Build your own resistance solderer

Great results for minimal investment

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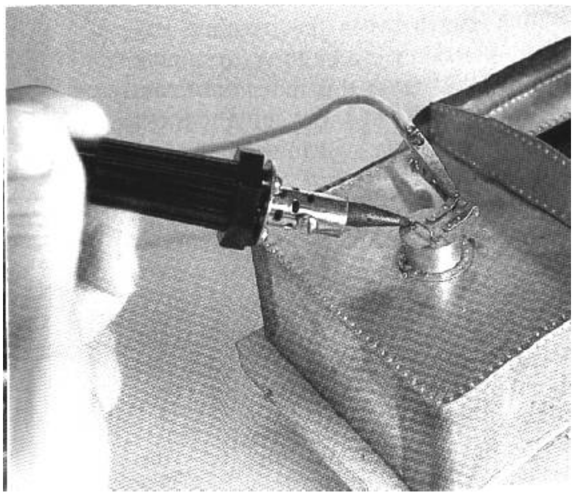

Photo 1 With a resistance solderer, you can solder the hinges on this tender hatch without undoing all the other joints.

If you're like me, you don't solder things unless you absolutely have to. The little hassles add up: plug in the iron, wait (and wait!) for it to heat up, wait some more while your work piece warms up. Watch out for the hot iron while you're readying the next joint! And when you're done, wait some more for the iron to cool down. It's too much work for a small job, so I put it off until there's no avoiding it. But there's a better way, both for small jobs and for more complex ones. I'm going to show you how to get over your resistance to soldering, by building your own resistance soldering unit.

What is a resistance solderer?

It's very similar to the familiar soldering pencil or gun, in that it uses a resistive metal to convert electricity into heat, permitting you to apply the heat at a specific point. It differs from the conventional soldering gun in that the *piece to be soldered* provides much of the electrical resistance. Thus, you are heating the work internally, insuring that the metal is the right temperature to make a strong solder joint. Additionally, since the heat is developed only where you want to solder, you don't have to worry about wasting time heating a larger area, and perhaps having some of your previous efforts come loose from the spread of the heat.

A resistance solderer differs, as well, in that the heating of the material is practically instantaneous. You step on the foot switch and the work piece is heated to working temperature in a second or two. When you release the switch, the resistance solderer's tip is cool to the touch. Only a small portion of the piece you soldered got hot, so it cools more quickly, too. *(Photo 1.)* This removes almost all of the obstacles of conventional soldering for me. No waiting for the iron to heat up, no waiting for the work to take the heat, no worries about burning my shirt sleeve or the workbench top, no waiting for the iron to cool. And of course, you're wasting less electricity on all that unused and unproductive heat.

What's the cost?

If you have read this far, I have probably addressed some of your irritations with conventional soldering irons. And now you're wondering, "Where do I get one of these wonderful things, and what's it going to cost me?" You have two choices: buy or build. You can buy excellent units from PBL, MicroMark and other well-known hobby suppliers. They are fairly expensive (typically around $250-300), but they are of very high quality and will last a lifetime -- a worthwhile investment according to those who one one.

Or, you can build your own for a fraction of the cost. It doesn't

Photo 2. The solderer is made from commercially available tools, modified to work together.

look as polished, perhaps, and it hasn't gone through a national electrical safety inspector, but it will do the same job. (Your trackwork uses the same voltages and amperages, by the way, so don't worry too much about the safety inspection. Use the common electrical precautions and you should be fine.) With this simple home-made solderer, you can solder wiring joints or attach brass detail parts in seconds. A unit like this will not be suitable for soldering really large pieces like 1:20 scale brass locomotive cabs or boilers, however. For that, you'll still need to use a torch. But it will replace your soldering iron for most jobs, and will let you do many things impossible to do with an iron.

Construction made simple.

Hobbyists have circulated plans for building resistance solderers for years, and ***Narrow Gauge and Short Line Gazette*** published an article in 1981 showing a unit constructed from a power transformer, a wooden dowel and a cheap D-cell battery. It was not a construction project for the faint-hearted, however. Clever minds came up with a safe and simple alternative, though, and the resistance solderer is now an item every workshop can (and should) have.

To simplify the construction, we're going to use commercially available products, and modify them somewhat so they can be combined to form a resistance solderer. The bill of materials lists the items you will need to build a basic unit. *(See sidebar.)* You can substitute equivalent parts wherever you wish. (That old Lionel ZW transformer in your attic would make a good power source, for example.) Construction should take only a couple of hours once you have the materials.

The resistance solderer I'll describe consists of three main pieces: the **power source**, the **footswitch** , and the **electrode**. *(Photo 2.)* You may also add a voltage controller if you wish, made from a household light dimmer switch.

The **power source** for your solderer will be an automobile battery charger. Most chargers produce 12 volts of direct current (12VDC) and between 2 and 20 amps (2-20A). Most people who have built one recommend 5A as a minimum. If you want to compare this with your conventional soldering iron, you can calculate the wattage by multiplying the voltage times the amperage: a 12VDC, 5A unit consumes 60W. That is *not* to say that it produces the same heat as a 60W soldering iron, however. Since the heat is generated right at the spot you want to solder, you will be radiating less of it into the air and thus you will be using less wattage to do the same job. On small parts, you have to be fast with the on/off switch, even at 2A, or you'll heat your part red-hot!

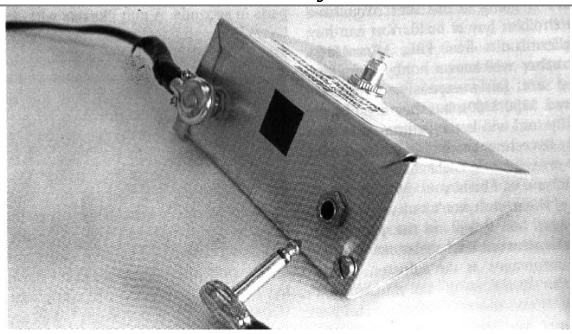

Photo 3. The footswitch controls the current flow from the transformer to the electrode.

A **foot switch** permits you to control the flow of electricity from the power source to the electrode. The box housing the footswitch has 1/4 inch jacks, into which the cords from the power source and the electrode are plugged. These are standard musical cord jacks and plugs. *(Photo 3.)*

The **electrode** consists of a bakelite handle holding a carbon rod. (This could also be made of wood or another insulating material.) A heavy cord connects the electrode to the footswitch. One wire of the cord is attached to the carbon rod, while the other wire hangs loose, with an alligator clip attached to the end. You don't really need a box of 50 cutting torch rods (I still have 49 in the box). Try to find some friends to share a box, or ask the welding supply to sell you one or two. If you have to buy the entire box, though, remember that you're still saving a lot by building it yourself. *(Photo 4.)*

Putting it all together.

First, modify the battery charger by cutting off the terminal clips from the battery cable. Strip the wires and solder both of them into one of the guitar plugs. (This may be a tight fit -- be sure you check all the clearances in the plug's shell before you solder the wires.) That completes the power source!

Next, make the electrode handle. Take apart the soldering pencil, and disconnect the cord from the heating tip. Cut the plug off the cord. Separate the wires on one end of the cord for about 6 inches, then strip both wires about 1/4 inch. Strip the wires on the other end and solder them into the other guitar plug. With a power hand drill, drill a 1/8 inch hole about 1/2 inch from the bottom end of the handle, then gently move the drill up towards the top end of the handle, giving the hole an angle of about 45 degrees. This will simplify moving the ground wire through it later. With a metal saw (hobby or hacksaw), cut the metal mounting barrel to leave about 1 inch above the base. Drill a 1/8 inch hole through the side of the barrel, and thread it for a 6-32 screw. (This is a set screw, not a critical measurement -- use whatever you have that will hold the carbon rod in place.) The rod can be sharpened to a fine tip in an ordinary pencil sharpener. Carbon, after all, is the same stuff a pencil is made of, minus the hardener and the wood. The fine point will permit you to focus the heat right where you need it.

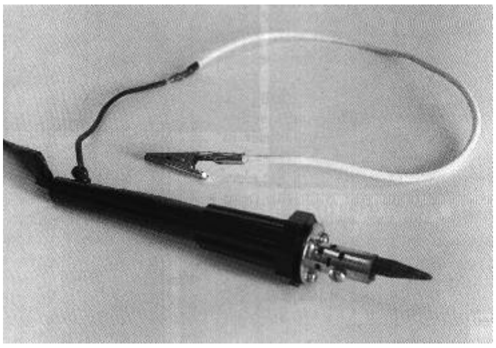

Photo 4. The electrode is made from an inexpensive soldering pencil handle. It can also be made from a wooden dowel or other insulating material.

Now, connect all the pieces of the electrode: thead the cord into the bottom end of the handle. Push one of the wires through the angled hole, and move the other all the way through the handle and out the other end. Solder the lower wire onto the alligator clip and tie a knot in it to keep if from falling out the bottom of the handle. Connect the wire on the upper end to the carbon rod. If you're using carbon cutting rod, it will be coated in copper and the wires can simply be soldered on to the copper coat. Otherwise, you'll have to devise something that will transmit the electricity to the rod and still permit changing it should it break. One homemade rig uses telescoping brass tubing to adapt the rod to the handle. Winding ten or twelve turns of thin copper wire around the rod would give a good place to connect the power wire; this can be clamped down firmly by the set screw for positive contact at all times.

Finally, you'll need a foot switch to give you control over the power and leave both hands free to work. Use heavy-duty components in this part, or you'll find yourself rebuilding it after the switch or the wires melt from the high amperage. Take a 2x2x4 inch aluminum project box (a two-part box for electronics projects) and cut the sides of the half with the screwhole flanges at a 45 degree angle with your hacksaw or hobby saw. Flatten out one bend in the other half, cut off the excess metal, bend a new edge and drill new holes for the screws. *(Photo 3.)* This will give you a box with an angle which will allow you to reach the switch easily with your foot.

Drill three holes in the box: one in the top and two on the front. Square up the front holes to fit the power jacks you are using. Measure the depth of the switch you're using and place the top hole to make sure that the switch will clear the bottom of the box when mounted. Mount the two jacks in the two holes on the front side. Using a heavy-gauge wire, such as household extension cord wire, connect the plugs and switches so one connector on each plug is directly wired to the other. Solder the two connectors on the switch to each of the remaining connectors on the two jacks. *(Figure 3.)* Screw the box together and it's finished!

Using the resistance solderer.

To ready the solderer, connect the three components by plugging the power plugs into the jacks on the front panel of the foot switch. It doesn't matter which plug goes into which jack, so arrange the charger and footswitch where they are convenient in your work space and put the plugs into the nearest jacks. Be sure to connect the electrode and charger before plugging the charger into the house power, or your get a lot of sparks from the jacks.

To use the solderer, you first prepare the pieces your are soldering in the usual way: clean them mechanically if necessary with a file, steel wool, sandpaper, etc. Make a physically sound joint if possible, one that would hold the pieces together without solder. Then apply the flux of your choice to the joint to further clean the joint and to spread the heat evenly over the surface of the metal.

If your charger has different amperage or voltaage settings, start out on the lowest amperage. This should be sufficient for most small and medium jobs. I have found that using higher amperages also tends to trip the charger's circuit breaker, which was designed to shut down power in case of a short circuit. A controlled short circuit is what you are trying to create with your solderer, so don't tempt the breaker. (You may wish to disable it if you feel comfortable you can do so, and use the resulting rig, safely.)

Now, the fun part. Clip the alligator clip on your electrode handle someplace on the work piece, the closer to the solder joint the better (it wastes less heat this way). Place the tip of the electrode at the point you want the heat, then press the foot switch. The flux should start to bubble almost immediately, so have the solder ready in your other hand and apply it quickly. Release the foot switch when the solder has flowed, then remove the electrode from the work piece.

You may lose a few pieces of work at first, as you get accustomed to this sequence of events. Welding supply houses sell these electrodes for *cutting*, not for joining metal, and you will find out why if you take the electrode off the metal before you turn off the current. What you will see is the same arc of electricity your car battery makes if you connect the cables incorrectly. It's big, and it's loud, but most importantly it's very energetic. The arc will punch a hole in a small piece of metal, and that expensive detail casting or that smooth surface you were working on will now have a big black pit. Moral: *always turn the power on and off while the electrode is on the metal.*

Advanced topics.

You can easily add a voltage controller, if your charger has only one setting, or if the lowest setting is still too powerful for what you are working on. A household light dimmer will perform the same function for your solderer, and reduce the electrical voltage getting to the transformer, in turn reducing the voltage that comes out.

This may be useful if you solder a lot of small parts like handrails, and find that they are heating too rapidly for you to work on easily. Mount the dimmer in a double junction box, with an outlet, so the dimmer controls the voltage at the plug. Plug your charger into this.

You could skip the charger altogether, do it the cowboy way and just get a 10A or 15A transformer with a 6V or 12V secondary. The usual caveats apply: put a fuse and switch on the primary side, and don't try it if you don't know what you're doing.

You can also experiment with different types of electrodes. Using the plugs in the footswitch box permits you to unplug one electrode and plug in another. The commercially available units usually have an add-on accessory such as a "tweezer" electrode. This puts the two electrical contacts on the fingers of a tweezer-like handle, permitting you to run the electricity and heat directly through the metal from one surface to the other. Some commercial rigs come with the tweezer as the standard electrode and charge extra for the kind you just built. Both are useful.

Resistance is *not* futile.[1]

Well, there you are. You now have a resistance solderer, and your modeling life will never be the same. You can now grind out those jobs in seconds that once were the thorn in your paw -- either painful or impossible to do with your iron and torch. And you saved yourself about $200 in the process, enough to buy the brass stock for that Big Boy you've been thinking about scratchbuilding. Go for it!

Bill of Materials

Automobile battery charger. 12VDC, switchable amperage is desirable (typically 2, 5, 10A). Cost: around $50.

Soldering pencil. A 20- or 30W iron from an radio or hobby shop. Cost: around $5.

1/4-inch carbon rod. The easiest place to find these would be at a welding supply. (Make sure you get the hard kind.) You can also find them in the core of certain carbon cells, but the chemicals that surround the rods are noxious and require care in disposal. Cost: $20/box of 50.

Aluminum project box.
5A pushbutton switch.
Electrical extension cord.
Computer power supply plugs/jacks (2 ea.)
Available at radio shops. Cost: around $15.

Wire stripper, solder, flux, soldering iron. Well, you have to start with *something*! You should already have these in your toolbox, though. Cost: around $15.

[1]Those guys on *Star Trek* didn't know about resistance soldering.

Afterthoughts

After using my solderer a while, I discovered two items in the preceding which must be changed to withstand the heat generated by the system: the foot switch and the connectors. You must have a 20A pushbutton switch if the switch is between the transformer and the electrode. These are a bit harder to find, but an electronics supply will have them. Ask around until you find one. Or, ask around at the local hardware stores and find a heavy-duty AC footswitch intended for power tools like drill presses. This permits connecting the electrode directly to the output side of the transformer.

The other issue is the connectors. Don't use guitar plugs (as originally shown in the photos-- they will eventually fail due to the heat generated. Instead, use nylon power supply connectors from the radio or computer shop. *(Photo 5)* They are inexpensive and will stand up to the heat. This will require making a rectangular hole in your footswitch box, but is worth the extra effort.

After writing the article, I made another very useful tool: a tweezer or pincer style electrode. Mine was made from bamboo kitchen tongs; any non-conductive, heat resistant material will do, but pay attention to durability here, too. *(Photo 5)*

I attached a couple of brass blocks to the ends of the tongs, drilled lengthwise to accept PBL tweezer tips, and crosswise for a set screw. The tips are about $3.50 a pair at Caboose Hobbies, and are probably available directly from PBL as well. I ran the wiring down the length of the tongs, then secured them with cloth tape used on bicycle handles (electrical tape will work fine, too). I used the same plug on the end of the wire as on the carbon electrode.

Rather than soldering the carbon rod to the wire in the electrode handle, it's better to use a mechanical connection -- like a set screw. That way, you can change rods easier, and you don't have to worry about the solder joint coming undone.

Finally, the issue of heat concentration. The smaller the tip, the more heat is concentrated on a smaller area. You can sharpen the carbon electrodes in a pencil sharpener. Or, you can use the PBL metal electrodes, which are about 1/16" diameter. This is how the PBL and American Beauty pencil are configured. It may or may not be easier to find them than the carbon electrodes. It's your choice; either will work.

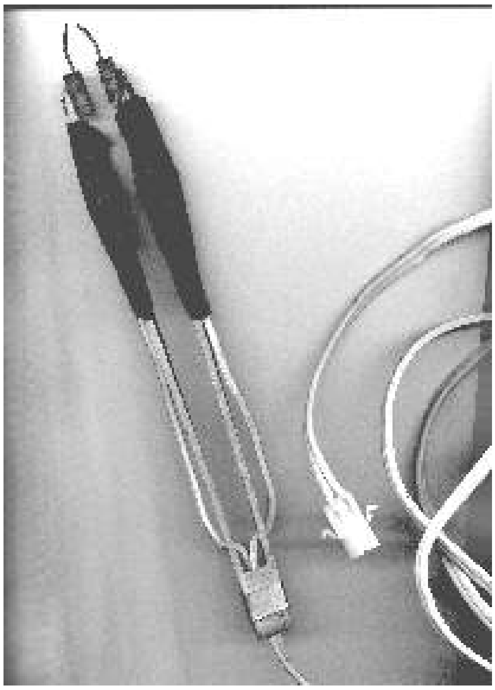

Photo 5. The tweezer electrode, made from wood pasta tongs. Note the computer power supply plug on the end of the cord.