Technical Tidbits No. 18

by Stephen Nelson (WA)

Soldering

My biggest challenge in repairing/restoring clocks is remedying previous repair fixes. More specifically, poorly soldered pieces are one of the most vexing mechanism problems that I run into; it seems that everyone loves to solder because it is such a permanent solution. If a little solder will do the trick, won't a little more work even better? More solder will always take care of a poor fit!

This Tidbit focuses on the repair of a poorly "fixed" Vienna Regulator crutch and putting a broken winding drum click back together. Before we get into the hows and whys of this article, let's first think about safety.

I use a variety of small torches to solder small pieces (see Figure 17 for two of them). Torches remind me of the rule I learned in a gun safety course: don't ever point a gun at something you don't intend to shoot. Likewise, don't ever point a torch at something you don't want to torch. Just as in shooting, it is very important to look around and behind the workpiece you are heating to see what you might be inadvertently about to torch.

Often the first step in repairing someone else's work is to remove the excess solder. There are times that the most effective way to remove solder is to heat the workpiece and then wipe it with a piece of cloth to remove the melted solder. Always wear a leather glove to avoid getting burnt.

I do most of my soldering on a firebrick. A firebrick is capable of withstanding fairly intense heat without cracking or melting. Granted, heating with an oxy-acetylene torch will melt a firebrick. But using propane, butane, or MAPP gas (this trademarked name belongs to Linde Group for a fuel gas based on a stabilized mixture of methylacetylene [propyne] and propadiene) torches will not melt a firebrick.

When you have finished soldering a workpiece, especially when working on a firebrick, remember that the workpiece is very hot. A firebrick retains heat and slows the cooling process. Especially when working on a firebrick, let the workpiece cool for awhile; make sure the solder has set before picking it up, and use a pair of tweezers or a pair of pliers to pick up the piece.

Flux is used to prevent oxidation of metals that are being soldered and to ease the flow of the solder on the metal and into cracks or crevices. Because many fluxes are acidic, it is imperative that eye protection be worn to prevent molten solder or acidic fluxes from splattering into the eyes. It is also important to look at what might be impacted by the acidic flux when you are putting it on a workpiece. One of the worst problems that I see is caused by a repair person soldering a broken part with the part still in the mechanism. The heated flux vaporizes and then condenses on parts near the piece being soldered. In a couple of years the flux, if not properly rinsed off, will destroy the surrounding bits. When finished soldering, always rinse the workpiece in cool water for 30 seconds as soon as the workpiece has cooled to remove any residual soldering flux.

This is a fairly obvious corollary: do not solder pieces that are still attached to the mechanism.

When soldering a complex piece—one that might retain flux in an inner cavity or such—it is a great idea to clean the workpiece after soldering in an ultrasound with an ammonia-based cleaner. Because ammonia is a base, it will very effectively neutralize any residual acidic flux.

It is a good idea, when heating solder, to think about where the molten solder might fall if it happens to drip. Sometimes I solder pieces held in a vise on the side of a workbench. There is nothing quite as exciting as having melted solder drop on your foot—or slip right through your socks or fabric shoes and come to rest on your bare skin.

Finally, an Exacto knife is very effective at removing excess solder—and skin. When using an Exacto, think about where the blade will go if it slips, and then do your best to not have anything in that area—just in case. I also remember the friend who was cutting veneer with an Exacto; fortunately, they were able to remove the piece of it from his eye after the blade snapped in two. Wear safety glasses when using sharp knives.

The steps I follow when soldering can be summarized as follows:

- Remove previously applied solder.
- Make sure the pieces are very clean.
- Make sure the pieces to be soldered fit together very well.
- Decide if the workpiece needs to be reinforced; if so, make an appropriate reinforcing piece.
- Use a moderate amount of flux.
- Use a minimal amount of solder.
- Use "just enough" heat.

The crutch hub shown in Figure 1 is from a Vienna Regulator mechanism. It had been previously broken and soldered.

As can be seen, the crutch arm is meant to have a round hole that fits onto the brass hub that mounts on the anchor arbor. This particular mechanism had led a hard life. I suspect the hub was not original to the crutch arm and someone had made a new arbor, which did not fit well. The resultant connection between the hub and the arm was flexible enough that it contributed to keeping the mechanism from running. That and someone had filed the pallets, shifted the pivot point for the anchor arbor, bent several pivots … well, let's just say there were lots of reasons it couldn't run.

The first step was to remove the previously applied solder. Heating the hub with a small butane torch allowed the two pieces to be separated; inserting a toothpick into the hub as soon as the flame was withdrawn made it easier to remove the hub from the arm.

Lightly reheating the end of the separated crutch arm made it possible to wipe the excess solder away with a piece of cloth. As mentioned in the safety section, wear a leather glove to avoid getting burnt.

An Exacto knife was then used to trim off residual solder that did not come off with the cloth. Small files or sandpaper can also be used to remove residual solder.

As shown in Figure 1, the original repairer did not do a good job of fitting the hole in the end of the arm to the hub. It was possible to gently bend the rim of the hole such that the end of the rim touched the point where it was broken from the arm.

Chucking up the hub in a jeweler's lathe allowed me to cut off the excess solder and adjust the hub's diameter so that it fit the hole in the end of the arm. Figure 2 shows the final fitment. Please note that the pictures in this article are nearly all shot through a 10× power microscope; the outside diameter of the ring on the end of the crutch is just 5 mm, or less than a quarter of an inch. The imperfections you see are truly very fine.

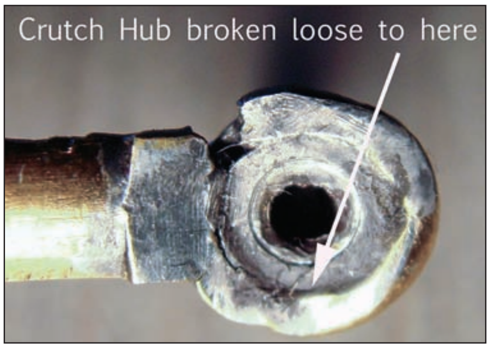


Figure 1. Crutch hub "as found."

Figure 2. Hub ready to be soldered.

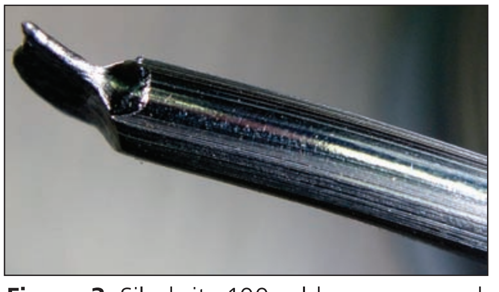


Figure 3. Silvabrite 100 solder compressed to make it easier to cut off a very small piece.

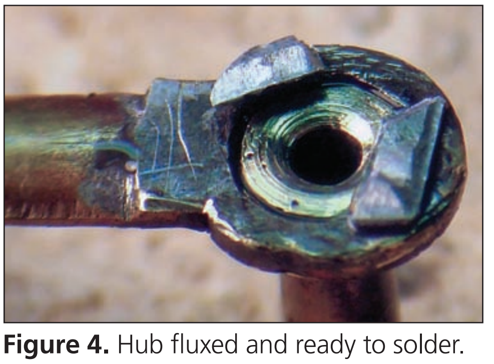


Figure 4. Hub fluxed and ready to solder.

Figure 5. Soldered hub.

The next step is to cut two very fine pieces of solder. I use Silvabrite 100, a tin/copper/silver alloy, for most of my soldering. It is stronger than conventional lead solders, flows very well, and melts in the 450-500°F (230-260°C) range—just below the temperature at which steel blues.

Stay-clean flux works very well with Silvabrite 100 solder.

Rarely do I need to braze or silver-solder the parts on a clock because the strains involved are typically not severe enough to warrant such efforts. I find that bits that require more structural strength than Silvabrite provides can typically be reinforced with a small bit of metal. This is easier than the more challenging effort of brazing or silver-soldering very small parts with the resultant degradation in metal strength.

It is important to not use more solder than is necessary; typically, very, very little is needed. The easiest way to cut very small pieces of solder is to first squeeze the end of a piece of solder so it forms a thin sheet. I then use a pair of small diagonal cutters to cut off small pieces.

The end of a toothpick makes an excellent applicator for placing just enough flux on the workpiece to lightly wet the parts to be soldered. It is important that both the workpiece and solder are fluxed. It is also important not to get flux where you don't want solder to adhere or flow.

It would be truly wonderful if it was possible to include a video of the solder melting into the hub in this printed article. For the next best view, please go to www.SN-Clocks.com, click on the "Technical" tab at the top of the page, then click on "Tid-Bits," then on "Tid-Bit 18 – Soldering."

Click on the first picture that has a triangle in the center, and then click on the triangle in the center of the large picture and watch, through a 10× microscope, as the solder flows into the workpiece.

Figure 5 shows the hub after this first application of heat and solder.

I did not believe that the hub was strong enough at this point, so I prepared a washer to lay over the end of the hub to reinforce the joint. Figure 6 shows this washer in place and ready to solder.

Figure 6. Reinforcing washer in place.

The video on SNClocks.com referenced above shows the tip of a toothpick used to apply flux and a chip of solder. It also shows the flux boiling off and the solder flowing into place.

As you watch the video, you will see that the flux boils when heated. This will sometimes result in the solder bounced off of the workpiece, or, as shown in the video, moving the reinforcing washer off of center. I minimize the impact of the boiling flux by heating very gently until the flux is all evaporated. Then I continue to heat very gently until the solder melts.

The boiling flux shown in the video did not cause concern while soldering because the solder, when it melted, has enough surface tension to pull the washer back to a centered position. If it is necessary to move a part after it is soldered, I typically will reheat gently, and when the solder has just melted, I use the tip of a toothpick to realign pieces.

Small butane torches are very effective for this kind of repair. It is important, even with a very small torch, to not apply the flame directly to the point being soldered, because this will likely just blow the chip of solder off the workpiece. It is most effective to heat the larger piece being soldered, applying the heat a short distance from the joint and letting the heat flow through the workpiece to first boil off the excess flux, and then melt the solder.

It is also important that the heat be withdrawn as soon as the solder has melted. There is no benefit to overheating a workpiece after the solder has flowed—and overheating will soften steel and brass.

Figure 7. Finished hub.

Figure 7 shows the finished hub after it was cleaned up and mounted on its arbor.

You can read more about this mechanism's restoration at http://www.snclocks.com/Fantastic-Clock-Mechanisms/Fantastic-Clock-Mechanisms/Rough-Month-Runner-Restoration

The winding drum click shown in Figure 8 broke at a stress point that resulted from the way the click was made.

Figure 8. Broken winding drum click. British penny shown for scale.

One of the steps in my mechanism restorations is rebluing the screws and other bits that were originally blued. The parts are blued by heating to around 515-530°F (270-280°C) in a conventional oven. This helps to stress relieve the parts and restore their original blue color, which is a protective oxidized surface layer. This click broke right at the point where there was a sharp angle in its overall form; such sharp angles create stresses in the metal and provide a likely point for failure.

It is interesting that this particular piece was broken half way through when it was blued, as shown in Figure 9.

Figure 9. Half of the click's broken face is blued—showing that it was broken half way through when heat-blued by the author.

Given the choice of making a new click or soldering the existing piece, I chose to repair the existing piece in the belief that the solder would be more than strong enough for the strain that the click's tail would see in use, especially if the internal stresses generated by the sharp angle in the pieces design were eliminated.

Fortunately, the click's break was very clean, leaving a granular face on both parts. These faces fit together perfectly. After cleaning the two pieces, one was placed on a firebrick such that it touched a small magnet. The small piece that broke off was then fitted to the first piece in exactly the same position that it occupied before being broken off, as shown in Figure 10.

Figure 10. Two parts of broken click held in place by a magnet.

Figure 11. Click ready to be heated.

Figure 12. Click after heating to melt solder.

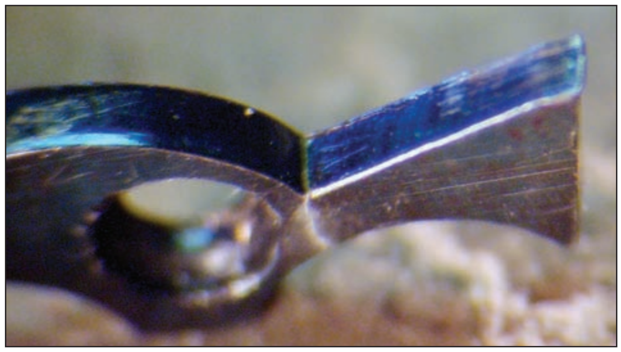


Figure 13. Showing solder penetration into crack.

A small magnet comes in very handy when repairing broken clock hands, pallets broken off of anchors, and the like because it allows one to keep very small parts in exactly the right orientation for their repair.

Figure 11 shows the click after a small amount of flux has been applied to the crack and the small piece of Silvabrite solder placed right over the break. Note that the acid in the flux dissolved the blue oxide layer around the crack.

As above, the soldering process was recorded with a digital camera shooting through a 10× microscope. The video can be seen in the same photo gallery referenced above on the SNClocks website.

The clock's owner was watching as I gently heated the click and saw very clearly what was happening because he could see the screen on the back of the digital camera used to record the video. He was amazed at how quickly the solder melted and did not believe that in the very short time that it was molten that it could have flowed into the entire crack. Figures 13, 14, and 15 show the penetration into the crack.

It was an easy matter to remove the excess solder with an Exacto knife and a piece of emery paper.

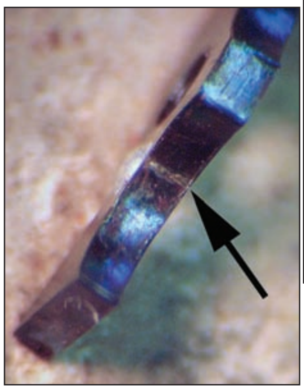
The click, when reinstalled in the clock, worked perfectly.

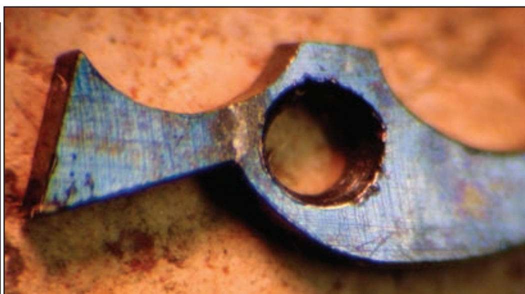
Figure 17 shows the two torches I use most often for my repair work. Of these two, the small butane torch (on the right in Figure 17) is the handiest and the one I reach for most often. It is perfect for jobs like the two discussed in this Tidbit. The Little Torch is in effect a mini oxy-acetylene or oxy-MAPP gas torch. It can generate a very small and very hot flame and is perfect for doing very small repair work.

Solder can be the bane of a repair person, or it can be the perfect solution to a problem. I hope this Tidbit gives you at least one way to make your future repairs a little easier as well as more attractive and effective.

For additional information on the techniques Steve Nelson uses in his workshop, visit http://www.snclocks.com/TechnicalInformation.

Steve's email is: steve@snclocks.com.





Figures 14, left, and Figure 15, above. Additional photos showing solder penetration.

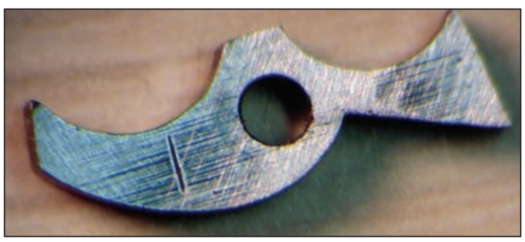


Figure 16. Back of repaired click.

Figure 17. Two of the torches I use in repair work.