Restoration of Bassoon Bass Joint Tenons

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A procedure for restoring weakened bass joint tenons to original strength by capping the tenon with wood.

This procedure is useful when splits in a bass joint tenon have weakened the integrity of a tenon. The tenon must be complete with no missing pieces. This procedure can even be done to fragile tenons with proper preparation. The advantage of this procedure is that minimal work is done to the bore, unlike replacing a tenon, which can cause considerable change to the bore at the tenon. It is also superior to installing a metal band or cap to a tenon as the modes of material movement of metal and wood are different and may come into conflict with each other.

Tooling

This procedure requires a lathe long enough to carry a bass joint between centers. The lathe will also be required for boring out a piece of wood so a chuck of three inch or greater capacity along with a boring bar will be required. Special tools will include short mandrels to hold the joints in the lathe. Details of the mandrels are described near the end of this article.

In Brief

The bass is mounted on a mandrel with the subject tenon at the headstock end. The end of the tenon is turned at a .070 taper (2°) for about ¾" leaving the tip end as thin as your comfort allows and leaving a shoulder at the other end. After removing the bass joint from the lather a block of new wood is mounted in the chuck and bored out and faced to fit firmly on the bass joint. After the new wood is glued in place with the grain properly aligned and the glue has fully cured, the tenon is turned down to match its socket. The new wood on the old tenon is oiled and sealed to match the appearance of the old wood on the tenon.

Preparation

It is advisable to remove all of the keys from the joint before doing the work. Although this job can be done with the keys in place they will get dusty from turning the wood the work will be easier with them removed.

To prevent accidents it is advisable to strengthen the splits before turning. If the splits are in good condition this is easily done by simply using super glue on the glue to hold them together during turning. Although sloppy glue work on the outside of the tenon will be turned off later, any excess glue on the inside should be wiped smooth. Errors in the turning can be caused by poor surface conditions in the bore where the joint is fitted onto the mandrel. Briefly sanding the bore to remove the surface bumps and roughness will improve the quality of the job.

Distorted Tenons

This procedure is easiest when the tenon is round and all of the splits are secure and the edges of the splits line up with each other. Unfortunately, this is not always the case. The splits may be weak and fragile, or the edges have become misaligned, and out of round tenons are more common than not. These conditions are best corrected before the tenon is turned down.

Correcting distortions is done as part of preparing the tenon for turning. Basically, steaming the tenons back to shape does this. The mandrel is heated sufficiently to turn water to steam, the end of the joint is dipped briefly in water and the hot mandrel is inserted into the tenon. Avoid getting the mandrel too hot as it might burn the finish of the bore; it is practical to increase the temperature of the mandrel in increments to arrive at a temperature that produces steam. If the steaming procedure can be done in the lathe some small degree of warping can be slightly corrected.

While the tenon is still on the warm mandrel wrap the tenon with cotton string. The string can be saturated with super glue creating a hard cocoon encasing the tenon. The glue will penetrate into the splits during this. Be careful not to glue the tenon to the mandrel. Fragile tenons particularly benefit from this reinforcement. The cocoon will be turned off later during the normal course of events. Cocooning is usually only required on notably fragile tenons.

Misaligned split edges are the most difficult distortion to correct. Usually by the time a tenon is brought in for repair the misalignment has existed so long that it is all but permanent. The hot mandrel will help as much as anything but getting the edges to stay in line will prove difficult. If string is used do not get it too tight as this may force the edges out of alignment. It may be necessary to file and sand the offending slippage out of existence in the bore.

Following any steaming allow the tenon to cool for a while on the mandrel. Some bore finishes may stick to the mandrel after they are

completely cooled; watch for this and keep the mandrel free. It is best if the tenon can be left overnight before turning. If only super glue has been used without steaming allow half an hour for the glue to fully cure before turning.

Setting the taper

The most important aspect of this procedure is that the tenon must be turned at an angle. A straight turning will not work. The grafting succeeds best if the maximum new wood is at the end of the tenon while the maximum old wood is at the other end of the graft. Also, a straight turning doesn't work well over the increasing bore diameter of the small end tenon.

Setting the angle on the compound of the lathe determines the taper. About 2° of taper works well. If preferred, the taper can also be set using a dial indicator to establish a .070 taper. (Knowing how to set the taper with a dial indicator is useful later when the finished tenon taper must be set.) The objective of the taper is to turn the tip thin while a slight shoulder remains at the back end of the taper. A 2° taper usually succeeds well.

By using the compound to turn the taper both the tenon and the graft are accurately cut to the same taper. The graft should be turned immediately after turning the taper without any change in the compound, guaranteeing that the tapers match.

Turning the tenon

The joint should be securely mounted on the mandrel for turning. The subject tenon should be at the headstock end of the lathe. If the mandrel does not fit good enough a bit of shimming with masking tape is advisable. Make certain to place the tape in a way that does not compromise concentricity; evenly spaced lineal strips are better than wrapping the tape around the mandrel. The tape is actually desirable as often holds the joint better than just the metal mandrel. Also, the mandrel lasts longer if the lathe tool has a barrier of tape to go through before hitting metal.

The lathe tool must be sharp. A dull tool working against splits may damage the tenon. The tools should be ground with plenty of relief. Wood can be cut with a more acute angle than used for metal. Set the tool to cut from left to right, from the end of the tenon toward the center of the joint. The leading edge should be perpendicular to the turning axis.

Before making a cut use the lathe to measure the actual length of the tenon. Turn the compound back and set it at a zero position on the dial. Move the carriage back until the tool just barely touches the shoulder of the tenon. Then turn the compound forward, counting turns until the tool will just touch the end of the tenon. Note the length through which the compound has moved. Mark the tenon length on a piece of masking tape near the end of the joint. You will need this information later when you do the final tenon turning. The lengths of bass tenons vary quite a bit, but typically will be somewhere close to 1.600". (Fox tenons are usually 1.595")

Begin turning in a conservative manner. I usually advance the crossfeed only about .010" per cut. Being too aggressive can be disastrous. It will take several cuts before the full length of the cut will be realized. I usually cut the taper about ¾" long. Make sure to leave a small shoulder at the end of the taper. Continue cutting as long as you feel comfortable. The thinner the cut at the tip the less visible with be the results. Watch for thin spots. When you feel that you have gone far enough take the joint out of the lathe.

Boring out the Graft

The graft needs to be made of maple. Using the same variety is desirable, as the results will be more similar in appearance. In a practical sense it is usually impossible to know what species of maple an instrument might be made from, so take whatever you can get.

A length of maple turned down to 2-2¼" is convenient if you anticipate doing this often. This diameter is adequate for either end of the bass joint. If the piece is also bored out to about 7/8" it becomes easier to part off the amount of wood needed for the job.

The graft needs to be made a bit long for more accurate fitting. Cut off a piece about 3/16" longer than the taper you cut on the tenon. I normally do this in the lathe with a parting tool. Set the wood in the lathe chuck with a gap of about 3/16" between the wood and the face of the chuck. This will prevent the boring bar from cutting into the chuck face.

Set up the boring bar and begin boring out the graft. It's normal to get the graft a very slight bit loose. This will be tightened up as the end of the graft is faced and squared. When checking the fit of the tenon in the graft take special care to remove all crumbs of wood as they will make your evaluation of the fit incorrect.

When the bore of the graft is just large enough to fit fully to the shoulder of the taper begin facing the end of the graft. If your boring bar is ground appropriately it will serve to both bore and face. The width of the facing only needs to be wider than the shoulder at the end

of the taper sufficiently to see what you are doing. Face back the end of the graft about .025" at a time until the tenon fits snugly into the graft. It doesn't need to be tight, merely snug. Excessive tightness may displace the edges of splits.

Gluing the Graft

The best work is not noticeable. To accomplish this take a moment to find the best alignment of the grain of the graft to the grain of the old tenon. Remember that the only obvious place when the fact of the graft will be visible will be covered with thread or cork. Getting the grain at the end knob reasonably aligned with the grain of the body is sufficient. Mark the pieces so that the graft can be positioned quickly after the glue has been spread.

Be sure to use wood glue. Epoxy is a poor choice for this job. There are many good wood glues available that will do a better job. Spread the glue onto the taper and the graft and put the pieces together. Work quickly so that moisture absorption doesn't swell the wood before you assemble the parts. Get the parts aligned the first time, as you may not get a second chance.

Wipe the excess glue from the bore. Don't worry about the excess glue at the end of the graft. Clamping shouldn't be necessary unless your glue is too thick. Set the joint aside for the glue to fully set.

Tenon Dimensions

There are five dimensions to be concerned with. The rate of taper; the length of the tenon; the lengths of the two knobs of the tenon; and the diameter reduction of the cork groove.

A properly fitted tenon should match the taper of the socket. Take a few minutes and measure to the diameters at the top and bottom of the socket and divide the difference of the two diameters by the depth of the socket. This will give the rate of taper of the socket. Set your lathe compound to the same taper.

The total length of the tenon should not completely fill the socket. It is desirable to leave a small gap between the end of the tenon and the bottom of the socket when the joint is assembled. This is typically on the order of about .015". The measured length of the tenon compared to the depth of the socket will probably show this difference.

The lengths of the knobs are somewhat variable. Different makers have their own ideas about this. In general the end knob should be longer as this provides more strength to the weakest part of the tenon. The upper knob doesn't need to be so long as the thread wrapping will give more stability if it gets closer to the shoulder of the tenon. I normally used lengths of .375" for the end knob and .150" for the upper knob. The diameters of these knobs are set by fit in the socket.

The cork groove between the two knobs should be .030" lower than the knobs. That is, turn the crossfeed in an additional .030". This provides a depth that is close to perfect for 1/16" cork in the groove and is about right for a good thread wrapping.

Final Turning of the Tenon

Begin turning by cutting down the excess diameter of the graft. Don't bring it down to fit; just bring it close. Next cut the length of the tenon to the dimension you recorded earlier.

After cutting the tenon to length I usually change to a square ended lathe tool that does all of the work of turning the diameters and shoulders of the tenon. Be sure to shape the tool so that it can cut the shoulder of the tenon without putting any post near the tenon at risk. (This is more of a problem on the wing than on the bass joint.)

Cut the two knobs at the end of the cork groove by turning the new cork groove between them down .030" from the existing oversize diameter of the end knob. The upper knob is still the original knob, which is usually longer than it needs to be and it will benefit from being shortened. You probably won't get down the old cork groove yet. Defining the lengths of the two knobs now will make turning the diameters to size easier.

Continue cutting the diameters of the tenon down at the taper using the compound until the tenon fits just easily into the socket. There should be no resistance to the tenon turning in its socket. As you cut the knobs down (and yes, it is possible that you will reduce the upper knob's diameter a bit) keep the cork groove turned that .030" below the knob diameters.

Finishing the Tenon

When you are satisfied with the fit of the tenon in its socket sand it a bit to both smooth the finish and to give just a bit more tolerance to the fit. After taking the joint out of the lathe oil the new wood. The line between the old and new wood at the end will disappear with the application of oil. The other joint in the middle of the tenon will be unseen under the cork or thread wrapping.

Different oils affect different varieties of maple to produce different degrees of darkening and color changes. In addition, as the oils oxidize over time the color will change. It's difficult

to give advice about just which type of oil to use to give the best cosmetic effect.

It is advisable to use a bit of shellac on the tenon to seal the wood and add another type of color to the wood. With practice it is possible to get the appearance of the new and old wood reasonably close.

If the tenon is to be thread wrapped you may proceed immediately. If the tenon is to be corked the fresh oil may interfere with contact cement. Waiting a day or two and/or sanding the cork groove may help.

Turning Mandrels

Special turning mandrels will be needed to hold the joint while it is in the lathe. You will find these mandrels useful for other jobs as well, such as holding replacement tenons for turning.

These mandrels are short, supporting only the ends of the joint. By supporting only that part of the joint near the ends the concentricity of the turning will be better.

A full length mandrel doesn't work. It is normal for the joints to have some degree of warpage or distortion. A full length mandrel attempts to force the joint into straightness and may damage the joint. In any event, the crooked joint will not fill onto the mandrel properly.

The nominal taper of a bassoon bore is .014. The units of measure are not important as long as they are the same. Whether you think of .014 inch per inch or .014 cm per cm the rate of taper is the same.

Make the mandrels out of aluminum or steel, as you prefer. Steel turning centers secured with setscrews in each end will be needed. They should be of a convenient diameter and stick out about 1" past the end of the mandrel. I use 5/8" for most of my turning tools, as it is a good size for use with collets.

The mandrel for the boot tenon of the bass joint should be about 7 long with a small end diameter of about .950". A turning center extending about an inch from the small end will be used for chucking. A shaft extending about 20" from the big end will be used for the tail stock center. The extension should be long enough to stick slightly past the far end of the bass joint. A tapered plug about 1" long should slide on the extension. This will hold the free end of the bass joint centered on the mandrel extension and should be sized to fit the bore about 6" inside the bell tenon. Note that the mandrel is chucked between centers while the joint mounted on it is held on the mandrel by the tapered end and centered at the big end with the plug. The bass joint is not actually held in the lathe but only on the mandrel.

Mandrels (plural) will be needed for the bell tenon of the bass joint. This is an area in which different makers have differing ideas about dimensions. For instance, Puchner bores at the big end of the bass joint are typically larger that Heckel bores in the same area. It is reasonable to expect that two or three different sized mandrels will be needed. My first mandrel is 6" long with a small end diameter of 1.275. A second mandrel with a small end of 1.300 is often used.

The bell tenon mandrel will need 1" long turning centers mounted in the ends of the mandrel just as the boot tenon mandrel did. The mandrel will be chucked in the lathe, the joint fitted onto the mandrel and the other end will need a bore plug for the tailstock center to fit into.

Never use tapered plugs to fit into tenons. The plugs should be turned to fit the diameter of the bore with a second greater diameter adequate to seat squarely against the end of the joint. Plastic is a preferable choice of material for the plugs. Masking tape can be used to adjust the diameter of the plug to fit the actual diameter of the bore.

Most of my end plugs are drilled and tapped so that they can be mounted on threaded shafts as well as used simply as lathe centers. For wrapping or corking tenons it is much easier to work between a pair of such plugs as centers rather than to use the mandrels. Indeed, I took this one step further and made a mounted plug with steps to fit both tenons of the bass joint. It's very convenient for wrapping tenons.

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