Making a Falcate Classical Guitar

John Parchem

4/5/17

Forward

When John first showed me three or four of his newly built guitars I was astonished at their vocal attributes – in over half a century of playing and trying guitars from renowned classical guitar makers such as Kohno, Ramirez, Hauser, and Fleta to name a few, John's guitars were not only universes away from the attempts of many students who had built their own guitars (which were beautiful visually, but unimpressive vocally), but more responsive than instruments from the best of the renowned Luthiers that I had played. Their superb basic tone color and resonance, especially their high overtones presented a harp-like quality. They exhibited a wide dynamic range and followed responsively throughout the range, enabling a vastly broadened interpretive menu: for example, piano subitos were not simply softer, but seductively engaging to the ear. The sustaining quality enabled impressive legato lines. The treble-bass balance enhanced voice leading and unfolding rich harmonies.

But the ergonomic features were the final deal maker. The cut-away enables high register access with far less strain. The slight fretboard arc helps considerably in counteracting an arthritic bar finger joint.

Playing my sleek, beautifully hand crafted, falcate braced classical guitar does require considerable revision on both right and left hand technique, support, and voicing strategies. The increased expressive responsiveness to these revisions is like having a sensitive conversational partner who listens intently to just you and then replies with things you have always longed to hear.

I find myself falling in love with the guitar all over again!

Douglas Rice

Preface

This is a blog of the making of my second falcate braced classical guitar based on the work of Trevor Gore as described in his and Gerard Gilet's Book *Contemporary Acoustic Guitar Design and Build.* The falcate top braces used are sickle shaped laminated spruce braces with carbon fiber reinforcement. The design is also a derivation of the Trevor Gore Medium Size steel string guitar. Basically, the falcate and back brace layout for the steel string design applied to a Hauser 37 classical guitar shape. My falcate steel string guitar is a very responsive and balanced good sounding guitar. My hope was to keep many of those positive qualities but with a traditional classical guitar sound. My first attempt produced a good sounding classical guitar but the high E treble string lost its punch up the neck. This second classical guitar has some brace changes described in the blogs to raise the guitars fundamental resonances to better support the high treble notes. This blog as the guitar build proceeded was originally posted on several luthier forums and my web site www.harvestmoonguitars.com.

John Parchem

Second Falcate Classical Guitar Build

This guitar is a commission from Doug Rice, my classical guitar instructor. He loved the sound of my first falcate classical guitar and my falcate steel string. More importantly though, he really liked the ergonomic features I added, a slightly narrower nut and the 20" radius on the fret board. He also liked the cutaway. For this guitar I selected a nice Engelmann spruce top and Panama rosewood back and side set. The tap quality and

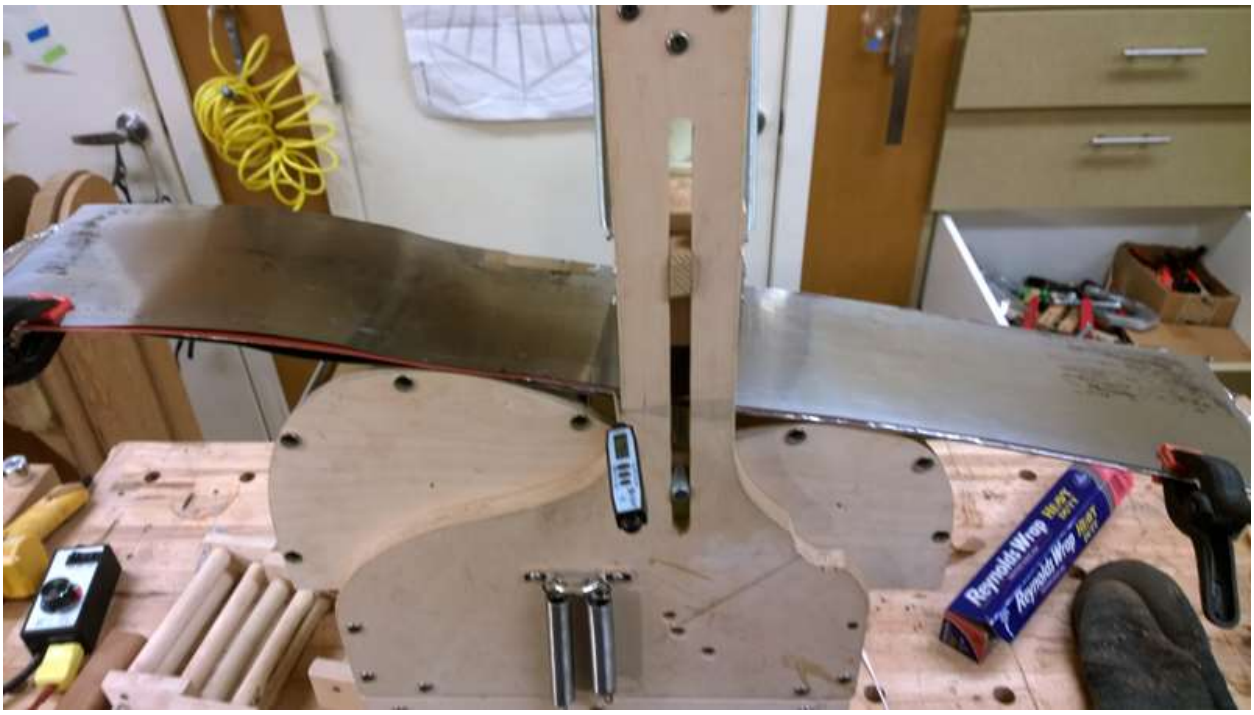
the stiffness of the rosewood was outstanding. I picked up the rosewood set a couple of years ago from Luthiers Mercantile International. I went totally classical and chose Spanish cedar for the neck. The main design difference from my first falcate classical is that the braces are one mm taller based on the results of my last guitar. Also I am trying to avoid all of the hidden mistakes I had in the last one. So far that is going well.

I used a plane and a shooting board to make a perfectly flat edge on the two pieces of spruce that will make the soundboard of the guitar. The gluing jig is based on an old Egyptian design using ropes and wedges to apply a joining force while keeping the plates flat.

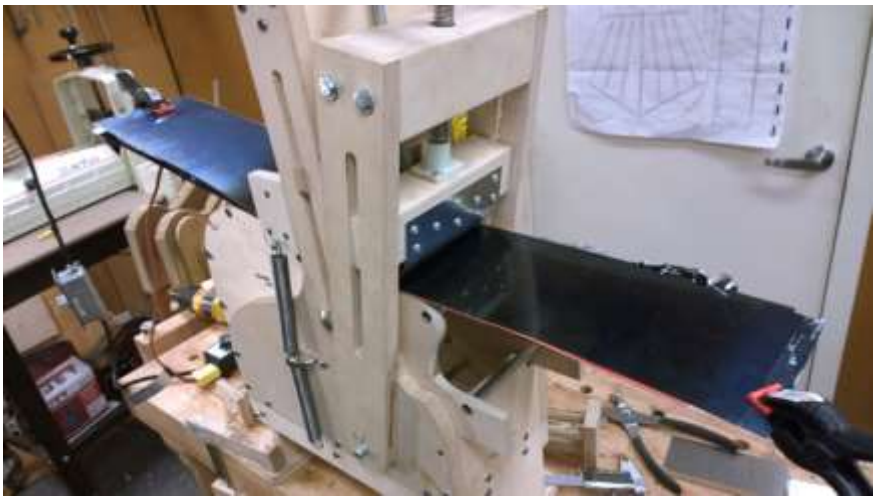
The same process for the back plates.

The sides are profiled using a template I made the last time I made this style of guitar and thicknessed to about 2 mm using a drum sander. Preparing to bend I also include a set of bindings with each side that I will use to trim the guitar body.

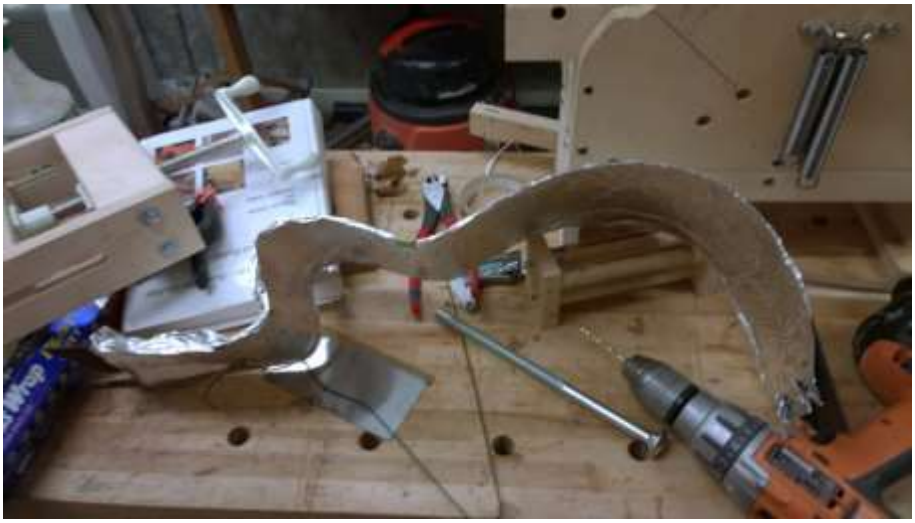
I use a Fox style bender named after Charles Fox, a luthier known for designing small shop guitar jigs. The wood is heated to about 300 F and bent into a mold.

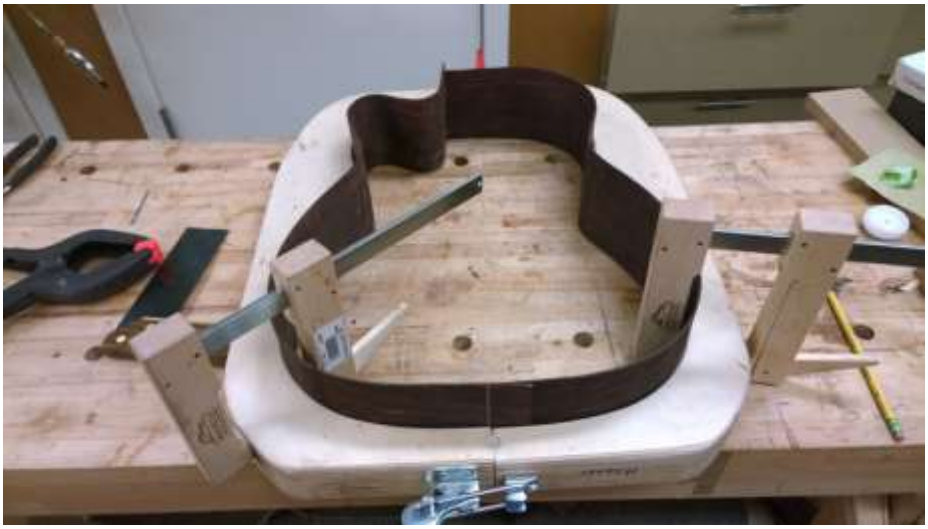


The Venetian cutaway that this guitar will have requires a very tight and difficult bend. To make the bend possible I first thinned the tightest part of the bend a quarter of a millimeter using a cabinet scraper. I also sprayed the side with Supersoft II a veneer conditioner. I use a separate mold and an extra press to make the Venetian cutaway bend.

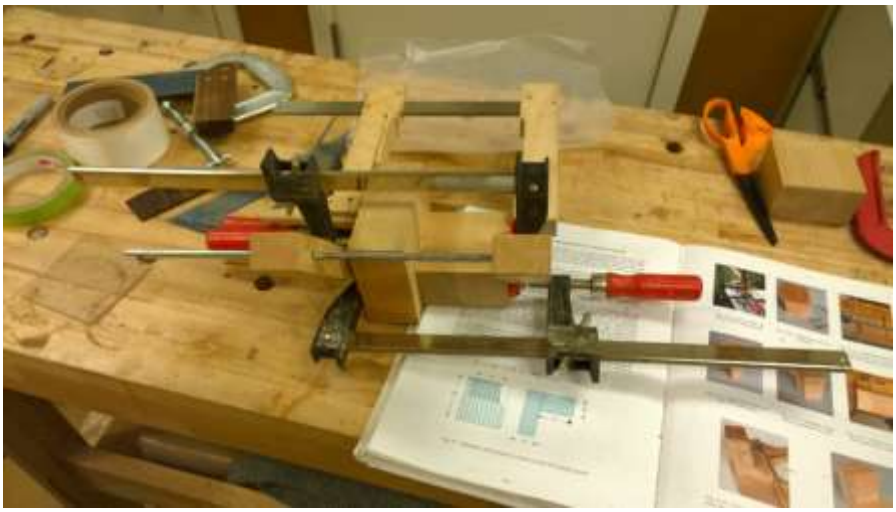


The bend went well for both the sides and the sets of bindings I bent at the same time.





This guitar will have a bolt on bolt off neck. The heel block is larger than most as the neck will join the body in a mortise and tenon between the neck and the rims and another mortise and tenon under the fretboard extension. The block also needs to be shaped to support the cutaway side.



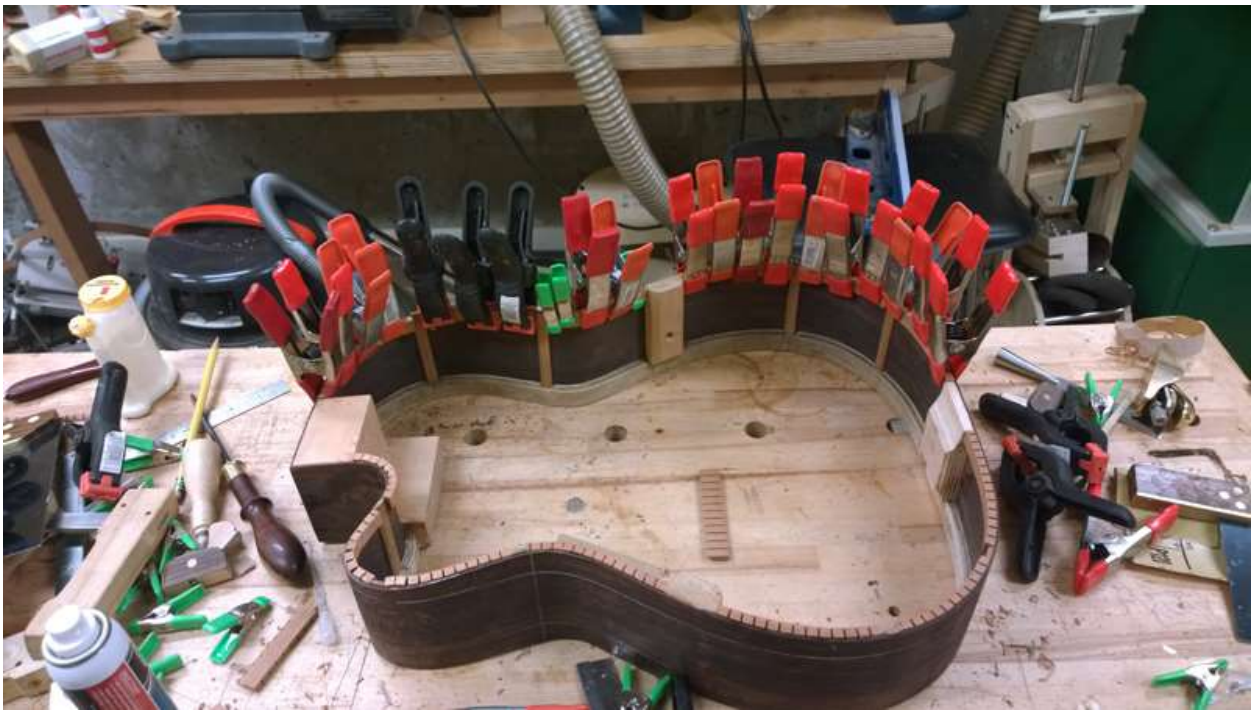
As shown a few clamps are required to get block properly glued to the sides.

Here are the rims with both the heel block and a plywood tail block glued on. Not shown in the pictures, the back rims of this guitar were profiled with a 10’ radius dish to give it a pretty significant curve. The top rims were profiled with a 32’ radius dish. It curves the top and provides the start of the neck angle built into the rims.

Stiff solid linings at the top of the rims helps the sound of the guitar by keeping more of the energy from the strings on the top instead of vibrating the rims (which do not produce sound). The linings are laminated to get them to the desired 5.5-6.0 mm, thickness, a thickness that would be very difficult to bend without the laminations. I used my Fox side bender to bend the lamination strips for the non-cutaway side. Those curves are shallow enough that I can compress them when stacked on top of each other. I hand bent the cutaway strips on a hot pipe using my rims as the bending template. The inside curve of each sequential strip needs to be tighter; each strip was bent to match the rims and the previously bent strip. Ultimately I ended up with a set of strips that I laminated right on to the rims using epoxy.

Laminating linings right onto the rims.

To finish the rims I fabricated and installed a couple of side mass mounts and some rim reinforcement strips. The side mass mounts allow one to add a heavy plate to the rims to lower the tops resonance if required during final setup. Here I am gluing on some standard kerfed linings to the rims for the back.



With both sets of linings installed I used the previously described 10’ and 32’ radius sanding disks to put the final profile on the rims. The tape in the picture is just there to stop me from sanding the top on the back’s radius disk.

Here the rims are assembled and profiled.

I build a rough neck blank using a 15 degree scarf joint. I cut out the headstock flip it around and glue it to the back of the neck as shown below.

I glued on a block of Spanish cedar for the heel.

I used a router table to make a slot for a two way truss rod.

The neck on this guitar is built a bit different than most classical guitar necks. As mentioned before it is a bolt on bolt off neck. Also to get the string paths correct, a classical guitar's neck generally needs to be pitched forward a degree or so to provide optimal string height over the top and the desired action. This guitar is being built with the neck pitched backwards a degree. The backwards slope allows the guitar to be built with a longitudinal curve on the top. I think the curve is pleasing esthetically but also pre loads the top allowing for a higher resonance on a lighter top. To make up for this slope in the wrong direction the fret board will be attached to a Spanish cedar wedge that will put the top of the fretboard in the correct plane. So I am tilting the neck back and tilting the fretboard forward. Visually the wedge becomes part of the neck as the glue line disappears.

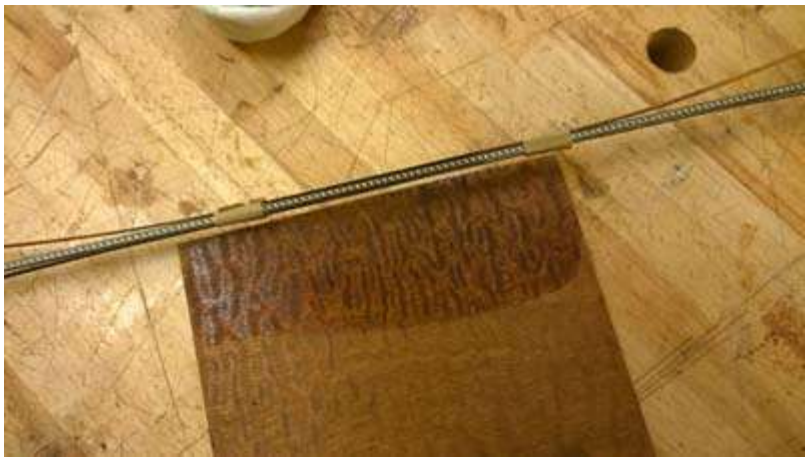
I hand cut the slots in the fretboard using a miter jig and a template.

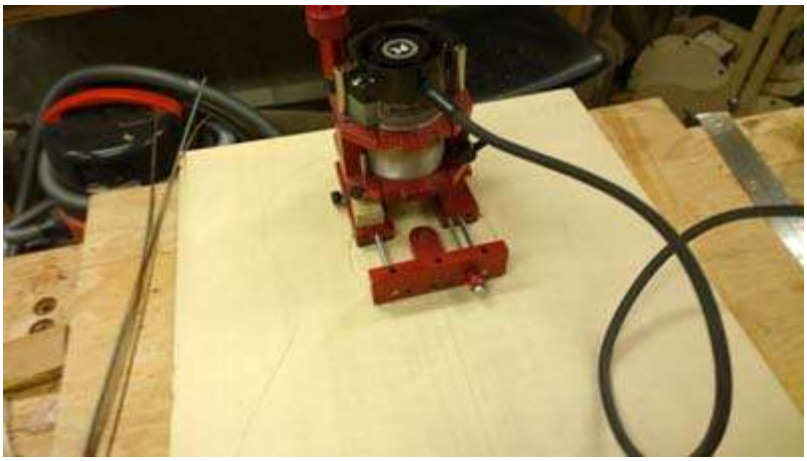
A thin ledge for the nut.

Gluing on a 4 mm strip of Spanish cedar that was then planed to form a wedge described above.

I went away from using special neck jig with a router and just used a table saw to cut the tenon. The advantages of the table saw is that I can still set the neck angle, but I can also angle the cheeks making it easier to fit the neck on the body. Also the procedure was so clean compared to mucking with the 1/2 inch router bit. I have a sawstop saw, so I am less nervous about cutting my fingers off. Ultimately I will buy a tenoning jig to make this an easier process. The neck will be a bolt on bolt off neck. The Spanish cedar glued to the fret board will be planed to a wedge to create the negative angle required for a classical.

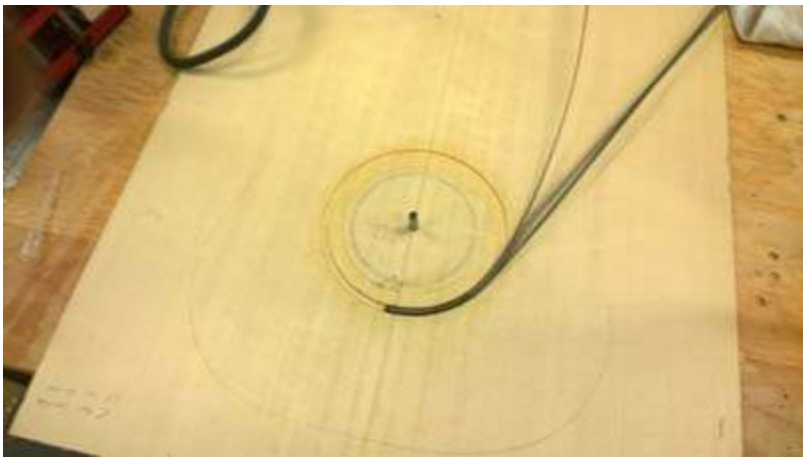
I wanted to make a classical guitar style rosette. I like to have them hint at being traditional but still be based on a solid wood ring. I got a new stack of rosette blanks off a luthier forum's classified pages and found one that looked like it would make a nice rosette. Also I have this whole stack of East Indian Rosewood\Black fiber strips I got at a Seattle Luthier Group auction from Gurian Instruments and thought this rosette was a nice opportunity to use them.

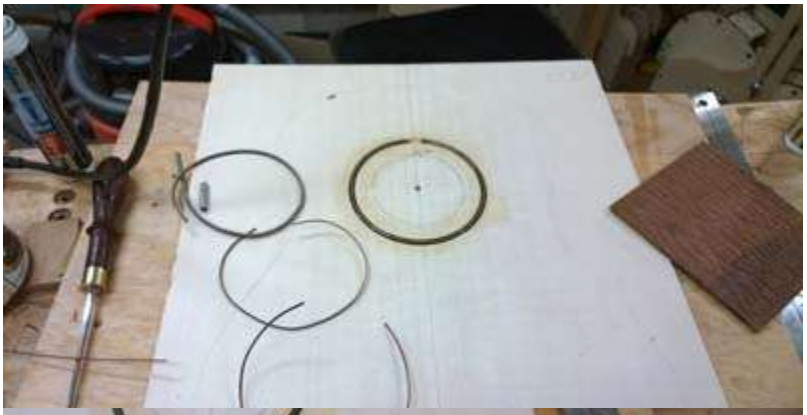


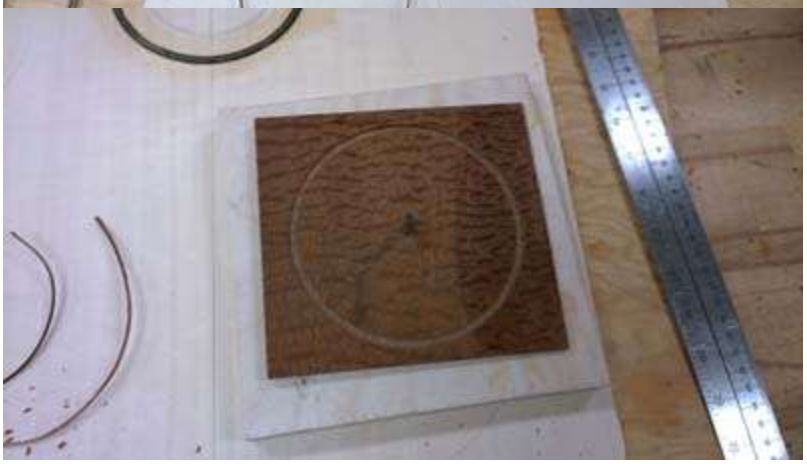


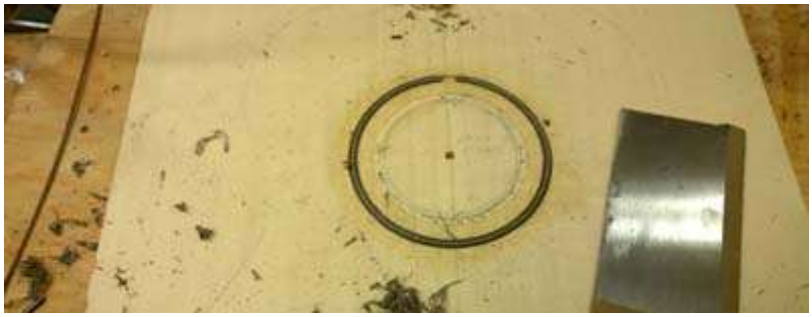
Instead of routing out the whole channel, I decided to make it on the sound board one section at a time. That way I can create tight channels for the rope binding and the EIR\B strips

I tried to put in the stack without pre-bending. I was using a heat gun as I worked put I got so far and the rope binding started to come apart.









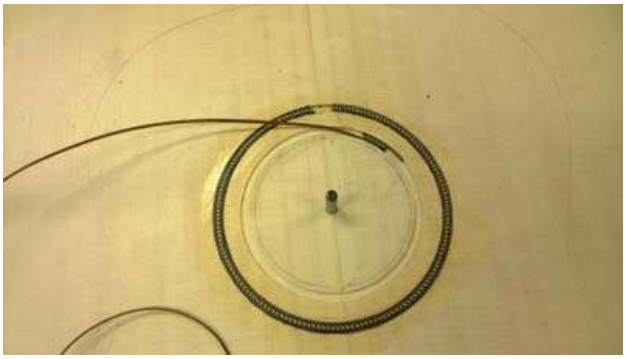
Ultimately I pulled out my bending pipe, bent everything close to the correct shape and found it easy to inlay the stack. I sealed the channel with shellac and I pushed the stack in place and flooded it with thin CA glue.

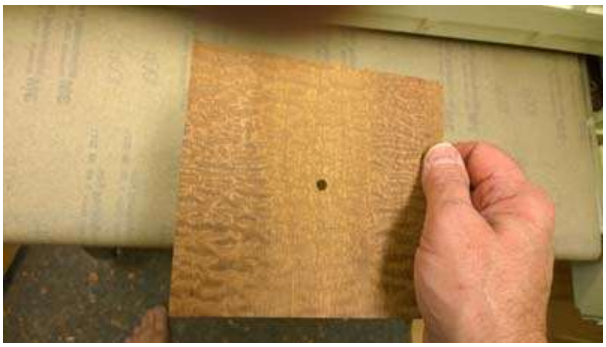
Before moving on to the next channel, the router base is set up perfectly to cut the outside of the wood rosette. I only cut to the depth that matches the thickness of the rosette channel. So without changing anything I cut to the outside line of the wood rosette. No measuring just negative space.

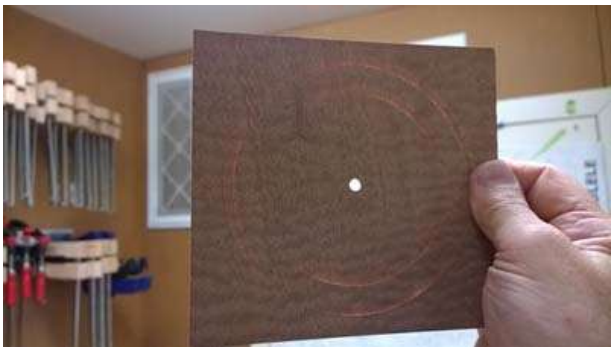
After first trying to cut the second ring I noticed that I needed to scrape the ring level so that the router will cut the next channel at the correct depth.

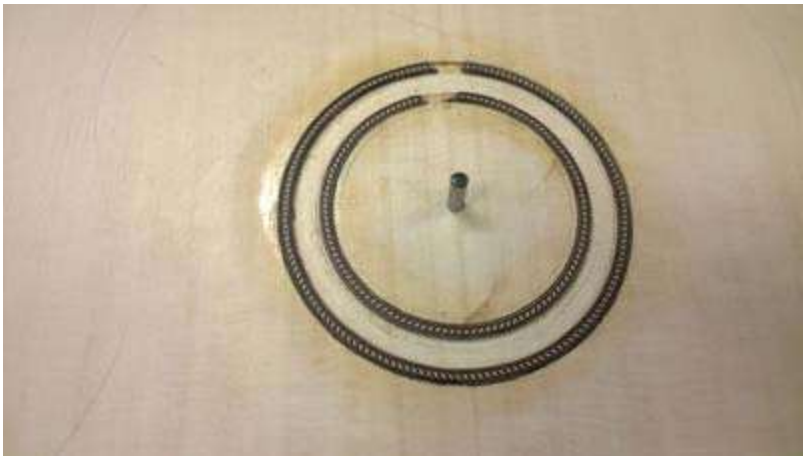
My stack is just a touch wider than my bit so I take a few passes and sneak up on the correct width. I make sure that any needed passes are going into the wood rosette area so that the router base is set to cut the inside of the wood rosette. Later when I run the back of the rosette blank though the drum sander a perfect sized ring should drop out.

I pushed in the second purfling stack and ran the rosette blank through the drum sander until my ring dropped out.





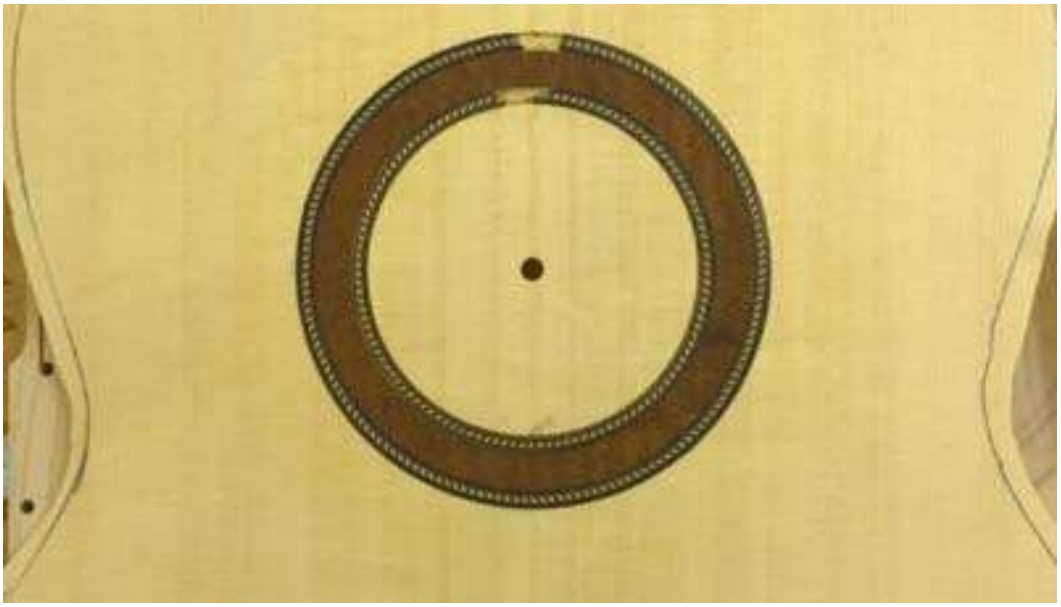




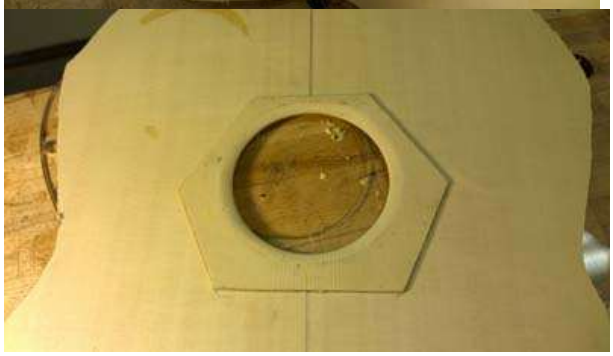
I routed the inside of the rosette channel sneaking up on the black fiber. This is where the Bishop Cochran base shines. I have gotten to where I can move the bit in .01 mm increments.

The ring snapped right in place. Not wanting to break it by pulling it out, and having previously sealed the inside of the channel with shellac, I flooded the rosette with thin CA glue.

Here it is finished and all cleaned up

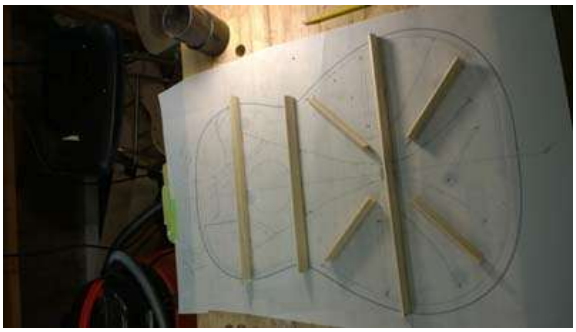


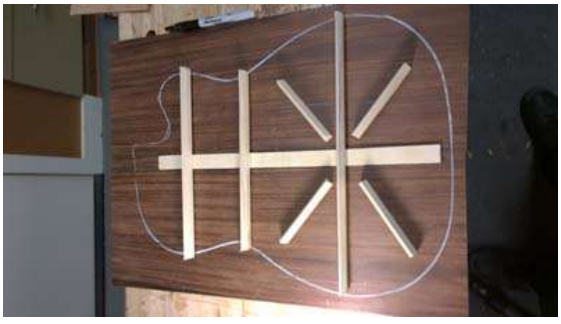
Today I installed the sound hole patch and am starting to brace the back.

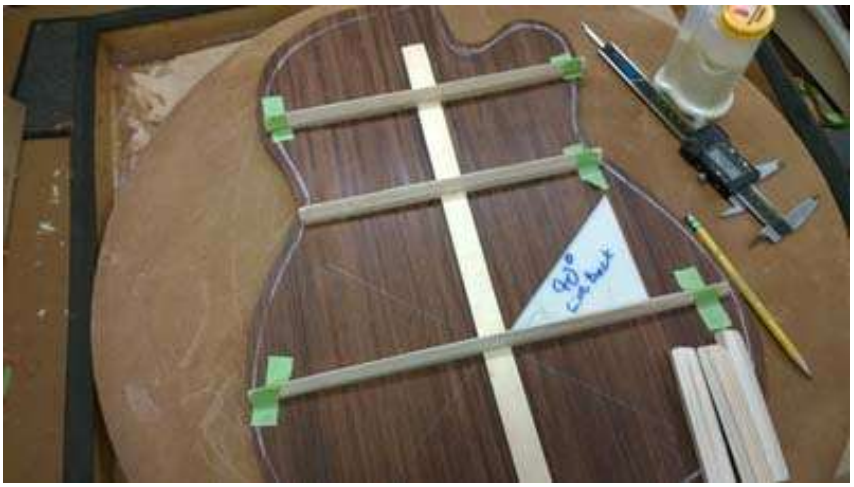


The back was thicknessed using a tap tuning method. A plate will vibrate at a frequency proportional to the stiffness of the plate. Using a formula from the Gore\Gilet book I am able to normalize the stiffness of a plate by controlling the thickness. In this case the thickness target was 2.4 mm. Once thicknessed the first task is to apply a cross grain center strip. This strip supports the long joint of the back plates.

I prepared a set of braces as per the Gore plans for an active back.







I cut channels in in the back center strip with a scalpel and chisel and rechecked the layout of the radial braces. I used a home built vacuum box to glue down all of the braces.

Glued and profiled Braces

I used my table saw to rip a whole bunch of 1.7 mm strips that I used to make the laminated falcate braces

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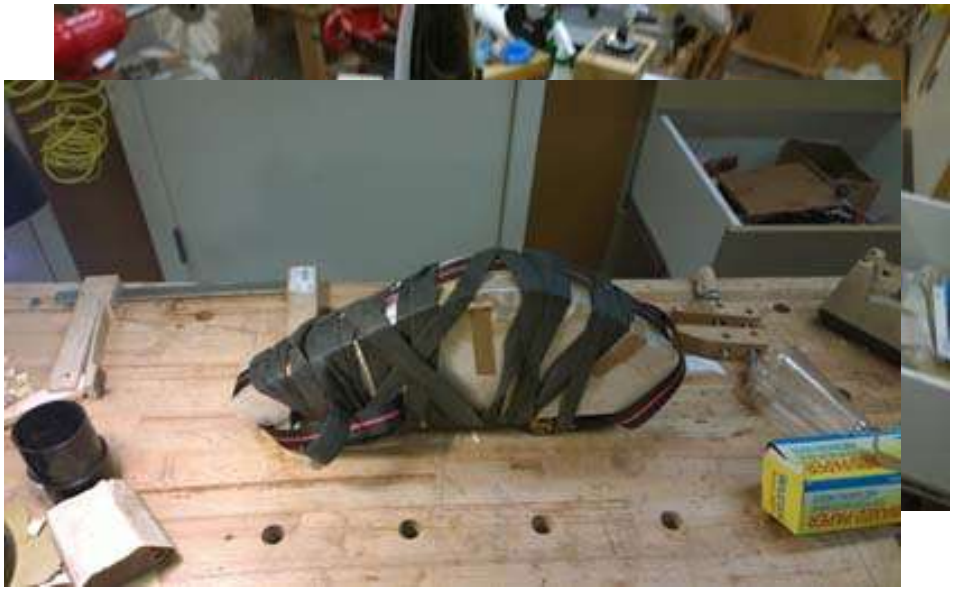
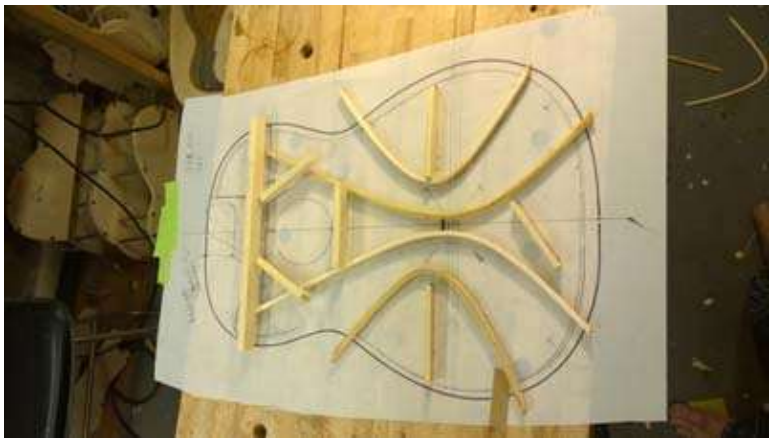
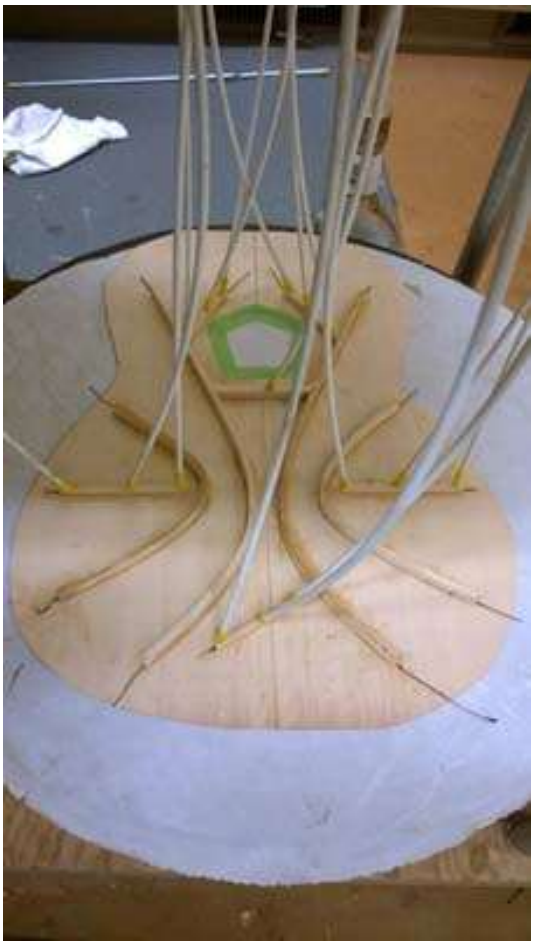


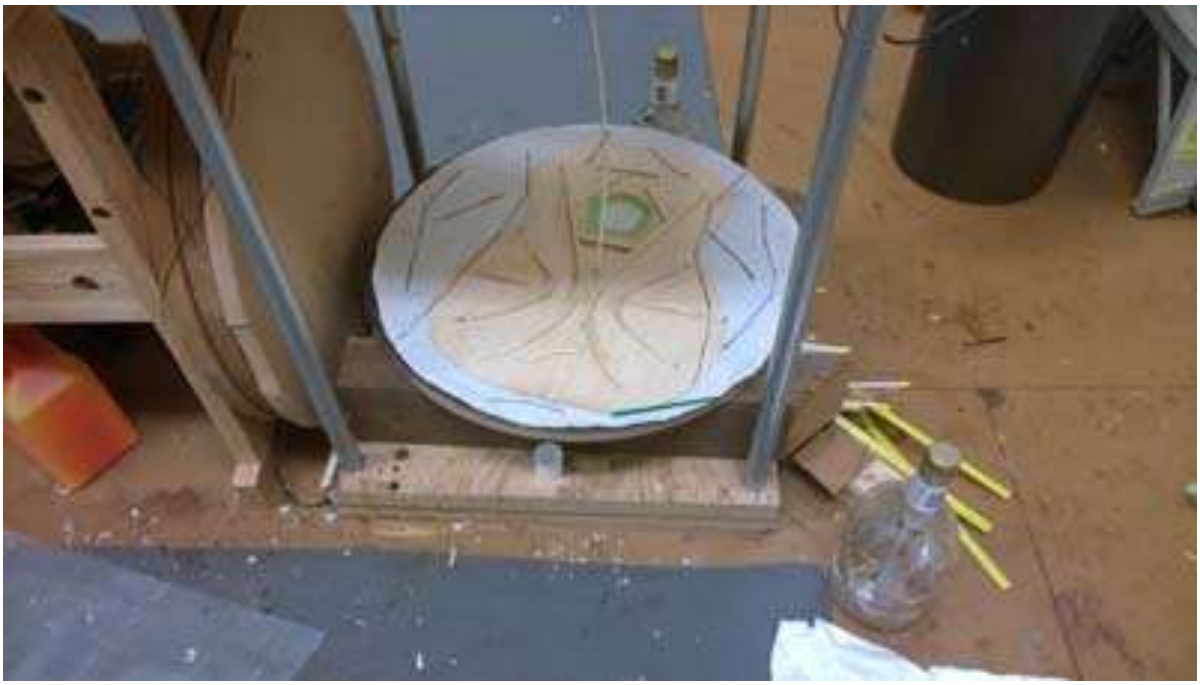
I used my hot pipe to bend all the strips to the two falcate brace shapes. I bend them at better than 2 times the width. After they are laminated I rip each to make the pair of falcate braces.

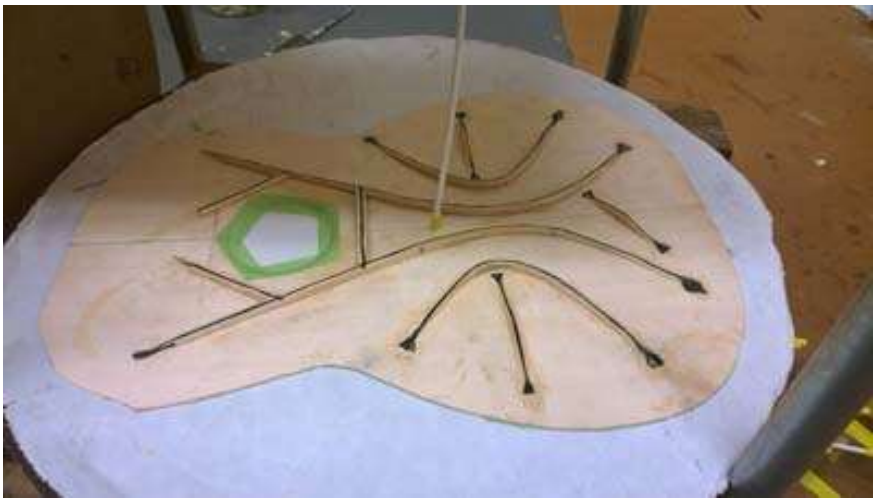


I also cut all of the straight braces as well.



I was a bit more deliberate while epoxying on the braces and carbon fiber and overall I was less messy. Still have a ways to go in that regard.





Here are a bunch of the components ready for assembly

Well I did one step forward, about 8 steps back then forward again.

I closed the box successfully, but when I tapped the closed box I was not happy with the resonance frequency of the top. It ended up about 10 hertz lower than my target. I was pretty sure the guitar would end up close to my first. As I really wanted to hear what the higher pitched top would sound like I ripped off the top with plans to make another.

I put the project on the back burner and built a top for an eight string classical guitar with higher falcate braces (8.5mm) and ended up with a top pitched at my target.

I pulled the first top I was using for this project. I had previously accidentally spilled a bottle of brown stain on a top after the rosette was installed and put it off in disgust. Well the stain came off with light sanding so I had a nice top with a nice rosette all ready for bracing.

Gluing on the new top!

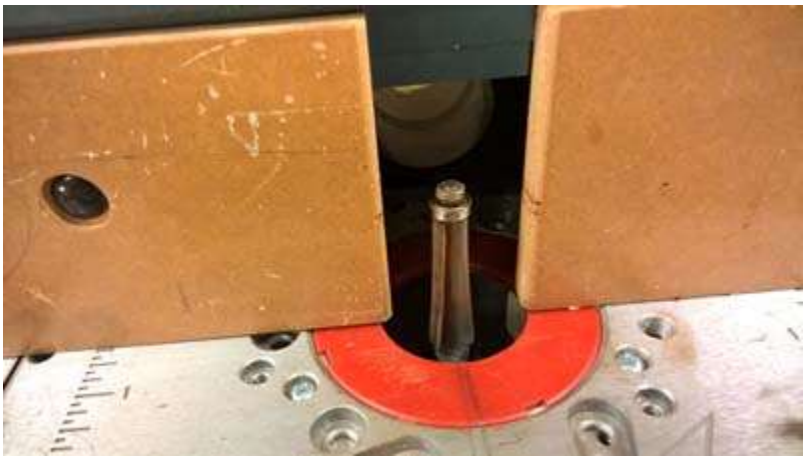
The Australian Blackwood bindings for the cutaway side I bent in the Fox bender were cracked so I bent a new set on a hot pipe. A fun job but I did learn a few things about bending on a hot pipe. First after very carefully achieving a perfect bend for the waist and cut away sections be careful. One can still crack a side bending the easier lower bout. Also I bent these bindings dry. I use a very very hot pipe. I found the wood got plastic much quicker dry, probably as the moisture keeps the wood closer to 220 degrees as it evaporates. Bending by hand I ended up with bindings that fit without having to be forced into the channel shape wise. Also I used a long fabric strip to bind the bindings after I glued them on. I have a 10' radius on the back. The binds fit the profile but they still need to be forced to the back radius. That forcing wants to twist the bindings a bit so they pull away from the channel. Binding them helped close any gaps.

Also I am happy with the resonance frequency of the box now. I think when I finished the guitar it will be very close to my target.

With the body finished I moved back to the neck.

For the first time I used my 20" radius bit to put a radius on the fret board. I got the bit from SJE Tools.

Radiusing the fret board on a router table:



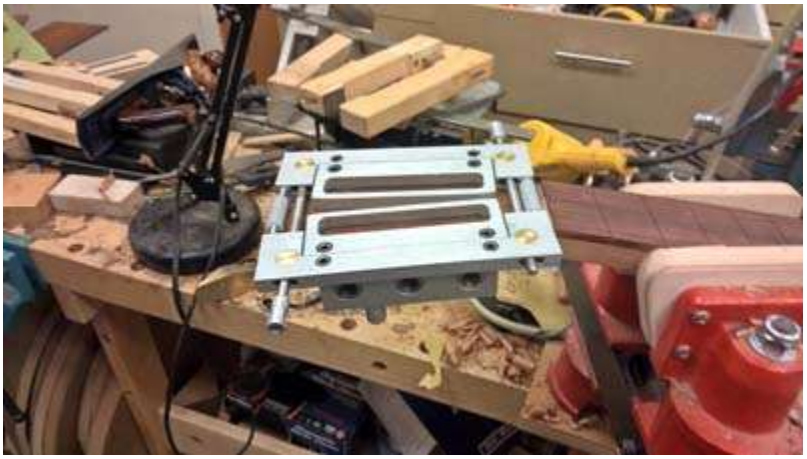
I cut close to the final taper of the neck in the heel portion. This allowed me to fit the neck to the guitar and check the neck angle before I routed the pocket in the top for the fretboard extension tenon.

Note how the mahogany glued to the fret board is sloped 4mm to 0 mm to give fret board a negative slope

Trim the head stock veneer for the head stock angle:

When the fretboard and wedge is glued on to the neck the glue line disappears.

I used a Luthier Tool jig to route slots and drill tuner post holes.



I used a spoke shave to remove most of the wood when shaping the neck. I measure out facets to guide the shape.

I use a rasp to shape the heel

Starting to look like a guitar!

I

The finishing process takes a few weeks. I use zpoxy (a finishing epoxy) as a pore fill. Before filling the rosewood, working with rosewood and white purfling lines I mix a small amount of zpoxy up, dilute it with alcohol and seal the bindings and purflings. The stuff dries to tack within an hour or so. At that time I zpoxy the rest of the instrument.

I used royal-lac shellac to finish the back and sides and neck and I did a true French polish shellac finish on the top. I have not yet done any sanding or buffing but it looks pretty good now. I am going to let the guitar sit a week to allow the shellac to cure a bit before finishing it.

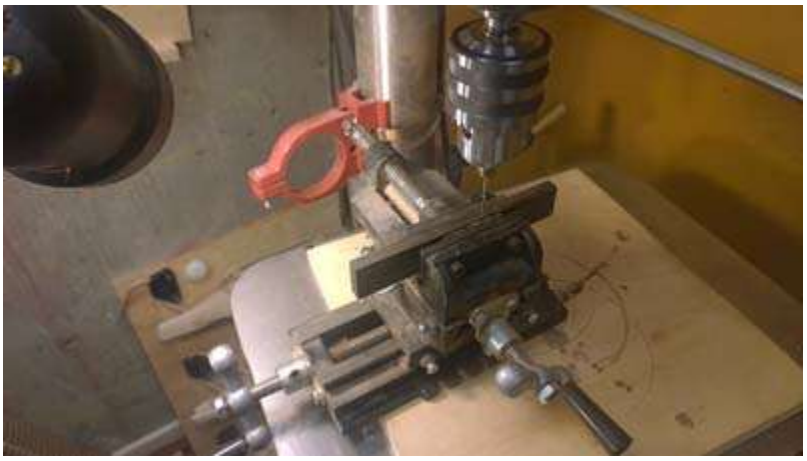
Before finishing the top I looked for glue on the top with a black light. Yup I had some smears in the center and some along the bindings. You can see the bright spot in the lower bout especially along the edges. This is after I thought I had the top clean.

I made one of two possible bridges Gore style bridges for this instrument. The first one I made is made out of Brazilian rosewood, the second will be made out of walnut and ebonised. I think the walnut will be a lighter bridge. They both are reinforced with two separated layers of CF fabric. I used a very dark block of Brazilian rosewood.

In the first set of photos you can see me ready to put the block together. I resawed the bridge blank I had into three strips 2mm, 3mm and 4 mm. These are put together such that the 2 mm is on top and 4 mm is on the bottom. The carbon fiber fabric will be separated by the middle 3 mm slice. As shown in the picture I used west system 105\206 epoxy for the lamination.

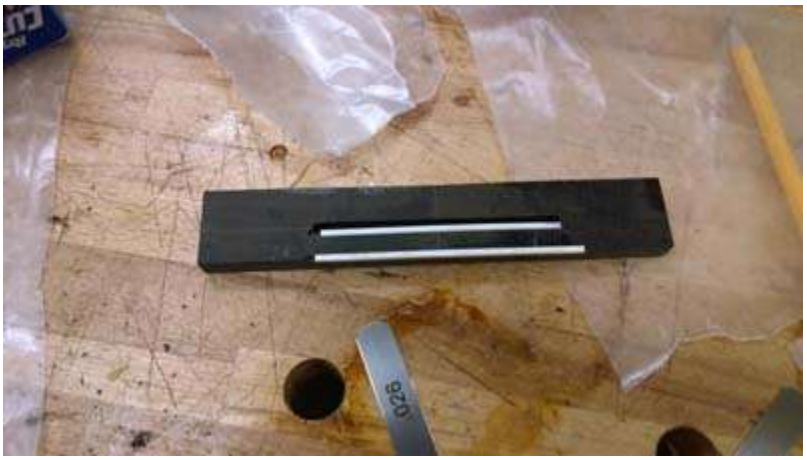
I had a previous walnut layup that I made when I made my last falcate classical guitar. They sort of look a mess until they are trimmed to size.

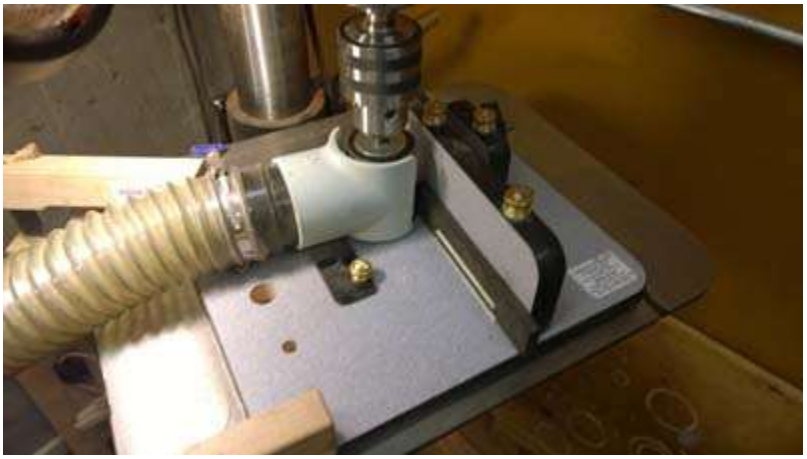
I marked out the tie holes on the blank and drilled them in the drill press. I attempted to make a nice aluminum jig for the tie holes but had trouble drilling the holes the twist bits I had did not cut it in the aluminum. I did not use the cross vice as a cross vice. I had punched the holes and just moved the vice in place for each hole.

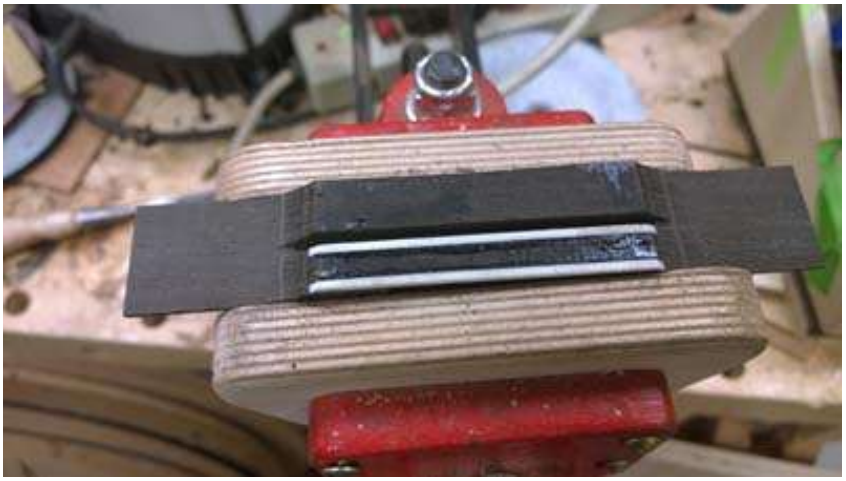


I mounted the blank (actually the second attempt) in my routing jig. In the first attempt I relied only on double stick tape and it did not stick. I cut that spoiled bridge diagonally and made the wedges that you can see in the photo.

I do four passes in this jig. The first pass with a bull nose 1/8" veining bit is to separate the tie and saddle block. This is done to the depth of the wings. I switch to a straight edged 1/8" bit and create 1.5 mm x 1.5 mm rebates on the tie block for bone strips. The last uses the same bit to cut the saddle slot. The Gore\Gilet book describes on additional cut with a 45 degree bevel bit to slope the inside channel toward the saddle. I do this with a chisel. I used a Luthier Friend jig to shape the wings.





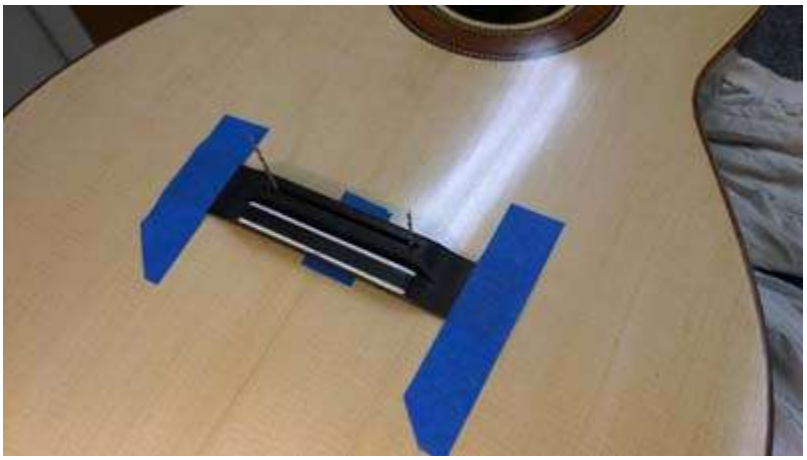


Here it is just needing a bit of finish sanding.

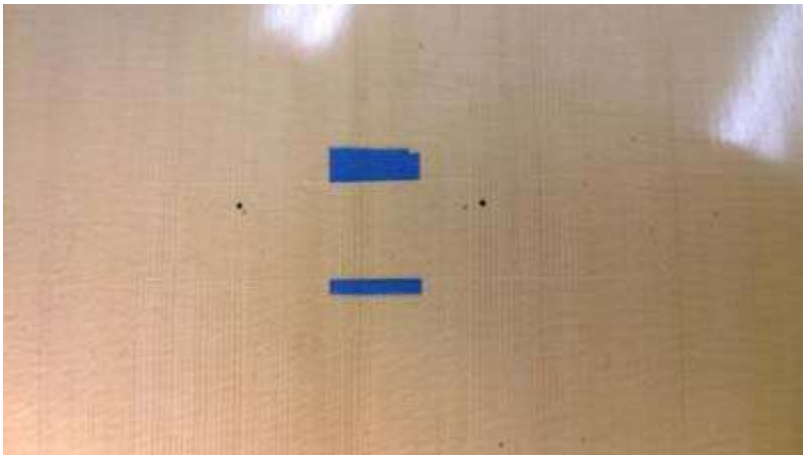
I finished applying shellac last week. To position the bridge I bolted on the neck. A perfect time for some encouraging photos. I still have yet to level sand or polish the royal-lac back and sides or the French Polished top. It looks good in the pictures, but it definitely has a hand applied finish look.

I set the fret board nut location to have a nut compensation as well as saddle compensation. I really spent a lot of time calculating and triple checking the location of the saddle. I did all of the measurements from the first slot as the fret board is about 3 mm short of the zero slot location. After it was taped in place I also checked the location against my other falcate classical (I could have thought about this first) and I had located it exactly in the same location.

I drilled a couple of 1/16" holes in the saddle slot and used the drill bits as location pins.

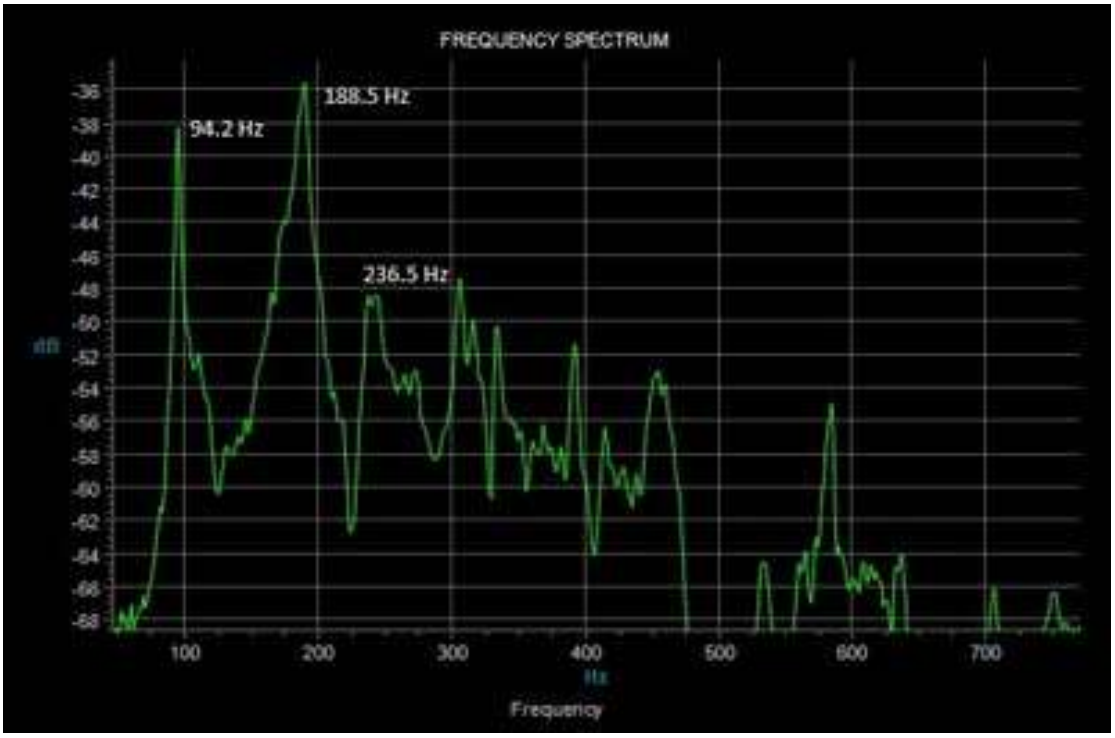


With the bridge in place using a new scalpel blade I carefully scored the finish and used a utility blade (actually three by the time I finished) to scrape the shellac under the bride.

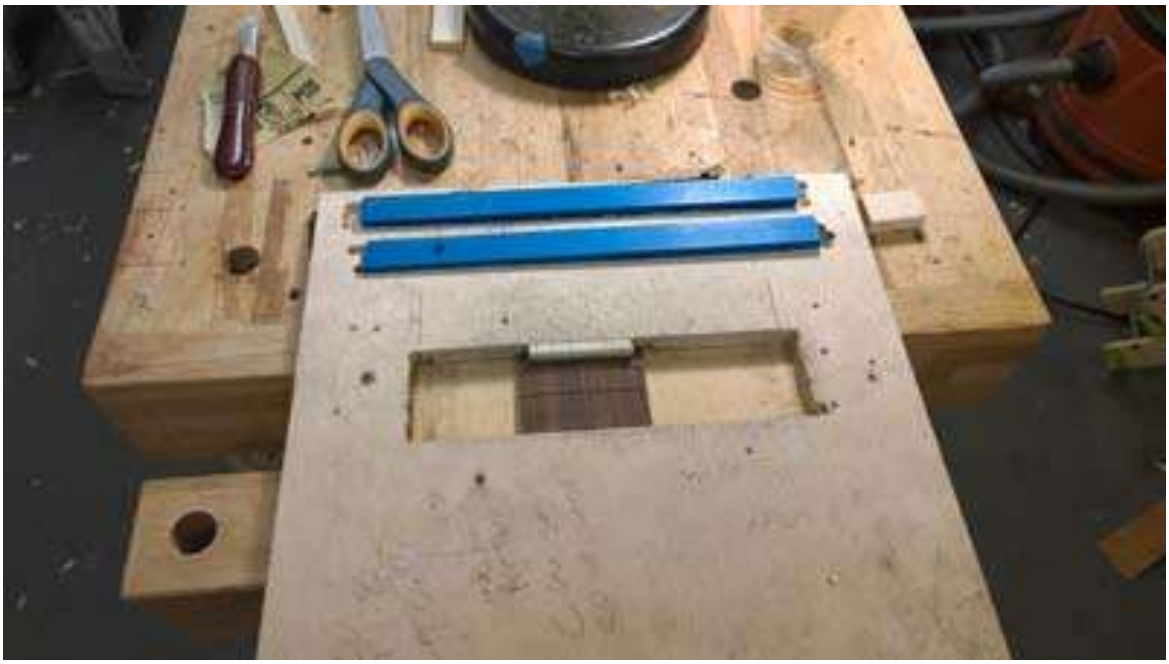


I glued the bridge in place. Added a couple of shims to the wings to help push them down and fired up my vacuum clamp to clamp the bridge. After about 6 minutes I stop the clamping and removed the still soft squeeze-out. It has been clamping for about an hour now so I can head back down.

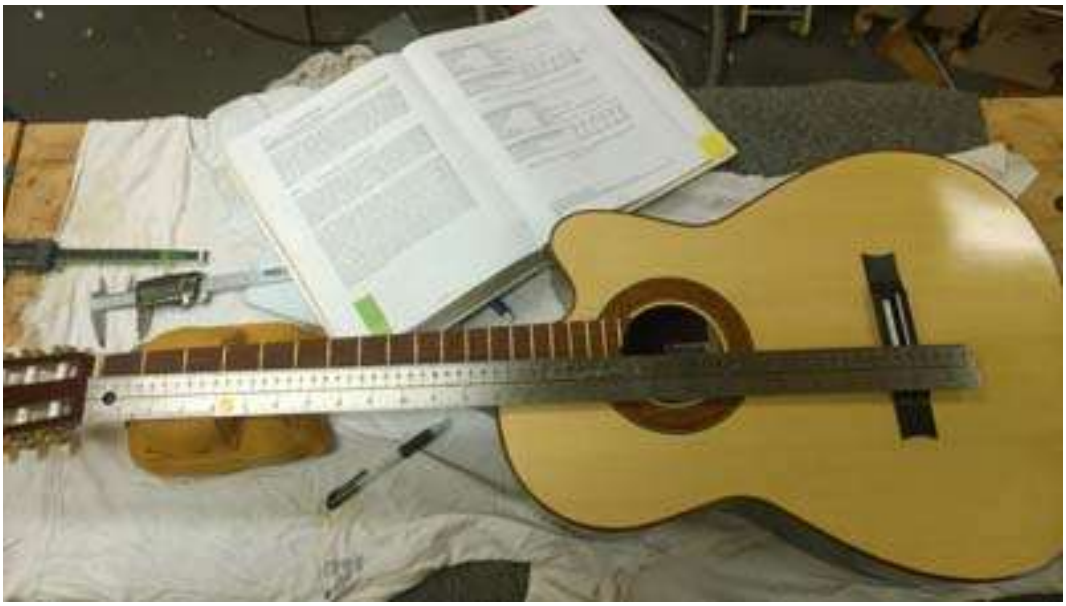
I made the compensated nut and saddle and strung the guitar up. The guitar sounded great about a half an hour after I put the first set of strings on. I am really excited to hear how it sounds over the next week. My target for the top, T(1,1)2, was 190 Hz, almost got it. I ended up at 94.2 Hz for the T(1,1)1 188.5 for T(1,1)2 and 236.5 for the T(1,1)3 as shown in the graph below. I still need to clean up the nut and saddle buff out the finish and do a final set up in a couple of days. Also I will add a small fret marker dot on the side of the fret board at the 7 fret.



I sort of cheated on the compensation as I used the same scale length and the same strings that are in the classical guitar example in the Book. I did not have to run the calculations. I made the compensated nut and then measured the active string length for each string and marked the saddle. I make the compensated nut a little differently than Trevor's method in the Book. I used my saddle slotting jig and my Bishop Cochran router base as a little milling machine. One turn of the set screw for the fence is equal to .8 mm. It is really easy to see it hit 1/8ths of a turn so I can cut with an accuracy to .1 mm or so. I leave a little extra compensation on the nut and fine tune once I have the nut mounted. I use a sharp chisel to nail the compensation numbers.



The Book has a table and tells how to make a table to calculate nut and saddle compensation based on scale length, strings and action. As I mentioned, I was able to use the example in the book. The table includes the active string length for each string. I used that measurement from the nut to mark out the saddle compensation.



The guitar is complete and it sounds pretty good. Since I completed the guitar I made a new nut to allow for some more spacing on the edges. This of course narrowed the distance between the strings at the nut. Here is a final set of photos

Luthier Terms

Falcate Braces: sickle shaped laminated spruce braces with carbon fiber reinforcement developed by Trevor Gore.

Linings, kerfed linings, kerfling: The linings are used to provide a gluing surface for the top and back. They are glued on to the guitar rims prior to gluing on the the top and the back. Kerfed Linings are linings that have regular cuts (kerfs) to allow easier bending. Kerfling is just another name for kerfed linings.

Purfling: an ornamental border, as the inlaid border near the outer edge of the guitar or sound hole.

Radius dish: A 24" round sanding dish that has a concave cavity with a machined radius. This guitar used a 10' and a 32' radius dish.

Scarf joint: a butt joint between two pieces beveled on their meeting surfaces.

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