

How flutes are made

The third article in the series: Padding and finishing

By Jim Phelan

Flutemaking lore: Q. What do you call a finisher who only works on D foot joints (foot joints with only one key)? A. The padder of little feet. The padder's motto: The buck stops here.

When I was eighteen I was apprenticed in an instrument repair workshop. In the summer of 1969 I padded my first flute using the 'steam and clamp' method as taught by the woodwind repairman under whom I was studying. We had 500 rental flutes to maintain for the Carl Fischer Company—in addition to equal numbers of clarinets and trumpet—and many of them required repadding. Taking a day and a half to do the job, as we now do on professional instruments, would have been utterly impractical. What I learned of value was to quickly assess the condition of an instrument and immediately decide what to do.

In the course of padding a flute, one has to make this kind of decision over and over again. Where is the leak? How big is it? Should I relieve the hard spot or fill in the leak? Where is the lost motion coming from? What is the best way to remove it? There is no time for equivocation.

Today, more companies are describing those people who install pads as 'finishers'. This makes sense because padding is a part of the finishing process which also includes fine-tuning the mechanics, polishing and regulation. Although, due to the advent of new and better pads, the actual time spent padding has been reduced, it is still the major part of the finishing job.

Mechanics and polishing: When the keymaker finishes with the keys, the keys are left tight. That is, there is a minimum space between keys and between the hinge tubing and the steel rods. No springs have been installed and the keys are not polished.

The first thing the finisher does is a visual check for obvious errors in keymaking and a check that there are no obvious clearance issues. In general, with 'standard' flutes, there are no problems. However, instruments having split E mechanisms, convertible B to C foot joints and the like, it is often the finisher who makes sure these extra keys actually work!

The flute is then polished. We, as flutemakers, consider this a make-or-break process. If the keymaker has conscientiously done his or her job and the finisher really knows how to polish, the keys and body can be brought to a mirror finish without losing the sharp detail of the mechanism and without 'wavy-gravy' in the flat surfaces. As polishing is a metal-removal process, errors in polishing are very difficult to repair. Therefore, it is always preferable to under-polish than to over-polish.

Jim Phelan started making flutes in 1976 for a venerable Boston firm. He published the first edition of *The Complete Guide to the Flute* in 1980. That book is now in its second edition and sixth printing. He left the flutemaking world in 1989 and spent six years working in high-tech and the medical instrument industry as a mechanical engineer. In 1996 he joined his wife, Lillian Burkart, to make the Burkart flute. Even so, they are still happily married.



The 'steam and clamp' method is used on some student model flutes. The pads are installed protruding more than usual from the cup. Spring clamps are used to press the pads down onto the tonehole. Steam is sent up through the flute body, softening the pads. The whole assembly is allowed to cool and to dry, usually overnight. A semi-permanent set, or seat, is giving to the pads which eliminates the need for shimming that is described in 'dry padding'.

A typical flute padding bench. The flute being padded has a detachable B foot. (The C extension has been fitted temporarily to the socket at the top of the footjoint.)

After polishing, the flute is thoroughly cleaned in an ultrasonic cleaner. It is absolutely critical that every grain of polishing compound is removed. Any polishing compound left in a post thread or bearing can migrate out over time and bind the mechanism. That is not a good thing in a new flute. I've found over the years that flute players get really grumpy when their keys don't go up and down!

The springs are now installed. Why now? It is far easier to polish a flute without springs than with. We still use a rather archaic method for installing the springs because, well, we haven't found any better method. Each spring, made of white gold, fits through a very precisely drilled hole a tiny bit bigger than the spring wire diameter. The finisher rounds one end of the spring and flattens the other. The spring is slipped through the hole round end first and the flattened end is forced into the hole using special pliers. Another special pair of pliers is used to give the spring a graceful arc. This arc is both aesthetic and functional, giving the key movement an even, smooth feeling and looking good at the same time

The keys are assembled with oil. This is a critical step because although one does not generally consider the thin layer of oil taking up space, it does. It is the finisher's responsibility to decide if the key feels right, if it is free enough, when the oil has been applied.

When it is assembled, the instrument is ready to have the pads installed. When I started padding flutes in the early 1970s, there were only traditional pads, though we didn't refer to them as such. Today, there are more choices. David Straubinger, Jim Schmidt, Jeff Smith, Luciano Pisoni and Ed Kraus have developed synthetic, or partially synthetic, pads. Each one is a bit different and is described later in the article. If the reader wants more information, the 'Flute' email list on Larry Krantz's website (www.larrykrantz.com) often has lively discussions on the subject of pads.

At this stage the pads are held in the cups using screws and washers, grommets or shellac (or some similar adhesive). Then the levelling process begins to make the pad fit perfectly on the tonehole. Using a feeler, the finisher first gets the pad touching in the front of the tonehole and the back evenly. If the pad is touching the back of the tonehole first, the pad is too thick and whole paper shims are removed. This allows the pad to sit lower into the cup and allows the pad to contact the front of the tonehole sooner. If the pad touches the front of the tonehole first, whole shims are added.

Then, the finisher feels around the pad to detect leaks and hard



spots. Partial shims cut from whole shims are used to raise the pad out of the cup where there is a leak. The whole shims can be cut to allow the pad to drop down to relieve high spots.

As little as twenty years ago, pads were not nearly as flat as they are now. With the advent of some of the pads mentioned above which are far flatter than traditional pads, more attention is now paid to the flatness of the tonehole and the cup. Flatter cups, pads and toneholes have all contributed to shorter finishing times and more stable pad jobs which, in turn, have had the effect of producing better flutes.

Towards the end of the finishing process, the finisher starts to play the flute. This is also an important step as playing settles the pads into the cups and starts to compress corks and felts. Spring tensions are checked, final adjustments are made and the flute is ready for the tester.

At Burkart-Phelan, the flute often goes home with the finisher who practises on it that night. This 'test drive' helps to ensure that the flute is solid and has no 'jacks-in-the-box' that would require the customer to return it for adjustment.

Styles of Padding:

Flute pads mimic the closing of the toneholes with our fingers. Our fingers are covered with skin and, hence, flute pads are covered with skin. Saxophone, bassoon and the lower-voiced clarinet pads are covered with leather. Pads for flute, oboe, cor anglais and clarinet pads are covered with what is euphemistically called fish skin. It is not skin and it is not from fish. It is a membrane that forms a sack around the intestines of an unfortunate cow. Measuring in thickness about 0.025mm, it comes in sheets about 300mm by 600mm. It is translucent and can form an air-tight seal.

The traditional pad is made from layers of cardboard and wool felt. These are glued together and one or two layers of fishskin are wrapped and glued around them. The glue that is generally used is mucilage because it is very thin and water-soluble.

There have been many attempts at making a more stable, reliable and durable pad. These started with the Dura-pad of 1940s vintage. This was simply a disk of rubber and was not very successful.

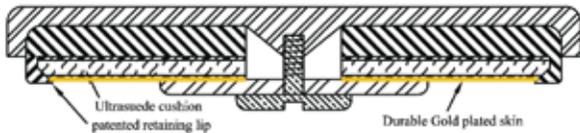
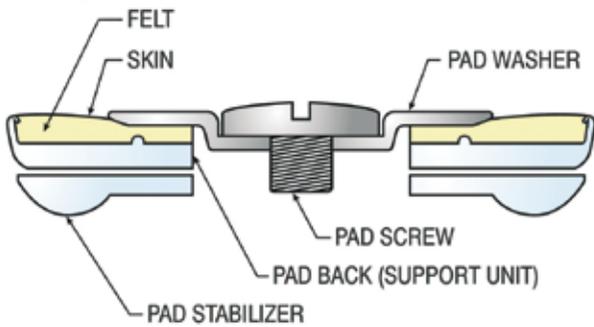
The Valentino pad was developed in the 1970's. A more sophisticated attempt, it is made of several layers of polymer varying in density. Today, the Valentino franchise is owned by J.L. Smith & Co.



A flute being padded. The blue material has been stuck to the flute to preserve the finish while it is being handled.

An assortment of paper shims used in padding a flute, colour-coded by diameter and thickness.





Three modern padding systems. Top: Straubinger pads (courtesy of Straubinger Flutes, Inc.) Middle: Schmidt Gold pads (courtesy of Jim Schmidt). Bottom: Valentino pads (courtesy of J.L. Smith & Co.)

in the USA, which is in the process of refining the original concept.

The Schmidt pad, made by Jim Schmidt of Los Angeles, is a combination of Delrin (a common polymer), Ultrasuede (a synthetic felt), and a variety of materials to cover. A tireless researcher, Schmidt is bent on finding a material more durable than fishskin.

To date the most successful and generally accepted synthetic pad is the Straubinger pad. David Straubinger of Indianapolis originated the idea of using a Delrin shell and a resilient layer made from Ultrasuede wrapped together with fishskin. David's pads still do not have the longevity of a felt and cardboard pad, but they are very easy to install and produce a strong, vibrant sound.

The wet method uses a layer of melted (not technically 'wet') shellac to hold the pad in the cup and to provide a way to level of pad. This is the method used exclusively in every woodwind instrument except the flute. Shellac can be melted easily with a spirit burner and solidifies rapidly—characteristics that are ideal for levelling pads. Shellac is put in the cup, the pad is put on top, the key is put on the instrument, heat is applied and the key is held shut. The molten shellac squirts to wherever it is need to level the pad. When it hardens, the pad should be perfectly level. Today, many repairers use hot-melt glue instead of shellac. The wet method works particularly well with toneholes that are not too big.

The dry method works better with bigger toneholes. When a pad is put in 'dry', it is held into the cup either by a screw and washer or a grommet-shaped device, sometimes called a French bushing. This is the gadget that holds a pad into an open-holed cup. The levelling is accomplished by the application of paper shims under the pad. Whole shims that look like doughnuts are used to raise the overall level of the pad in the cup so that the pad is touching the front and the back of the tonehole. Partial shims are used to 'fill in' leaks, or places where the pad is not touching. At a more sophisticated level, a good padder will recognize when cutting shim material out from

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under a 'hard spot' will greatly shorten the padding job and produce a more stable shimming architecture.

I should be mentioned that Clifford Trettick, a padder's padder, uses a hybrid method that employs a layer of hot glue on which he places the paper shims and then the pad. Reportedly, he does this very successfully.

Repair

As it is the padders who normally do repair, I think it is appropriate to review some of the conventions used in flute repair.

To my knowledge, Germany is the only country that requires a government-issued certificate for someone to hang up a shingle advertising 'flute repair'. As for the United States, there is no such requirement. This has, in my opinion, led to a somewhat sorry state of woodwind repair in general. Hence, it is good to state what is expected when the player visits a repair shop.

Here are the definitions of the most common repairs.

Overhaul When a flute is overhauled, it is made like new. It is completely stripped-down and all old felts, corks, adjustment papers and pads are removed. All lost motion is removed. That means that any excess space between keys due to wear is removed. Then, the flute keys and body are polished, thoroughly cleaned, an anti-tarnish polish is applied and the flute is assembled as if it were a new flute. Because so much work is done, it is imperative that the flute be well played-in, re-checked and any changes made before being returned to the customer.

Repad Occasionally, a player will decide to try a different kind of pad in a relatively new flute. Perhaps a flute that was purchased and not played for a long time or seldom played is resurrected. In these cases where there is not much wear from playing, a repad is recommended. A repad is exactly what the name implies. The old pads are removed and new pads are installed. Of course, the sections should be taken apart, cleaned and new oil applied. Again, thorough checking needs to be done before returning the flute to the customer.

COA (Clean, oil, adjust) The COA should be an annual ritual for every flutist. It is an excellent time to talk to your repairer about any small problems you might be having with your flute. Far better to take care of small problems before they become dire.

In a COA, the repairer checks to see how well the pads are covering and re-shims the pads as necessary. This often also requires modifying the adjustments between pads. Once the flute is playing well, the mechanism is disassembled, the old oil is cleaned out and new oil is applied. The flute is re-assembled, the pads are re-checked and the flute is play-tested.

It should be noted that some repairers prefer to disassemble, clean and oil before doing the pad work. It should also be noted that replacing pads is generally at extra charge.

Pad replacement: The player should examine the flute's pads for torn skins. This is a sure sign the pad should be replaced. A repairer may recommend replacing a pad if the pad has become too stiff and is no longer flexible. This can happen with felt pads over time. I strongly recommend, and I think most repairers would agree, that the replacement pad should be of the same style as the other pads in the flute. 

