good-quality adhesive-lined heat-shrink tubing. The adhesive melts as the tubing is heated and makes a watertight seal as it cools. I keep a stock of various diameters from ⅛ to 1 inch.

Corrosion cleanup

In a perfect world, all the wiring on our boats would be marine-grade tinned wire and all connections would be watertight and sealed. In the real world — or at least the real world on *Nine of Cups* — most of the wiring is untinned and most of the connections were never watertight. When a bilge pump, water pump, or one of the myriad of other electrical devices on board needs to be replaced, I can be assured that the feed and return wires will, at the very least, be oxidized and quite possibly corroded.



For a reliable joint, wire strands must be bright, not corroded.

I prefer to solder any unions that could possibly be submerged or exposed to salt spray. I make a good solder connection, then use marine-grade heat-shrink tubing to seal the connection. To make a good solder joint, it's essential that the wires be shiny and free of any oxidation. Even if I am making a crimp terminal connection, I want the conductors to be shiny and free of corrosion.

If the conductors are heavily oxidized or corroded, the only remedy is to replace the wire. If the wires seem brittle, have a powdery residue, or are green with corrosion, the oxidation has gone too far. Trying to re-use corroded wire is a bad idea. The connection and/or wiring will more than likely fail sooner, rather than later. Even worse is the possibility that the wiring may overheat, melting the insulation and creating the risk of fire.

If the wires are only lightly oxidized, however, it is possible to clean the conductors, leaving them shiny and bright. I use a very mild acid solution to remove the oxidation, then another solution to neutralize and remove the acid. Both solutions are quite benign and easy to make.

Acid solution – Add 1 teaspoon of salt to ⅛ cup of vinegar and stir until the salt is dissolved. Any kind of vinegar will work. The container can be just about anything, but since I use the solution frequently, I store the solution in a marked jar. When I need to use the solution, I shake the jar until the salt is dissolved.

Neutralizer – Add 2 teaspoons of sodium bicarbonate (baking soda) to ⅛ cup of water and stir until the soda is dissolved. As with the acid solution, I store this in a marked jar.

If the wire isn't stripped already, I strip the insulation off to the desired length, spread the conductors, and immerse all the exposed copper in the vinegar solution. I swish it around in the solution to keep the salt dissolved and speed the removal of the oxidation. For lightly oxidized wires, it takes about 2 to 3 minutes to clean the wire. For more heavily oxidized wires, it may take as long as 10 minutes. When the wire looks uniformly bright and shiny, the first step is done.

I next dip the exposed wire in the soda solution to neutralize and remove the acid. I swish it around in the soda water for 10 to 15 seconds then wipe the wire with a clean rag to dry it. It's now clean, bright, and ready for soldering.