by Stephen Nelson (WA)

Mechanism Assembly Tips

Not long ago I read an excellent article on moving pivots when assembling a mechanism.[1] Scotty Dean presented a number of examples of hooks and pushers that can be used to move pivots around when trying to get them to slip into their appropriate holes. His article reminded me of several phone calls from novice clock restorers who were working on their first Vienna Regulator mechanism and having problems getting pivots to cooperate. The one that really stands out was from a gentleman who had replaced the weight line on a one-year-duration weight-driven Viennese mechanism and who couldn't get it to run after he had put it back together. The challenges he faced are the subject of this Tidbit.

It doesn't take much pressure to inadvertently bend, or even remove, a pivot when dealing with the finer pivots in Viennese or French movements. And, while I have seen time and again that an experienced craftsman can do phenomenal work with tools that only serve to expose a mere mortal's lack of skill, the gentleman mentioned above epitomized the problems that inappropriate tools can cause for beginners. (While I like to think the tips I offer for putting together mechanisms can be of value to both novice and experienced clock restorers—my real focus is on those who have not yet mastered the fine touch that renders seemingly impossible challenges easy.)

Back to my friend with the weight-driven year runner that wouldn't do its thing. Fortunately, he lived fairly close, so the next weekend saw him and his mechanism at one of my benches. Although he only bent two pivots, that is still two too many. We discussed his procedure for assembling the mechanism while straightening the bent pivots; from this discussion I learned that he had used a pivot locator identical to the top one in Figure 1.

He also mentioned how difficult it was to get the front plate of the mechanism to slip onto the posts that hold it to the backplate, especially when trying to get all the pivots in their holes. And he commented that he really didn't have any idea how he should approach a more complicated mechanism—say a three-weight.

So—three challenges—how to locate pivots, how to cope with plates that don't want to slide back onto the pillars that hold them in place, and how to approach more complex mechanisms.

Let's start with the tools I use to locate pivots when putting mechanisms back together. At one point, after bending a pivot in a Vienna Regulator, I decided to make a pivot locator that would be a bit more forgiving. This tool is the second from the top in Figure 1. It consists of a very fine pin-vise and a piece of 0.010" (0.25 mm) pivot wire that is shaped so it can be used to push and pull pivots.

I use this tool on clocks with robust pivots—say 0.025" or larger—but have found that I bend a lot fewer pivots if I use either my bench tweezers (the larger ones labeled AA in Figure 1) or, on more delicate mechanisms, the very fine pair of tweezers at the bottom of Figure 1—number 5 tweezers appropriate for handling watch hairsprings.

Even a 0.010" piece of pivot wire with a hook on the end or a pair of larger tweezers gives me too much purchase when attempting to manipulate arbors and pivots in a delicate mechanism. My experience has led me to a simple rule: use the smallest or finest tool you can for really delicate work to keep from exerting too much force—like using the right-size screwdriver for a screw.

Even with the finest tool, you will still have problems putting a mechanism together if the pillars do not want to slide into the plates.

Many of the mechanisms I work on have the front plate held in place by tapered pins set through the posts that hold the plates apart, as shown in Figure 2.

Figure 1. Pivot locators.

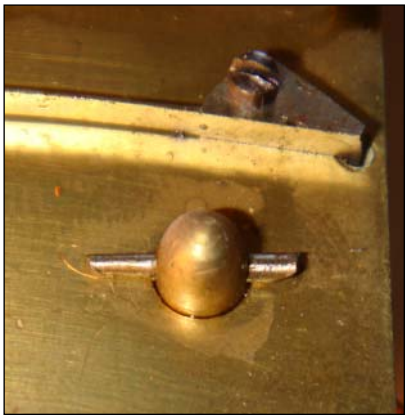

Figure 2, right. Taper pin holding a front mechanism plate to a post.

Figure 3. Rough pillar pin hole.

Figure 4. Shard removed from around pin hole.

When I disassemble a mechanism I check to see how easy it is to slip the plate back onto the posts holding the mechanism together. It is common to have some friction due to the pillars not quite lining up, but it is also common to find that a pillar doesn't want to go into a plate hole, usually because of damage either to the pillar or the hole.

While the pillar in Figure 3 really doesn't look that bad, nonetheless, the shard around the pin hole is enough to make it harder to slide the mechanism plate onto the pillar. It is very important that the plate be able to slide onto the pillar with minimal friction when trying to guide small pivots into their hole; otherwise, one cannot apply a light touch to the plate, light enough that the end of the pivot can be slid along the plate until it lines up with its hole. This brings up another point. When restoring pivots, I round the end of the pivots so they can more readily slide along the plate when I am putting a mechanism together. Rounding the end of pivots will be discussed further in a future Tech Tidbits on stoning and burnishing pivots.

Figure 4 shows the same pillar after being filed with a very fine pivot file to remove the shards around the hole. I stress that I used a very fine pivot file because it is way too easy to remove too much material from the pin, resulting in a loose fit in the plate. While an experienced machinist can probably do this task with a large file, I find that my students find it easier to not go too far on a task like this when using a tool that allows a slow removal of material.

I also inspect the plate holes; sometimes the hole has been deformed where the pin has been hammered in. In this case I remove the deformation so the pillar can slip into the hole with a good, snug fit.

With the pillars and plate holes fitted, we can now focus on a few pointers for locating pivots when putting a mechanism together. Figure 5 shows my setup for this effort.

Yes, that is what you think it is—a roll of toilet paper. I have used a lot of different mechanism holders, but a roll of TP is by far the best option for holding a mechanism as I put it together. It lets me readily turn the mechanism to get a better view of the pivot as it is guided into its pivot hole, and the mechanism is at a comfortable height above the bench when resting my hands on the side of the bench (see Figure 6).

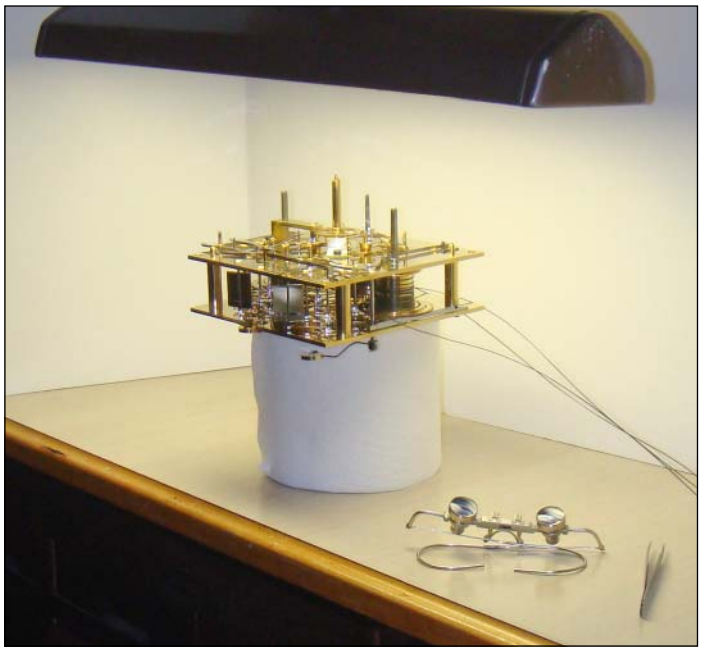

Figure 5. Setup for guiding pivots into holes. (Please note that in Figures 5, 8, and 9 the mechanism is shown completely assembled. I didn't have a movement apart when preparing this article. Figures 6 and 7 are later additions to the article that clearly show the stage of assembly under discussion.)

Note, too, the light just above the mechanism; a bright light shining through the pivot holes is visible on the pivot when guiding pivots into their holes. This really helps to find really small holes. I adjust the light such that it is not shining in my eyes, but is focused on the top of the mechanism so I can see the light shining through the pivot holes.

And, there are my tweezers and binocular loupes. I will discuss the various optics I use to view my work in an upcoming Tech Tidbit.

Figure 6. Moving a pivot.

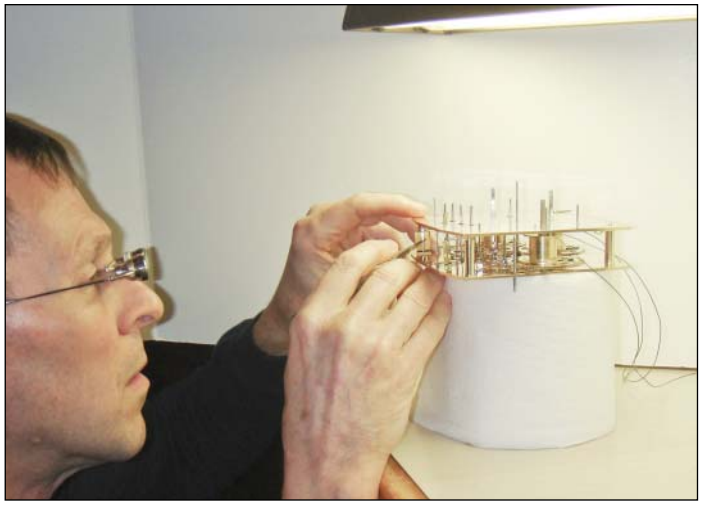

Figure 6 shows me ready to slip pivots into pivot holes. It is probably obvious that I am kneeling on the floor in front of my bench as I manipulate arbors and pivots. In this position, with my wrists resting against the sides of the bench, I have sufficient control and can see what I am doing with the pivots.

It is also pretty obvious that I am touching the mechanism with my fingers. Having tried both cotton and nitrile gloves, I found that the best option for me is to keep a bottle of rubbing alcohol on the bench and periodically wipe my fingers with an alcohol-moistened tissue. The diluted isopropanol is mild enough that it does not excessively dry out my fingers, but it does remove the organic acids that so readily etch the plates.

I have skipped over the steps of locating all the gears in their appropriate pivot holes in the backplate and laying the top plate over the taller pivots. I'm starting this discussion at the point where the long arbors (winding arbors, the minute arbor, the gathering pallet arbor and the second hand arbor—if an extended arbor that drives a second hand) have all been guided into their holes. This is the point where it becomes tricky—getting the remaining pivots that are on arbors of roughly the same length into their holes.

Being right-handed, I prefer holding the tweezers in my right hand. With this in mind, I tend to start slipping the pivots into their holes on the left side of the mechanism, as shown in Figure 6. I find this easier than starting on the right side. I imagine a left-handed person might find it easier to start on the other side. You need to try both and decide which is easier for you. But whichever side you prefer starting on, the first step after laying the top plate over the longest pivots is to loosely pin the lower pillar on the side on which you will be starting.

Figure 7 shows which pillar I loosely pin when I start on the left side of the mechanism.

I gently squeeze the two plates together on the left side of the mechanism (as shown in Figure 8) while looking between the plates with a light shining down from above. If you are left-handed, you might want to start on the right side.

Once I have seen which pivot on the left side of the mechanism is touching the underside of the top plate (i.e., which pivot needs to be guided in first on the left side of the mechanism), I then gently spread the plates the least little bit so the pivot can be shifted into its hole. Figure 9 shows how I spread the plates.

My index finger is on top of the pillar on the left side of the mechanism, and my thumb is below the top plate; by squeezing my fingers together I can gently lift the top plate.

It is surprising how often a bright light above the mechanism reflects off of a pivot as I guide it to its hole, giving me guidance as to where the hole is. When the pivot is aligned with its hole, I gently squeeze the plates together as shown in Figure 8 and then find the next pivot that is now touching the top plate on the left side of the mechanism and proceed as above.

Figure 7. Which pillar to loosely pin first?

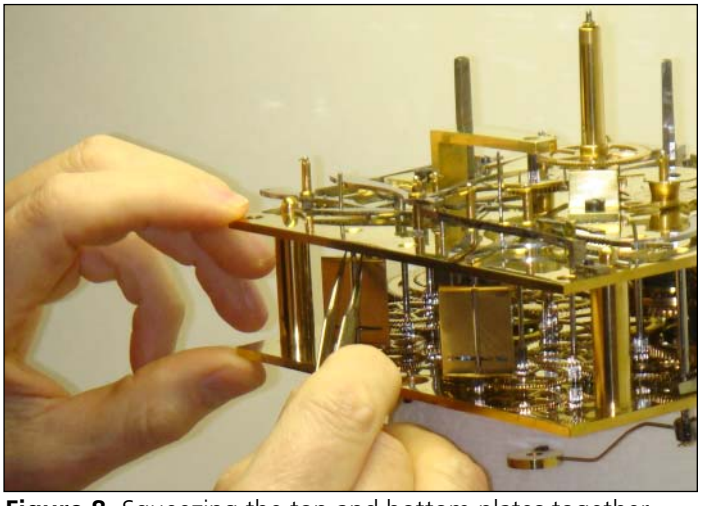

Figure 8. Squeezing the top and bottom plates together.

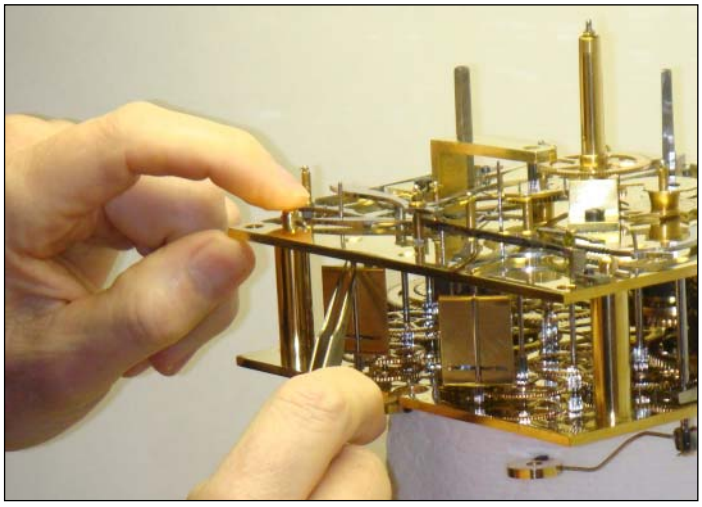

Figure 9. Spreading the mechanism plates apart.

In truth, often I am not so much lifting the top plate, but just lessening the pressure against a pivot as I slide it along the underside of the top plate to get it into its pivot hole. I guess this is the advantage of using really

fine tweezers and not trying to be overly forceful when moving the pivot. I find that I can lightly apply pressure as shown in Figure 9, allowing me to slide the rounded end of the pivot along the underside of the plate until it finds its pivot hole.

I have also found it most effective to grip the arbor, perhaps a quarter of an inch down from the pivot, when guiding pivots into their holes. I do not find it effective to grip the pivot itself, especially on the finer mechanisms with pivots as small as 0.009" in diameter; it is way too easy to bend these pivots even with fine tweezers. Besides, tweezers are made of fairly hard steel, and it would be unfortunate to scratch a pivot when putting the mechanism together.

By starting on one side or the other of the mechanism, and by loosely pinning a lower pillar, I minimize the number of pivots that want to be slipped into their holes at the same time. Once I get the pivots on one side into their holes, I loosely pin the upper pillar on that side (the pillar on which I have my finger resting in Figure 9) and then proceed to locate the pivots in the center train, and finally the train on the right side of the mechanism.

Don't get me wrong; once in a while I will come up against two pivots that both want to be slipped into their pivot holes at the same time. This is difficult; often I resolve it by starting over on the other side of the mechanism. So far this has allowed me to focus on one pivot at a time. Once in a while, one or more of the pivots in the center train will need to be guided into its hole before finishing the left-hand train. But by identifying which pivot is resting against the top plate, I can decide which pivot needs to be located next.

Sometimes too I will look at several pivots and not be able to tell if one is actually in its hole. When in doubt I use the tip of my tweezers to lift very gently on the underside of the gear associated with the pivot in question and see if the gear will lift, with its pivot sliding up into its pivot hole.

To summarize my tips for getting pivots in pivot holes:

- Use a pivot locator that is appropriate for the size pivots on which you are working.
- Clean up the pillars and plate holes.
- Round the end of pivots.
- Use toilet paper rolls for a good mechanism holder.
- Have a bright light shining down from above the top plate.
- Use rubbing alcohol to keep your fingers clean.
- Lightly pin the lower pillar on the side on which you are starting.
- Grip the arbor, not the pivot.
- Start on one side of the mechanism and work your way to the other side.
- Loosely pin the side you start on when you get the first train's pivots in their hole.
- Practice gently squeezing plates together and spreading them apart.
- Use light shining through pivot holes to help guide pivots into holes.
- Test by gently lifting gears to see if the pivots are in their holes.
- If two pivots both have to be slipped into their holes at the same time—try starting from the other side.

I hope that the techniques I discussed above help novices, and perhaps even a few experienced clock restorers, in their efforts to put mechanisms back together! For additional information on the techniques I use in working on Vienna Regulators, visit http://www.snclocks.com/TechnicalInformation. My email is steve@snclocks.com.

Note

1. Scotty Dean, "Some Thoughts on Pivot Locator Hooks," *Watch & Clock Bulletin* (April 2010): 186.