Diagnosing the Problems of Bassoons

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Caveats

There are two important points that should be understood by anyone reading this information:

This information comes from Chip Owen—not Fox Products

This information is based on my experience as and instrument maker, an instrument repairer and a performer. It is intended for the use of persons intending to repair bassoons. It would be easy to assume that since I am employed by Fox Products that this information is what Fox Products uses in the process of making bassoons.

The skills and techniques involved with making bassoons and repairing bassoons are not always the same. Instrument making begins with raw materials and shapes them to the desired end. Instrument repairing begins with an existing instrument and contends with the results of forces and influences that have caused an instrument to deviate from a desired condition.

The art of instrument making involves knowing how to design an instrument and how to convert the designs into reality. In the process of this, an understanding of materials is vital both to use materials to provide the qualities desired in the finishing instrument and to make an instrument that will withstand the forces and influences that might adversely alter the instrument's future. This is true whether the maker produces limited volume one-at-a-time instruments or is employed in the manufacture of large quantities of instruments as part of a large corporation.

Instrument repairers have the job of satisfying the needs of existing instruments within the limitations defined by the customer. Understanding the unique influences on an instrument that have resulted in the present condition is often vital to returning an instrument to the customer that will best satisfy the unique needs of that customer.

The different objectives of making and repairing often require different sets of knowledge. The information I am providing is intended to aid in understanding both areas so that a bassoon can be repaired most effectively.

Not everything I suggest is appropriate to everyone's purposes.

Every one of us brings a different background into our skills as repair technicians. Every customer with which we deal believes that we look at their instruments the same way they do. Every boss runs their business with different objectives than their employees. There is very little I can offer that will provide universal satisfaction.

I work on bassoons as though nothing else exists. They are all I work on. I don't work on a brass instruments at all. I haven't worked on a clarinet, flute or saxophone in decades. But I've done just about anything that can be done to a bassoon. My view of repair work is so narrowly confined that I see problems that don't exist to anyone else.

Let me tell you about some of these problems. But don't feel that you have to inherit them from me. Knowing about them may help you someday but trying to keep track of all of them may get in your way for the work that feeds your family.

I might know more about working on bassoons than you do but I certainly don't know more about your unique circumstances than you do. Take what I offer and adapt it to your situation in a way that fits into your reality. Use what you find appropriate. Ignore the rest.

Defining an instrument

A woodwind instrument is a body with a longitudinal bore, lateral tone holes, and an excitation mechanism. Everything else is peripheral to the basic instrument and exists to control the instrument's output or to protect the instrument's integrity

I have included this definition in order to focus attention on the most important aspects of a woodwind instrument. Too often, attention is focused on peripheral problems without relating those problems to the true instrument itself.

Typically, when we repair a woodwind most of our time is spent working on keywork. Gluing on corks, changing pads and tightening hinges tend to become the objectives of the repair work. Keywork exists only as a control mechanism. It does not produce musical sounds on its own. It exists only to control the tone holes that are out of reach (or too big) for our fingers to control. As repair technicians it is important to learn why good hinges contribute to the instruments ability to make fine musical sounds or how improperly installed pads can detract from those sounds.

Much of my repair work on bassoons is oriented toward the body of the instrument. Most of the time keywork is simply in the way and must be removed so that I can get to the object of my repairs. Until the body is in proper condition any work on keys can only yield limited results.

Tenons

Broken Tenons:

The most severe form of tenon problem is a tenon that is broken off. This is usually immediately obvious. However, sometimes the nature of the break allows someone to stick the parts back together, either with or without glue, making the break temporarily less obvious. Be assured that the break will soon become obvious. There is no glue that will successfully bond the broken pieces back together. There is simply too little good glue surface for success.

Bass Joint Tenons are the most commonly broken tenons on bassoons with the boot end more common than the bell end. These tend to break often due to an excess of leverage causing traumatic breakage. In addition, these tenons also tend to have the greatest problems with splits which will eventually lead to full breakage. Split tenons can and should be fixed while it is easy to do.

Wing Tenons almost always break from sudden force. It is rare for a wing tenon to deteriorate over time and break.

Split Tenons:

Both tenons of bass joints are very vulnerable to splitting. It should be normal procedure during any inspection procedure to check the tenons for splits. When only one or maybe two splits exist, and the edges line up perfectly, it may be adequate to mend the splits with super glue. When several splits exist in a tenon or if the edges no longer line up, or if the tenon is otherwise distorted, the tenon needs to be restored.

Restoring a split tenon is preferable to waiting until the tenon must be replaced. It is possible to restore a split or distorted tenon to new condition without replacing the tenon. This involves a special technique of grafting new wood over the old tenon. It can be done with almost no visible evidence of the repair, except that the tenon looks new.

Splits also occur in wing tenons. Because of the tenon cap and the bore liner these splits are not visible until the cork or thread wrapping is removed from the tenon. These splits cause a degradation of the performance of the instrument and need to be eliminated. It may be adequate to fill the gap with super glue and maple dust. A more comprehensive repair involves turning most of the wood off on a taper, down to the bore liner, and grafting on new wood. This project will also require fabrication and installation of a new tenon cap.

Out of Roundness, and Other Distortions:

Some degree of out of roundness is common and should be ignored. Bores that are obviously oval may need some attention. Split tenons often are accompanied by out of roundness and also by split edges that don't line up. Before a split tenon can be restored these distortions should be reduced.

The method for restoring roundness requires a mandrel with the taper of the bore. This mandrel should be short, about six to eight inches, as joints are rarely straight enough to tolerate a mandrel filling the full length of the joint. The mandrel is heated up, the end of the joint is dipped in water, and the mandrel inserted into the joint. The resulting steam softens the wood and the distortion reduced. This may require several applications and the joint should be allowed to cool on the mandrel for several hours. Take care not to be too aggressive as too forceful an insertion of the mandrel or too much heat could cause other damage to the joint, the tenon, or the finish.

Another common form of distortion is the shrinkage of the bore under a tenon. This occurs in all wooden jointed wind instruments. It occurs because the wood has been thinned and pressure applied at the thinned section. In general, don't be too concerned about this unless it develops to an unusual magnitude.

(One of my favorite amusements is modern makers of historical instruments. They carefully study every detail of an instrument's design ascribing all sorts of reasons for the original maker to have made certain design details, all the while ignoring the forces that may have generated those details. Shrunken tenon bores are an example of such details.)

Old Tenon Replacements:

I have seen many tenon replacements that have been done very badly. The two common reasons for bad replacements are the use of inappropriate materials and the failure to restore proper dimensions. The use of metal or plastic tenons can destroy a joint. A tenon replacement that does not reasonably restore the original bore may cause considerable performance problems.

A few years ago I removed a lovely replacement tenon from a Heckel bassoon. It was nicely made from a piece of brass tubing. The bore was one inch in diameter throughout its three inch length; there was no taper to the bore. Apparently, the only objective of the replacement tenon was to facilitate the assembly of the instrument. No consideration was given that the use of the wrong material might damage the joint, nor was any consideration given that there might be any importance to the bore dimensions. Apparently, there was no awareness that the objective of replacing the tenon was to restore the instrument, in its entirety, to its proper performance condition.

The use of dissimilar materials for replacement tenons can cause serious problems. Wood moves as a result of changes in its moisture level. The amount of change will be different according to the radial, tangential and longitudinal relationship of the grain of the wood. Metal and plastic move omnidirectionally according to temperature. Sooner or later the movements of the dissimilar materials will come into conflict and cause damage to the instrument.

The worst examples of dissimilar material damage usually occur in the wing joint. Inevitably, when plastic has been used to fabricate the replacement tenon there will be a split up the groove of the wing. It was apparently reasoned that since the wing joint is already lined then it should be okay to use a tenon replacement of plastic. This doesn't work. The thin walled liner within the wood body of the wing joint does not constitute enough volume of non-wood material to become a problem. However, when the thick walled plastic tenon insert is installed the volume of plastic is sufficient to cause damage. The thin section of original wood remaining between the bottom of the groove and the counterbore for the replacement tenon is not able to withstand the movement of the plastic insert.

The bore taper of any wind instrument is important to the performance of that instrument. Replacing a segment of that bore without also replacing the bore itself leaves something missing. In reality, it is impossible to perfectly replace the bore that existed before a tenon was broken. Not even the original maker can do that. Too many forces have conspired over time to alter the bore in that tenon. However, a conscientious repairer can restore the bore to what is reasonably and approximately what that bore would have been.

Binding Sockets:

A problem that occurs primarily in new instruments and mostly in warm and humid times of the year is when the tenon and socket bind, making the instrument difficult to assemble and disassemble. Joints that may have fit fine when the instrument was made have taken on humidity and swollen enough that wood is binding on wood.

It could be either the tenon or the socket or both that have changed enough to cause the problem. The solution is to simply remove some wood. Since the area of greatest change in a piece of wood is at the ends the best areas to relieve are also at the ends. The opening of the socket can be scraped out with a triangular scraper and the end knob of the tenon can be filed down. Do as little as necessary to accomplish the objective and try to do it with minimal visible effect. Remove wood over as broad an area as possible so that the original taper of the tenon or socket is maintained. Don't bevel or round over the edges.

The worst part of this problem is that it occurs most often to new instruments. The new owners are terrified of the problem and the thought of anyone going near their new and expensive instrument with a cutting tool is even more terrifying.

Corked Tenons vs. Threaded Tenons:

The primary reason for the use of thread wrapped tenons on bassoon is for strength. The boot end tenon of a bass joint is rather thin and must withstand quite a bit of stress. Cork provides no reinforcement. Thread adds strength.

Of course, nothing so simple remains simple for long. There are performers who feel that thread wrapping inhibits their instrument's ability to vibrate properly. For them nothing but corked tenons can possibly work properly. Corked tenons are also more practical for instruments with straight (rather than tapered) tenons as corked tenons are easier to get into straight sockets.

In a modern world more familiar with corked tenons on most woodwinds, the use of thread wrappings on bassoon tenons seems wrong to many persons. Actually, the real problem is that other woodwinds need to use cork.

Threaded tenons are the "original" way of lapping a woodwind tenon. This goes back several centuries when only large instruments were made with joints. Small instruments were usually made in one piece and the question of tenon wrappings didn't exist. As the need for breaking smaller instruments down into joints arose the problem of where the joints should occur also arose.

Old instruments with irregular tone hole spacing were not too much of a problem for locating a tenon. Modern instruments with properly spaced tone holes leave little room for tenons. Oboes are probably the worst example of this. With such a short space available for a tenon the use of cork is necessary for effectively for sealing the tenon against air leakage.

Bassoons are still made the old way with irregular spacing, in addition to being large instruments. As a result there is a lot of room available for tenons. A bassoon's tenons are long because structurally they need to be and because there is plenty of room available. Thread wrapping works well for bassoons.

More on Threaded Tenons:

Using the correct type of thread can become important on bassoon tenons. The proper thread is cotton or linen thread. It is more important to avoid using the wrong type of thread. The worst type of thread for use on tenons is polyester. Polyester thread can destroy a tenon!

Polyester thread is too strong and elastic. When polyester thread is wrapped onto a tenon the sum total of all the tension can dramatically shrink a tenon. This can occur within a day or two.

A number of years ago at Fox we were searching for a new source of supply for tenon thread. Someone picked up some polyester thread at a local store to try. The day after it was applied to a joint another person, unaware of the difference, noted that the bore was undersized and had it reamed up to size. The thread was subsequently removed and the wood in the center of the tenon was now so thin that light and shadows could be seen through it!

Plastic Bassoon Tenons:

Fortunately, tenons on plastic instruments don't break as often as those of wood instruments. But when they do they are more difficult to repair and joint replacement is often necessary.

Fox and Renard plastic bassoons are made of polypropylene which cannot be solvent bonded. <u>There is no glue that will bond polypropylene!</u> The use of epoxy for body repairs to polypropylene bassoons is doomed to failure.

It is possible to replace broken wing tenons by making use of the thermal expansion factor of the plastic. The replacement tenon is made larger than the counterbore by about .005". Then the tenon is placed in a freezer and the body heated in hot water. The tenon shrinks, the body enlarges, and the tenon is quickly inserted into place. When the temperature of the joint returns to normal the tenon will be held tightly in place. The bore will need to be reamed to dimension and finished. This job is best done at the factory where the properly tooling for completing the bore is at hand.

Bass joint tenons are not replaceable. The trick that works well on wings fails on basses. There just isn't enough mass of material to make it work properly.

Socket Liners

All wooden bassoons normally have a metal socket liner in the boot joint lining the socket for the wing joint tenon. These can cause a couple of different problems.

Out of position socket liners:

It is not uncommon to see boot joints with wing socket liner problems. At some time in the past the liner came loose and was pulled out of position as the wing joint was separated from the boot. The socket liner may have been completely pulled out or may only have just slightly moved out of position. In any event, its now a problem.

The obvious part of the problem is the raised rim of the liner. The potentially greater problem is the gap between the bottom of the liner and the end of the bore. This gap is not only an acoustic problem but it also exposes the vulnerable end grain behind the bore liner to moisture. Failure to remove and properly restore the liner can lead to serious damage.

In addition to the acoustic and body damage the liner itself becomes damaged over time making it more difficult to repair. The raised rim becomes bent over insuring that it can no longer be simply removed and replaced. The bent over rim also effectively shortens the depth of the liner. This can result in the bottom of the liner being broken away from the sides. These sockets are not easily replaced and whenever possible it will be easier to repair and reinstall them rather than to fit a new liner.

Removing a socket liner:

Metal socket liners can be difficult to remove, if you don't know the trick. Basically, the liner is soldered to a piece of pipe which provides the means to pull the liner out.

A steel plumbing nipple and a cap will be needed. Turn one end of the nipple to fit snugly into the socket. Tin the end of the nipple with soft solder and solder it into the socket. The heat required to accomplish this will also serve to soften the adhesive holding the socket liner in place. While the nipple is still hot, but after the solder has hardened, screw the cap on the other end of the nipple, insert a ½" steel rod through the other end of the joint and bang the nipple out with the socket attached. After unsoldering the socket from the nipple it can be cleaned up, straightened as needed and reinstalled in the socket.

Straightening a distorted socket liner:

That same nipple that was turned down to pull out the socket liner can be used as a mandrel to straighten the liner. However, while accuracy was not very important to pull the liner, accuracy becomes more important for straightening it.

Take good measurements of the liner diameters to determine the taper of the liner. (Most, but not all, bassoon sockets are tapered.) Use this to set the angle of the compound to the same angle. Turn the same taper onto the mandrel down to a diameter that allows the socket to almost completely fit onto the taper. Replace the cutting tool with a burnishing tool to spin the liner onto the mandrel. It may be necessary to anneal the socket to get it properly straightened. If the spinning causes the socket to elongate the extra length can be easily trimmed after installation.

Re-Installation of the socket liner:

The socket liner was originally secured in place with a heavy adhesive or epoxy. Epoxy usually works fine and is recommended.

Be sure to clean up the sides and bottom of the wood socket of all old adhesives. Don't depend on it being round—it probably isn't. Test the fit of the socket carefully. It should fit snugly, which also means that it could be difficult to get out to apply the glue. The bore hole is rarely perfectly center at the bottom; try to find the best position and mark the socket so that it can be replaced in that position.

Take care to remove all of the excess epoxy out of the bore before it begins to set. After the epoxy is cured any extra metal sticking above the surface of the boot joint should be filed away. Be sure to leave the edges smooth; any sharp edges will damage the cork or thread tenon wrappings on the wing tenon.

Split Sockets

Splits in the sockets of bassoons are not uncommon. Repairs to unlined sockets require special approaches because of the thin oily wood surrounding the splits. Lined sockets also have splitting problems that are, to some extent, the result of the liners themselves.

Unlined Socket Splits of the Boot and Bell:

Splits in the unlined bass socket of the boot joint are more serious than splits in the bell socket as the bass socket splits will have more effect on the performance of the instrument. Repairs to either socket are essentially the same.

Socket splits can be a source of leaks. Even though the split appears to be tightly closed, it may open unseen while the tenon is in place. During this period the splits acts as a bypass around the tenon wrapping allow a direct leak from the bore at the bottom of the socket to the outside at the end of the joint. Achieving an effective seal of a single joint is for naught if the assembly of that joint with another opens a leak.

The stress on a split caused by repeated widening of the split each time the joints are assembled can cause the split to extend itself. These splits are easier to fix while they do not extend past the band surrounding the socket. When they extend past the band a bit more effort may be required.

It is not possible to effectively glue the thin edges of wood so that they will be strong enough to withstand future stresses. Effective repair of this condition requires reinforcement of the area surrounding the split. This is done by removing the band, bonding fabric to the wood and carefully refitting the band.

Band Removal:

Bands are sometimes, but not always, easily removed. First remove any posts or screws that go through the band into the wood. Be careful: Some posts are soldered to the band and are not intended to be removed. Also, make a mark crossing between the wood and metal under the pancake key rod. This will make it easier to align the band later. If you are very lucky (you—not the bassoon) the band will now simply fall off. More often the application of heat to the band is needed. Take care with the torch not to burn the finish on the wood. A piece of automobile inner tube rubber wrapped around the band will provide a good grip without getting your hands burned on the hot metal. It may be necessary to get the band hot enough that oil in the wood next to the band smokes and bubbles. Don't get it any hotter. In some circumstances a thin blade can be slid between the wood and the band to free the band.

In truly stubborn cases it may be necessary to use a gear puller to remove the band. A pair of lugs are soldered to the sides of the band for the arms of the puller to engage and a piece of metal placed on the end of the joint for the puller to push against. Tightening the screw on the puller will remove even the most stubborn band. Using this technique on the bell or the wing joint bands will require a special fitting for the puller to push against. Unfortunately, the solder from the lugs may leave a shadow on the band that is hard to remove. This technique is best saved for when replating the band is also involved.

Straightening the band:

A common reason for socket splits is that the band has been bent. Dropped boot joints have a habit of landing on the most vulnerable side of the boot band. If a boot band is visibly bent into the bass side socket a split is almost certain to found. The band will need to be removed and straightened using whatever large diameter mandrel will do the job.

Straightening the socket:

Deformed sockets are even more common than split sockets. Be conservative about straightening them as the process of straightening them can also split them.

The procedure is based on steaming them back to shape. A mandrel needs to be turned with the correct taper and diameter for the socket. The mandrel is heated hot enough to rapidly boil water. The socket is dipped into water and then placed onto the mandrel. The steam softens and reshapes the wood. Be sure to keep everything in line; this can be done in the lathe between centers. Repeat this a few times, finally leaving it to cool on the mandrel.

This can be a stressful procedure. Bind the band tenon to resist any excess stresses that may make any crack worse. I like to use cotton string as it also acts as a reservoir for more water to produce additional steam.

Reinforcing the split:

Split sockets are fixed by reinforcing them. There is not enough wood to glue the edges together nor is there enough wood to even think about pinning the split. Anyway, pinning isn't really effective with maple.

With the band removed and the tenon cleaned, a piece of cotton or silk fabric is wrapped around the tenon. At a minimum this fabric should extend about an inch to each side of the split the full width of the band tenon. The fabric can be wrapped fully around the tenon if you choose. The fabric is bonded to the wood tenon with super glue, liberally applied. Strips of newspaper can be used to rub the fabric onto the wood and remove the excess super glue. Be sure to use plenty of ventilation while doing this.

If any parts of the fabric do not appear to be well bonded to the wood apply more glue and again use the newspaper strips to rub the fabric onto the wood.

Wide open splits:

Socket splits are often seen with gaps that must be filled. The best material to use is maple sanding dust. Fill the gap with the dust and with super glue at the same time as the fabric is being applied. The fabric and the band will hide any unevenness on the outer surface. Be sure to overfill the inner side in the socket so that it can later be cut down to be smooth with the rest of the band.

Refitting the band:

After everything else has been done, it is unlikely that the band fits correctly. The band tenon must be filed down so that the band fits accurately before gluing the band back into place.

It is difficult to know just how the band fits its tenon. A strip of paper used as a feeler gage between the band and tenon will help you know where it is too tight or too loose. Ideally, it should fit evenly all the way around. Don't expect that to happen but try to approach it. Be sure to keep the shoulder of the tenon clean so that the band butts up against it tightly. At this point the band should fit just loose enough to freely bottom against the shoulder.

A paper shim seems to benefit the fitting of the band to the joint. Cut a piece of newspaper to fit around the tenon without overlapping. The bottom edge should be carefully to closely match the shoulder. The top edge can be trimmed after the band is installed.

I prefer to use shellac to glue the band. I don't like to use flexible gap filling materials such as silicone. In my experience, a carefully fitted band with a paper shim all glued on with shellac works very well.

First paint on a coat of shellac and lay the paper directly into the wet shellac. Apply more shellac onto the paper and inside the band. The band can now be slid into place. It probably won't go fully to the shoulder because of the additional thickness of the paper. Wipe off the excess shellac before tapping the band fully into place with a mallet, taking care to get the alignment marks lined up. Avoid getting the shellac onto the finish as the alcohol in the shellac may damage some finishes.

After trimming off the excess paper sticking out the top of the band reinstall the any posts and other hardware, check for any more shellac oozing out and leave it to set overnight.

Socket Splits at lined sockets:

Splits can also occur by lined sockets. This most commonly occurs near the wing socket of the boot joint.

Socket liners can be a cause of splitting. The dimensions of the metal socket liner don't change even though the wood continually moves. If the wood shrinks around the liner the only way to relieve the stress is to split.

Usually these splits can be filled by removing the band and filling with maple dust and super glue. Rarely, the socket liner may also need to be pulled to effectively fill the split.

Cracks at the wing socket liner have a habit of heading toward the C♯ trill key tone hole. If this is the case it may be desirable to line the tone hole. Usually it will be sufficient to fill any gaps with maple dust and super glue.

U-Tubes

The u-tube system includes not only the u-tube itself but also the bracket assembly that holds the u-tube. Problems with the u-tube itself are usually easily fixed. Problems with the bracket assembly require more effort.

Testing the U-tube System:

A water test for u-tube system leakage is easily done and should be part of any diagnostic procedure on a bassoon. With the boot cap removed and the u-tube in place, immerse the bottom of the boot joint in water so that the water lever rises to just cover the wood above the brass. With all of the tone holes closed, close one bore of the boot while blowing into the other side. Watch for bubbles coming out from the u-tube system. If bubbles only come from the gasket between the bracket and the u-tube then only the gasket needs to be replaced. If bubbles come from the top edge of the bracket then the bracket assembly needs to be overhauled.

Gaskets:

U-tube gaskets are normally bonded to the base plate of the u-tube. They should not be glued to the bracket. The rubber gaskets used on Heckel bassoons can be loose or bonded to the u-tube.

Gaskets are normally made of 1/16" cork bonded to the u-tube base plate with contact cement. Some players made request that the gasket be made of thicker cork. 1/8" cork shouldn't be a problem; 3/16" cork is getting difficult and ¼" cork is too thick. The thicker cork thickness tend to be too stiff to provide a good seal and more likely to swell into the bore as a result of the moist environment in the u-tube.

When cutting the bore holes from a new gasket be sure that the edge of the gasket will not swell into the bores. This is a common problem. It also occurs on the rubber Heckel u-tube gaskets. Any gasket material that might swell into the bores should be trimmed back.

U-Tube Dents & Damage:

U-tube dents are often seen. The biggest are usually flattened bottoms that occur when some school kid takes off the boot cap and then confuses his bassoon with a pogo stick.

U-tubes dents often occur as a byproduct of swabbing the instrument. Outward dents often result from the improper use of the wrong kind of swabs. Wrapping a cloth over a metal shaft to use as a swab is better at producing dents than at removing moisture. The old style woolly push swab does a great job of pushing debris into the u-tube and a poor job of removing moisture. The best type of swab for the boot joint is a pull swab that can go in the big bore, through the u-tube and out the small bore.

Bracket Assemblies:

Removal and overhaul of u-tube brackets requires some knowledge of how they are made. There are several variations on the same theme that require different procedures.

Bracket assemblies are made of a band, a plate, two wood screws, two u-tube studs with nuts, and (maybe) one or two alignment pins. There are lots of ways to make those parts and put them together. All of the parts are made of either brass or nickel silver. They can all be run through some acid to clean them and scratch brushed to make them look nice.

The u-tube studs are made a couple of ways. Studs for Fox and Renard bassoons are silver soldered to the underside of the plate. All other makers use a double ended stud with a small thread which is screwed through the plate into the wood and a large thread that holds the u-tube. Some of these may use wood screw threads into the body. Gripping the stud to remove it can be done with the larger collet type swedging tool from Ferree's.

The wood screws should be of brass. If they are of steel they should be replaced. Any steel parts in this moist environment will rust and cause problems.

The alignment pins in cheaper bassoons are usually simple nickel silver pins that are crudely driven into the end of the boot. The pins in Heckel brackets are screwed in place.

The way in which the plate and band are assembled is the most important feature in terms of the quality of the assembly. From worst to best, the two parts may be entirely separate, press fitted together, soft soldered or silver soldered into a single unit. Whenever possible, loose or press fitted parts should be silver soldered into a solid unit. Scratching alignment marks into the two parts before disassembly will aid in correctly soldering them together.

Before reassembling the bracket assembly check that the bracket plate and the u-tube plate are both reasonably flat and will mate well with each other. If you are using new wood screws be sure that the countersink is deep enough. Be sure you know which way the bracket will fit onto the boot.

The bracket needs to be sealed onto the boot. The preferred material to use is clear household silicone sealer. Coat the end of the boot and the inside of the bracket and put the bracket in place. Screw it down with the wood screws. The studs and alignment pins can be added after the excess silicone is cleaned up. Avoid smearing the silicone onto the wood finish too much as it may cause difficulties in the distant future when the body is refinished.

Fox/Renard brackets are the easiest to reseal. They are held in place with two wood screws; the studs are soldered in place and there are no alignment pins. The better German instruments that use solid plate and band assemblies and are a pleasure to work with. Lower quality German instruments with separate bands and plates can be a problem. The band is often held in place with screws installed through the sides of the band which are then filed down so that the slot is no longer accessible. The screws must be located (not always easy), drilled out. Later, the holes in the band should be plugged, the plate and band silver soldered together, and then you have a good u-tube bracket.

Boot Caps:

Boot caps can sometimes be difficult to remove. This is often a byproduct of moisture leaking from the u-tube. The moisture gets between the bracket and the cap and sets up a corrosion that holds the parts together. At other times the cap is simply too tight.

To remove a tight cap hold the boot with the cap on top, holding it only by the cap at a slight angle to put a strain on the cap. With a rawhide mallet tap around the open end of the cap, tapping over the part with the u-tube bracket under it. Continue tapping around and around the cap until the parts loosen. It is rare that this does not succeed in loosening a cap. Be sure to clean up the parts before replacing the cap.

When caps simply are too tight it may be necessary to file down the bracket band to get a better fit.

When caps are too loose to stay in place it may be necessary to tighten them by cutting down their open end. Be sure to check first that there is enough room under a shortened cap for the u-tube. Scribe a line around the open end of the cap by setting it, open end down, on a flat surface and using a sharpened tool that held on the surface that will make a mark about 1/16" above the surface. Then use a grinder, belt sander, or file to cut the cap back to the line.

Water Damage

Water is the greatest enemy of a bassoon. Moisture is primarily introduced into the bassoon by the player. Failure to control the moisture, both by daily care and by periodic maintenance can contribute to the premature demise of an otherwise good instrument.

Boot Rot:

The beginning of the unlined side of bore, at the u-tube, is the most vulnerable area on the bassoon. All of the bore preceding this point is lined to protect the wood from moisture. The accumulation of water in the u-tube while the instrument is being played can gain access to the unlined bore because of careless or ignorant handling of the instrument and eventually lead to a serious condition.

The area affected is usually quite predictable. The first area to be affected is immediately at the beginning of the unlined side on the thin outer edge, that is, the point furthest from the lined side bore. From there the affected area may proceed straight down the outer side of the bore or it may go directly toward the front (little finger) G♯ tone hole. This tone hole may also be seriously affected.

Diagnosing Boot Rot:

Often, the first hint of a problem will be observed by noting the condition of the G♯ pad. Moisture normally damages the leather faster than the wood. Boot rot should be suspected if this pad is noticeably in worse condition than other pads, or if it is the only new pad on the instrument.

After removing the u-tube look at the concentricity of the unlined bore and the opening of the brass u-tube bracket plate. Normally, these should be fairly well aligned. If the wood has visibly swollen into the bore there is a moisture problem. Keep in mind that these holes may not have been perfectly lined up when the instrument was made. However, they would have been reasonably closely in agreement.

With the u-tube still off, poke a sharply pointed tool, such as a #11 x-acto blade, into the wood at the outer edge of the unlined side. Compare the resistance to other areas around the bore. If the outer edge is noticeably softer boot rot may be a problem. In minor cases the difference in softness is not very great. In severe cases a knife point might not meet with any resistance until it gets to the brass band! Be sure to note how far down the bore the soft wood extends.

If you think the rot is more than superficial the u-tube bracket will need to be removed. Further examination of the extent of the rot will be possible and more effective treatment will be easier.

Treatment of Boot Rot:

There are three objectives in treating the rot condition: eliminating the soft wood, restoring the bore and preventing future rot problems.

In minor cases the simplest treatment is to simply use some super glue on the affected area. The soft wood is highly absorbent and will suck up the glue like a thirsty drunk. After a first application has hardened apply a second coat to test the area. A single application may be all that is needed for a minor case. If a second application is needed the case may be more than minor and more aggressive treatment may be needed.

For more than a minor case the u-tube bracket should be removed. This will allow the super glue to be applied to the end grain at the end of the boot as well as in the bore. As before, the areas which have been affected will suck up the glue. The super glue will simply sit on the surface of good wood.

Having hardened the wood with the super glue, re-install the u-tube bracket if it had been removed. Any swollen areas now need to be restored to their original dimensions. Since it is extremely unlikely that you will have either the dimensions or the tooling to restore them, it is necessary to do a good job of approximating them. The brass u-tube bracket plate will provide some guidance in this. A half-round file with a curve slightly smaller than the bore's curve will do a good job. Lay as much as possible of the length of the file against the side of the bore and file out the swelling until the bore is once again straight and the end of the bore again matching the hole in the u-tube bracket plate.

This method of restoring the bore dimensions may seem very crude but with a bit of care you will end up with a much better bore than existed when it was swollen. That swelling was causing problems for the player. The problems crept in so gradually that the player was probably blaming all of his problems on his reeds, or was searching for the right bocal. Don't be too surprised when the player announces that you have solved problems his has been suffering with for a long time.

Major boot rot requires major surgery. It will be necessary to bore out the end of the boot joint and insert a new piece of wood. The insert can also be made of hard rubber or grenadilla. I prefer to use maple as I can finish the surface to better match the existing maple bore. This can restore the value of the instrument better than adding an obviously different material. The insert usually extends to a point past the problem area and to where it is least visible when looking through a tone hole.

Major boot rot often requires accompanying surgery to the G♯ tone hole. It is very likely that the wood of this hole is also in bad shape. The hole will need to be drilled out and filled with a new piece of wood. This is best done before replacing the bore segment underneath the hole, thus giving a better finished job in the bore. Be sure to line up the grain of the wood correctly. If done correctly there should be little evidence at a casual glance of the work that has been done.

All of the wood surfaces in the area need to be treated to prevent future problems. This can take longer than the main procedure. The wood should be oiled several times over a week or two. Finally a sealer coat of shellac should be applied over the area. It is not necessary to coat the entire bore segment, but certainly coat the first few inches of the unlined bore above the u-tube.

Other types of water damage:

Once past water problems in the unlined boot bore and the G♯ tone hole, water problems tend to get more unique. Although there is no lack of opportunities for water damage there aren't many that occur often enough to describe. But there are a couple.

One signal of water damage that is somewhat unique to Fox and Renard bassoons occurs in the finish. These instruments are stained using a water soluble aniline dye. If moisture somehow comes from within the instrument and gets to under the surface of the finish, the dye can be drawn away and the color in the area will fade. This is usually seen in the wing joint groove near the metal finger tubes or the C♯ tone hole. The cause is probably that moisture is getting around the tube at the bore liner and attacking the wood. A related condition often coexists. The wood swells to a degree that the pad arms for the E♭ vent and for the E/F♯ trill and high E keys appear to have shrunk leaving the pad cups no longer centered over the tone hole facings. This problem should be called to the attention of Fox Products for correction.

Preventing water problems:

Although regular maintenance including the use of bore oil can reduce the problem, effective prevention of water problems must originate with the player. Proper holding of the instrument and swabbing after use are very important.

A bassoon in use must never be laid flat over the knees of the player. This is a common situation among young players. The instrument must be kept at an angle or straight upright. The use of a bassoon stand can help considerably.

The common problem of moisture in finger holes can be reduced by rotating the instrument correctly. The common habit when a player rests is to rotate the instrument so that it lays flat against the leg. This leaves the finger holes in the most vulnerable position to intercept the flow of water in the bore. If the player learns to rotate the instrument the opposite direction the finger holes are kept out of the moisture flow and the problem is greatly reduced.

Swabbing of the boot joint should be done with a swab that pulls through the u-tube. This is the best method of removing the water that has collected in the u-tube. It is also more effective at keeping this part of the bore clean. The old style push swabs only push moist debris into the u-tube. They were originally intended to be used with the u-tube removed. They don't work with the u-tube in place.

Any moisture in the boot joint when the instrument is placed in its case immediately moves into the unlined side bore. This will happen in any bassoon case. Band directors who do not give them bands sufficient time or insist on proper cleaning of the instruments are actively contributing to the damage of these instruments.

Epoxy

I am including this section because of the ways in which I have seen epoxy unsuccessfully used for body repairs of bassoons.

Epoxy often just plain doesn't work! I see a lot of epoxy on inner surfaces of bassoons that has not cured properly and remains gummy and flexible. Apparently, the oil in the wood inhibits the epoxy from curing, or maybe old or poor quality epoxy was used or it was poorly mixed.

I frequently see gobs of it spread over splits. Presumably, someone thought that if enough epoxy could be used any problem can be fixed with it. If the epoxy can be seen on a surface it hasn't been used properly.

Epoxy shouldn't be used for wood to wood gluing. There are many glues made for wood that are far superior to epoxy.

Epoxy should not be used to fill in areas of rotted wood. It doesn't penetrate well and it certainly isn't going to be effective when applied to soft flaky wood that is threatening to fall out. There are other glues that do this better. If the site is falling-out rotten the rotted area needs to be bored out and replaced with new wood.

The best places to use epoxy usually involve bonding wood to metal or other non-porous materials. For instance, the metal socket liner in the boot joint that receives the wing tenon is appropriate to install with epoxy. Gluing in a hard rubber bocal socket in the top of the wing can be done with epoxy. All of these involve a well fit joint; none of them involve smearing epoxy on an exposed surface.

Epoxy may have a lot of good qualities but most of the adhesive needs of a bassoon are better served by other adhesives.

Finishes

Maintenance of the finish on a bassoon is an important and often overlooked part of taking care of the instrument. At a minimum, cleaning the finish should be an integral part of any complete service of an instrument. When possible, repairs to a finish can keep an instrument looking good allowing the major project of refinishing to be deferred.

Cleaning finishes:

Because of the variety of finishes that have been used on bassoons, and because of the difficulty of knowing what type of finishes may be on any bassoon, it can be risky to use solvents to clean any finish. For example, the acrylic enamel used on Renard and older Fox bassoons does not have a problem with alcohol, but the oil varnish used on newer Fox professional models can be damaged by alcohol.

The safest material I know of for cleaning finishes is mineral oil. It safely removes embedded dirt from finishes without damage to the finish itself. Brushing it around the bases of posts with a key cleaning brush can be an effective way of cleaning the mess that inevitably accumulates around posts. On the other hand, if used too liberally the oil can take a day or so to settle down and not be a problem on the surface, and it can leech out of the wood and get on the pads. Tone hole facings should be sealed before the cleaning is done. This is my first choice for cleaning finishes and I use it regularly.

A more aggressive method of cleaning uses rottenstone. This finely powdered abrasive is more familiar to us as tripoli. It is used with either water, which gives a glossy finish, or with oil, which gives a more satin result. Typically, take a moist cloth and dip it into the rottenstone and rub it onto the finish. At first it will look like you have smeared mud all over the finish. When you think you've done enough let the water dry and wipe off the dried residue. This should be done before cleaning the body with oil as described in the previous paragraph.

Rubbing out a finish with rottenstone can go a long way to restoring a dull, aging finish. It is best used when the finish is largely intact. Broken and cracked finishes will probably not benefit from this.

Repairing a finish:

Super glue can often be used to touch up small areas of finish. Small dents and chips can be fill or covered with a drop of glue. After the glue fully hardens the spot can be filed and sanded smooth with the surrounding finish and rubbed out or buffed to restore the shine. Don't try to do too much with this, however, this technique can be very effective for fixing small area problems.

Not quite refinishing:

Whenever possible, the complete refinishing of a bassoon should be avoided. If it is possible to add finish to a limited area this can accomplish this goal.

Soft finishes such as are typically seen on Heckel bassoons are the easiest to work with. It is practical to add finish to limited areas. One product that is good for this is "Tru-Oil" by Birchwood-Casey. This is a gunstock finish that is readily available anywhere gun supplies are sold. The Tru-Oil is applied by hand, rubbing it onto the area. The excess oil is wiped off and the piece set aside to dry. This oil dries quickly and two or three coats can be applied in a day. Remove the nearby posts when you do this to avoid discoloring them.

Another finish that can be applied over an existing finish is French-polish. This is a labor intensive method of applying a high quality shellac finish. The results can be beautiful but it takes a while to learn the technique and the finish is not the most durable. However, I prefer to use this technique to restore an existing Heckel finish rather than to remove the old finish and start from scratch. The stripes in a Heckel finish are very difficult to replace and this finish will keep and improve the original finish appearance.

Refinishing: To do or not to do—That is the question!

Bassoons are long lived instruments. A properly maintained instrument is capable of a usable life well in excess of half a century. Any instrument that lasts that long will inevitably need to undergo a substantial restoration at some point in its lifetime. Deciding when to do it is the first problem to be solved.

Is this instrument worth the effort?

Every maker has made instruments that are simply not worth the effort of reclamation. At one end of the scale some makers have made no instruments worth the effort. At the other end of the scale every instrument from certain makers will have value, but not always as instruments that can be used for performance.

Is the existing finish restorable?

Some types of finishes can be restored without refinishing the instrument. Typically, these are high value instruments; the appearance of the finish is frequently part of the value. Restorable finishes are usually based on a soft natural oil varnish. They wear smoothly without chipping off. On the other hand, finishes that form hard shells, such as lacquers, tend to break off in chunks leaving well defined edges. These finishes are not restorable and will require complete removal before refinishing can proceed.

Is the existing finish repairable?

Refinishing is a major project. Drastic changes are being inflicted upon the instrument. If the existing finish can be repaired this should be considered as a preferable alternative. Unfortunately, the proper repair of any finish usually requires some knowledge of the type of finish being repaired. A technique that fixes one type of finish may destroy another type.

Types of Finishes:

Oil Varnishes: The better makes of bassoons use oil based varnishes. These tend to be softer than the more modern finishes. The instruments are perceived to play better as a by product of the softer, more flexible finish. Oil varnishes wear away more smoothly than lacquers and plastic finishes and a very typical wear pattern can be seen on any Heckel bassoon.

Lacquers: Lacquers tend to be brittle finishes. Their primary benefit is to the maker as they can be applied within a very short time span. Lacquered bassoons eventually look bad because of the broken appearance of the finish.

Plastic Finishes: I'm lumping several modern finishes together under this heading. Polyurethane is the most familiar plastic finish. This is a good durable finish but it is not possible to do a good job of repairing a polyurethane finish. Acrylic enamel is used on all Renard and older Fox bassoons. Generally this has proven to be a durable finish that can be repaired effectively.

Stains:

Heckel bassoons and some other German makes use color in the finish itself. As a result, the color wears away as the finish is worn. Repairing a colored finish can be difficult as the thickness of the finish directly affects the density of the color.

More often, the wood is stained before the finish is applied to the stained wood. This is usually a simpler approach. Since the color remains even when the finish is worn or missing a coat of finish can be applied to the wood without a problem of matching the color.

Avoid using common hardware store wood stains. These are usually meant to be used on soft woods such as pine. They don't give sufficient color density to look good on maple. It is better to use water soluble aniline dyes. These have better color penetration, can yield better color density, can be applied more evenly and can be mixed to give any desired color. NGR (Non-Grain Raising) stains are also an excellent choice in pre-mixed stains. Alcohol soluble aniline dyes tend to fade faster than water soluble dyes and are more difficult to apply evenly. Oil soluble aniline dyes are useful for mixing into varnishes and lacquers to apply colored finishes.

Bocals

Bocals are vulnerable to many kinds of damage. Neither their importance to the instrument nor their value make them immune to the hazardous environment of a school. Often the biggest question to be answered about repairing bocals relates to the cost of the repair compared to the cost of a replacement bocal.

A good bocal is incredibly sensitive to changes in dimension. Bending the bocal slightly and bending it back to its original position will make a noticeable difference in the performance of the bocal. There is almost nothing beyond changing the cork that will not alter the way a bocal performs. Keep this in mind whenever working on a bocal.

Bocal Seams:

All of the best bocals are made of sheet metal and are formed into tubes with seams. Although seamless bocals are made they are consistently considered to be lower quality bocals. I know of one maker who produces both seamed and seamless bocals, designating the seamed as professional and the seamless as student. The reasons for this are not clear, but the point remains that if a decent bocal is desired it's going to have a seam.

Split Seams:

Bocal seams will split. This usually occurs as a by product of twisting the bocal. Twisting can occur when the player attempts to reposition the bocal by moving it from too close to the reed end of the tube. If the bocal cork is too tight the tube can twist. If the player attempts to bend the end of the bocal up or down it may split. Almost all split seams are caused by mishandling.

Split bocals should not be repaired if the seam is wide open or distorted. If they have been damaged to that degree they are trash! There is no possible way that any repair can approach restoring the bore dimensions to anything closely approximating the original dimensions.

Split seams can be repaired by silver soldering the seam or by soft soldering a patch over the split. The patch is more durable but presents an appearance problem. Because of that some repair technicians like to silver solder the seam. With silver soldering the problem is that it can be very difficult to get the solder to flow into the seam and the heat of silver soldering can soften the tube making the bocal more vulnerable to future problems.

My usual recommendation is to patch a bocal. Usually this will be more cost efficient and more durable. The exception to this is splits at the tip of the bocal where a patch would make it impossible to put the reed on. For the few professional players who want to have a high value bocal restored without a patch there is at least one technician of whom I am aware that can do this job. For the rest of us it is worth it to let him do it for us.

Dents and Kinks:

Removing dents from bocals is largely a matter of accessibility. There simply aren't tools available that can work the full length of a bocal. Ferree's makes a good cable but doesn't supply balls small enough. I'm not aware of anything else that even comes close.

Before removing dents it might be pertinent to know if they are really affecting the performance of the bocal. If the bocal plays well, it might be better to leave them alone.

Rings and buttons:

The ring at the big end of the bocal and the vent button are both soft soldered in place. If they are observed to be loose they should be resoldered.

I'm always amazed at how many bocal buttons are sold as repair parts. Somehow school kids manage to take a lot of buttons out of bocals. Fortunately, they are relatively easy to replace.

Watch out for oversized vent holes. Some players like to enlarge the hole on the theory that they are fixing problems. They're also creating other problems. The correct size is about .031"-.032". Use a #68 or a 1/32" drill.

Caveat Emptor:

On last piece of advice about bocal repairs: Don't guarantee bocal repairs beyond recorking. Bocals are just too sensitive. It will be impossible to restore a damaged bocal to its original playing condition. Make sure that your customer knows that the repaired bocal will not play like it did before it was damaged. There's a good chance that it will be better, but there's also a chance that it will be worse.

Bell Rings

Although primarily decorative, bell rings do serve an important duty in protecting the end of the bell from damage. In addition, there is not much than can degrade the appearance of a bassoon to the audience faster than a broken bell ring.

Repairing broken bell rings:

In short: Don't bother. It rarely succeeds. Bell rings break because they became brittle with age, and/or the wood swelled beyond the rings ability to withstand, and/or they were assaulted in some way. In any event, there isn't any glue that will succeed in withstanding the reason the ring broke. To make matters worse, all glues leave an ugly glue line and repaired bell rings usually look bad.

Real ivory bell rings are the most frustrating type of rings when they break. The fact that they are ivory demands greater interest in restoring them. Yet, they don't repair any better than plastic or other fake ivory rings.

Replacing bell rings:

Replacement rings for a few makes of bassoons are readily available. However, there's a lot of bassoons around for which the makers no longer exist or are otherwise not accessible. Buy 'em when you can; make 'em when you can't.

The biggest challenge to making bell rings is getting a material with the right appearance. The simplest material that comes close is natural ABS rod. (Small quantities of 3" natural ABS are available from Ed Kraus.)

The attempts I have seen at producing "made to order" bell rings have been terrible. It is better to first set up the bell in a lathe to true the end where the ring will be fit. Then the inside diameters are of the ring are cut to fit the trued bell, leaving the ring blank slightly hanging over the end of the bell. I prefer to turn the ring with it on the bell. This allows the ring to be turned to better match the bell. Be sure to mask the finish adjacent to the ring with a heavy layer of masking tape to prevent accidents. The turning is done mostly by hand using a hand-held scraping tool to shape the ring. A fragment of the original ring should be used to get the profile. Be sure to true the end of the ring to match the end of the bell. Smoothly polish the surface and buff it to a shine.

Metal bell rings:

Metal bell rings on so-called "French Bells" may not break but they do get loose and rattle. Unless you happen to have shrinking dies on hand in sizes for every make, it is easier to glue the ring in place.

To glue a metal bell ring in place, set the bell upside down and apply super glue to the underside of the ring where it meets with the wood. Use a fine stylus to deliver the glue in small quantities rather than pouring a great mess over the end of the bell.

By the way, it is usually not practical to remove a metal bell ring when refinishing a bassoon. Removing them usually requires destroying them. It's more realistic to finish over the ring and carefully remove the finish from the ring afterwards.

Keywork & Padding

While the body may be the true instrument and the keywork just "control devices," modern woodwinds have come to depend on those devices to such a degree that neglecting them can negate any amount of effort put into perfecting the body.

Rollers:

Key rollers are a nuisance. They are perceived as a means of improving the movement of fingers from one key to an adjacent key. In reality, they can often be more detrimental than advantageous.

Little finger rollers often involve a stretch to access the further roller. There's not much that a repair technician can do to change the distance to the key without major work to alter the keys. Extending the roller spatulas further from the hinge can backfire. The longer radius results in a greater arc of movement at the end of the spatula. As the nearer key depresses more the further key becomes more difficult to access. The roller remains so much higher that it becomes more of a barrier than helper. Think twice before yielding to the pleas of a small handed bassoonist begging you to extend the keys.

In general for finger rollers, set the pair so that the further roller is slightly lower than the nearer roller. This will ease the movement from near to far without becoming a problem moving from far to near. Reversing this, with the further roller set higher than the near, can make movement from near to far difficult, or even impossible.

Rollers for the keys operated by the right thumb have their own problems. Most persons don't realize that the right thumb is not held flat against the keys bur rather contacts the keys somewhat on its side. This makes movement from the pancake key down to the F♯ key so easy that a roller isn't really needed. However, movement up to the B♭ is a different story. A roller in the thumb B♭ key can easily become a barrier to the thumb. The lower to the body this key can be set the better. There is no musical reason for the existence of rollers between the thumb F♯ and G♯ keys. (There was once a reason that became moot after the F♯/G♯ trill key became a standard part of every Heckel system bassoon, over a century ago.)

Right thumb rollers can be counter-productive because of size. In order to add a roller to any key the key must first be made larger. Most of the time this is not a problem. However, adding rollers to the right thumb keys demonstrates the worst case of this problem. The distance between the B♭ and F♯ keys, with two pairs of rollers added, becomes noticeably greater than without the rollers.

More than anything else, what rollers do best is to rattle. Rollers need to be lubricated. The bassoon was not really intended to be a percussion instrument. If you can hear the rollers, they need to be oiled.

Lever Keys:

The long lever keys of the wing and bass joints have potential for causing leaks. The great length of these keys relative to the short hinge length makes them very vulnerable to any slop in the hinge. Any lateral shifting resulting from hinge slop can translate into a pad that may not close in the same position each time it descends.

The particular keys involved include the high D, high C, high A and the C♯ keys of the wing joint, and the low C key of the bass joint. In addition, the low D key and the low B♮ and B♭ levers of the bass joint, although they don't have pads, they will feel insecure to the player when they have sloppy hinges.

The three high vent keys (high D, C and A) of the wing joint present the greatest problem. These are commonly padded with cork pads which often show the range of the hinge slop. When the keys closes in different positions, they impression in the pad will become wider than the vent hole rim. Each different position can have a degree of leakage involved. These hinges must be tightened so that the pad always closes in the same position and the pad replaced.

The C♯ key on the wing and the low C key of the bass joint always use leather pads. Although the problem is similar the results are not quite so severe as with the high vent keys of the wing, it is the same problem and similar action should be taken to correct it. It is not uncommon to see the round hole of the low C key generate an oval impression in the pad.

The type of pad used in the high vent keys of the wing can be significant. Cork pads are the most common in use today. However, cork can fracture when pressed against the metal vent rim, causing a path for leakage and eventual failure. Cork is also somewhat noisy. Some German instruments come equipped with leather pads. These may be quieter but are more guaranteed to fail. The oxides that form on the rims of the metal vent liners tend to stick to the leather, eventually ripping the center from the pad leaving only felt to close the hole. Some synthetic pads may be the best for these holes. In particular, Valentino pads work quite well.

The guide posts that are used on all of these long lever keys can be a source of noise if the hinge is sloppy. It is a good idea to add something to keep the key from hitting the guide post. Automobile pin stripping is readily available as a tape and can be wrapped around the sides and bottom of the lever key inside the post.

One last item about the vent keys, particularly of the wing joint. One of the most familiar sights I see when first opening the case of a bassoon received for repair is of the wing lever keys bent askew. They should be lined up straight along the length of the wing. Normally, there should be a single straight line extending from the pad cup of the C♯ key up through the lengths of the C♯ key and the high C key. The lengths of the high A key and high D key should be parallel to this centerline of the wing joint.

Whisper Key:

The whisper key system presents a variety of adjustment problems. Coordinating the geometry of four keys plus a whisper key lock to close the vent hole of a bocal whose vent hole may be different from the next bocal to be used while not causing any difficulty in the closing of the low E key can be a daunting task. The solution to this is to make certain that each piece of the puzzle is correctly finished before starting with the next.

First, a bit of nomenclature; there are enough pieces to this puzzle to be confusing. At the low end, the whisper key starts with the *Low E Key* or *Pancake Key.* At the upper end of the low E key, a *lift arm* activates the *bridge arm* of the *bridge key*. The bridge key is automatically activated either by the low E key for low notes or by its primary activator, the *whisper key spatula* of the wing joint, which lifts the *upper bridge key arm* of the bridge key. The upper arm of the bridge key in turn lifts the lower end of the *whisper key pad key* to close the pad. The lower end of the whisper key pad key has a *"camelback casting"* which usually includes a *two holed flat spring* secured with two screws intended to provide some accommodation for misadjustment. At the top of the whisper key pad key an offset rod allows the hinge to extend beyond the end of the wing joint to a pad cup [hopefully] positioned to close the *bocal button* or *pip* or *nipple* or *bocal vent* or *whisper key vent* on the *bocal* or *crook* or *esse* or *pipe.* With so much crazy nomenclature it's no wonder the damned system is so much trouble! And of course, the next expert in line has a different set of names for everything.

One of the most common problems causing whisper key problems is the assembly of the wing joint to the boot joint. If the wing is not lined up correctly the whisper key adjustment will be wrong. If the tenon does not fit securely in its socket the adjustment may be unpredictable. Don't waste time with the whisper key until the joints fit together properly. Settle any questions about the assembly of the wing, boot and bass joints, including any body lock, before starting with the whisper key.

A second common source of adjustment problems is sloppy pivot screw sockets in the ends of the keys. Any lateral movement of the hinges will degrade the action and proper adjustment of this system. Unfortunately, several of the castings on the ends of these keys are usually placed on the hinges in a way that makes the pivot sockets difficult to tighten.

1. Begin the adjustment with wing, boot and bass joints assembled and with the whisper key pad key removed.
2. The upper arm of the low E key should be kept as low as possible. Normally, this arm is not corked and should not touch the body. However some makes use this arm instead of a foot at the back of the pancake key touch to set the pad opening. If this arm is raised too high off the body the action of the key will be bad—keep it low. The height of this arm may need to be modified to accommodate a whisper key lock.
3. The bridge key is adjusted next. Both the upper arm and the bridge arm must be in contact with the arms that lift them at the same time. The lateral angle of the bridge arm affects the amount of movement of the pad at the top of the system. If the bridge arm is close to the low E key's hinge the movement will be small; if it is far the pad movement will be greater.
4. If the instrument is equipped with a right hand whisper key lock this is the time to adjust how it lifts the bridge arm. The lateral position of the bridge arm will need to be aligned with the lock. When engaged the lock should lift the bridge arm very slightly higher than the low E key will lift it. When disengaged the lock must not keep the bridge arm from being in contact with the low E key's lift arm. Coordinating these events may require changing the height of the low E lift arm or altering the shape of the end of the bridge arm.
5. With the low E key, the bridge key and the spatula all coordinated, the whisper key pad key can finally be put in place. Examine the way the camelback contacts the upper arm of the bridge key. Keep the contacting parts as squared up with each other as possible. Check that the edge of the two holed flat spring doesn't dig into the top of the bridge key's lift arm. The pad should close with the bocal button square to and centered in the pad. Keep in mind that an overly thick pad can make this more difficult. The pad position can be adjusted by rotating the pad arm on the offset hinge extension.
6. The pad should now close when the low E key is closed. The primary adjustment is made by twisting the length of the pad key between the camelback and the lower offset casting. Some adjustment can also be made by the radial position of the pad arm on the extension rod or by raising or lowering the end of the camelback. There must be no resistance to closing the low E key. The pad opening of the whisper should be on the order of 3/32". Make sure that the amount of movement of the whisper key spatula is similar to the C♯ key beside it.

Of course there's always ways to make life more complicated. Whisper key locks are made in many forms that each have their own unique problems. Little finger whisper keys (rare) or right thumb whisper keys (very rare) add usually a bit of nuisance. High A bridges which close the whisper key whenever the high A key is opened are desirable and becoming more common. The high A bridge is an arm added to the center of the whisper key pad key. At rest, both the camelback and the high A bridge arm must be in contact with their respective contacts at the same time. When the high A key is depressed the whisper key pad must close.

The two hole flat spring seems to cause a lot of nuisance. Its purpose is to allow a small amount of space in the system to accommodate misadjustment. There needs to be a gap between the spring and the camelback casting behind it. This spring also tends to be a source of noise and benefits from a thin layer of ultrasuede applied to the spring.

The position of the bocal is certainly important to the adjustment of the whisper key. The bocal should not extend out square to the broad axis of the bassoon, but rather a bit outboard. Placing it above the high A vent hole is about right.

Some bocals, especially from East German makers, have the bocal button placed in an unusual position somewhat in the back of the bocal. Their instruments are made to suit this non-standard position. Getting a "normal" bocal from other makers with more standardized button positions to work on an East German bassoon is a major problem.

Nickel Silver Hinges:

Many bassoons use nickel silver as the material for hinge arbors. This is somewhat unique to bassoons as most woodwinds use steel for these parts. Nickel silver can be a very good material for this purpose but there is really nothing about it that makes its use unique to bassoons.

One of the best features about nickel silver hinge arbors is the noise level. They're simply quieter than steel. Experiments with exchanging the hinge arbors which are otherwise identical except for the material have been consistent in their results. In dry unlubricated keys the difference is quite noticeable.

Nickel silver hinge arbors also seem less vulnerable to being bent. Keys with minor bends in the key and/or the hinge arbor don't seem to show as much resistance to movement as would be expected if the arbor was of steel.

Of course, everything about nickel silver hinge arbors isn't ideal. It is not as easy to straighten a bend hinge arbor in nickel silver as it is in steel. Often, they seem to simply refuse to straighten. Nickel silver isn't as strong as steel either, and small diameter threaded arbors are better in steel.

In the same area, another hinge detail also somewhat unique to bassoons are the unthreaded hinge pins that are used in many shorter hinges. These are just simple straight pieces of nickel silver rod with a curl at the end that shows outside of the post. They are held in place simply by friction. Be careful not to loose these. They are becoming hard to replace. Obtaining the correct diameter stock for making a pin is nearly impossible.

Boot Action Rods:

The action rods or pins going through the boot joint shouldn't be as confusing as they seem to be to some persons. There's nothing sacred about them. Apparently, some persons must believe that the pins originally supplied with their instrument were somehow perfect and that the maker has a carefully designed perfect length for each pin. Nope.

Pins should be made from a lightweight material that presents little or no friction to the walls of the hole through which it moves. 3/32" black nylon rod is readily available and makes excellent pins. The glass pins supplied with old Kohlerts shatter nicely when dripped and are hard to adjust for length. Metal pins are great for noise generation. Wood pins can bind.

The length of the pin is determined by the results. Make sure that the closed pads are not held open (B♭, High G Ring, G♯) by a too long rod and that the pad on the A tone hole is open the correct amount.

Particular care should be taken with the pin under the F♯ rocker. There needs to be some free play with this pin. If this pin is too long the high G ring key may open causing some strange tuning problems.

The most common problem with these pins is that the corking on the keys at each end of the pins wears away too soon. Cork is useless for this purpose. Ultrasuede is my favorite material for the purpose. Some leathers also work well.

Plastic Bassoons

The use of plastic for making bassoon bodies presents both advantages and problems.

There have been essentially three types of plastic bassoons made on a production basis: Fox, Linton and Selmer. The Linton bassoon, originally developed by Jack Linton, became the property of Armstrong, which in turn became part of UMI. The Artley bassoon is a direct descendent of the Linton bassoon. The Selmer plastic bassoon is currently sold under various Selmer names. The Fox plastic bassoon is also made under the Renard trademark. My knowledge of the Linton and Selmer plastic instruments is limited and most of the following applies to the Fox plastic bassoons.

Plastic can be an excellent material for musical instruments. Its biggest liability is the difficulty of combining the economics of manufacturing plastic goods with the very different economics of the limited production of bassoons. Despite that, good instruments can be made from plastic if sufficient attention is paid to the differences between wood and plastic.

The greatest advantage to using plastic bodied bassoons is in institutional situations. Schools often don't take good care of bassoons. Plastic will tolerate abuse and neglect better than wood.

Technically the biggest problem with plastic is that it is heavier than maple. Fox chose to use polypropylene as the lightest plastic that would do the job. Linton scavenged the body to remove any excess material that could possibly be eliminated. Selmer apparently ignored the problem and produced a bassoon that is ponderously overweight.

The penalty for using polypropylene for Fox and Renard bassoons is that this type of plastic cannot be solvent bonded. There is no adhesive that will bond to polypropylene. Whatever adhesive you can think of, it won't work. Any problems that require one piece of material to be attached to the body must involve a mechanical attachment. Conventional procedures that work with wood or other plastics need to be modified to accommodate this problem.

Stripped threads are an occasional problem that need a different technique. When posts are broken out the repair is best done by installing a Heli-Coil. This is a steel thread insert that is easily installed with some special tools. A new post must be installed—there is no give to the Heli-Coil and the old post is not going to end up in the correct position.

Another aspect of plastic is the thermal expansion factor. Plastic expands with heat and shrinks with cold. Don't tighten hinges between posts too much. On a cold day the instrument will shrink down and the keywork will bind.