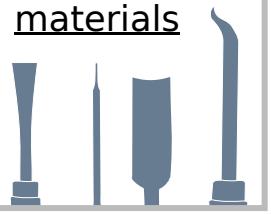
The violin making manual

MakingTheViolin.com

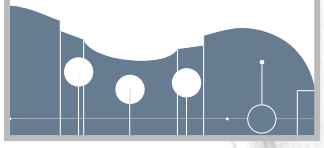
Foreword and F.A.Q.

Tools & materials

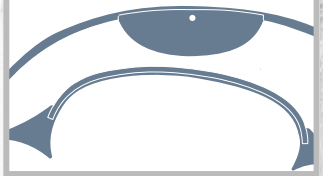


Templates

Mould & blocks



Ribs



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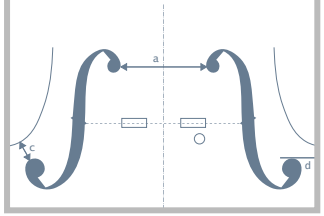
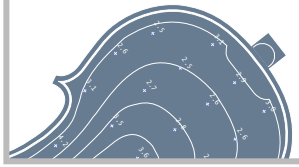
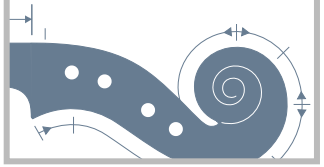


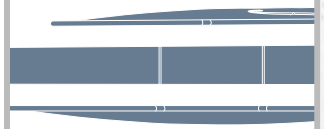
Back



Neck & scroll

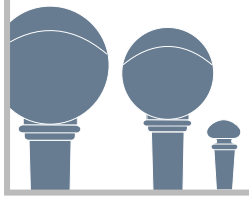


Assembly



Varnishing

Setup



Tuning

Measure-ments

WWW

Forum

By Vojtěch Blahout, v. 2016

Welcome!

The purpose of this guide is to give basic information about violin making. The aspiring violin maker will have the opportunity to build an instrument from start to finish with the help of step by step tutorials accompanied by drawn images.

To make the best of the electronic format, all the images are in vector graphic format SVG, drawn to exact real world dimensions. At every step of you building experience you can print out the plans and drawings and use them in direct comparison with what you have at hand. The SVG graphic format is supported by most modern browsers and editable by the free Inkscape.

My goal was to create a site that would give starting points to those interested in violin making. The work is by no means complete. There is always room for improvement and I encourage anyone who feel they might be able to contribute to do so, either by commenting on the pages, or sending their contributions to me at vojtech.blahout@gmail.com. All additions will be duly credited.

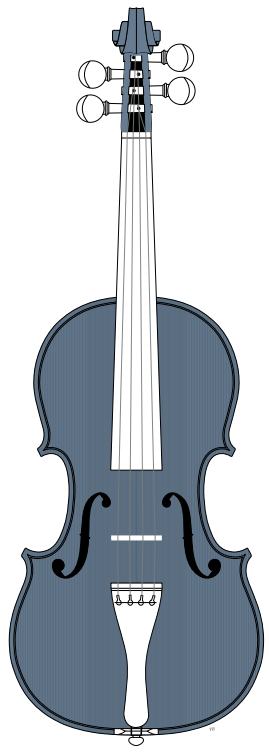
Together, we can make this site a rich, structured information source on violin making.

Enjoy your stay,

Vojtech Blahout

PS: You can now download the whole site as a PDF, see the link "PDF" on the front page.

Stradivari Messiah 1716



Frequently asked questions

Q> I have a question/I don't understand what you mean by XY . Where do I get an answer?
A> If your question or a comment is about a section of the manual, please feel free to post a comment on the appropriate page or register in the forum and ask your question there. I will try to get back to you as soon as possible. Or you can always contact me by email vojtech.blahout@gmail.com.

Q> I want to edit or add to the content on the website, where is the registration?
A> Due to massive spam attacks, I was forced to close down this option. Please send me an email and I'll set up an account for you. Commenting, at the bottom of every page, is available without registration, at least for now.

Q> I want to use the images on this site in my own project, presentation...
A> By all means, use whatever you need, but please consider linking back here or using any other suitable way to acknowledge the source. You can edit the images in Inkscape.

Q> I see no images on the right side of the text.
A> If you are having problems viewing the images, click http://caniuse.com/svg to see whether your browser is supported. With some browsers, ie. Internet Explorer 6-8 there is the option to install the Adobe SVG plugin http://www.adobe.com/devnet/svg/adobe-svg-viewer-download-area.html to correctly render the images.

Q> I use Internet Explorer and some of the images have wrong aspect ratio.
A> Please, if you can, use Chrome or Firefox to view the site. I haven't found a reliable method to display the SVG images across all browsers. The SVG rendering will hopefully get in line with other browsers in the next release of the browser. Clicking on the image will display the correct full size version even in Internet Explorer.

Q> I'm not sure my printer is precise enough to print the plans.
A> Please click on this Test file and print it out on your printer. Check that the ruler matches yours. If it doesn't you need to find a way to scale the output, usually in the printer's settings, so that the printout passes the comparison test.

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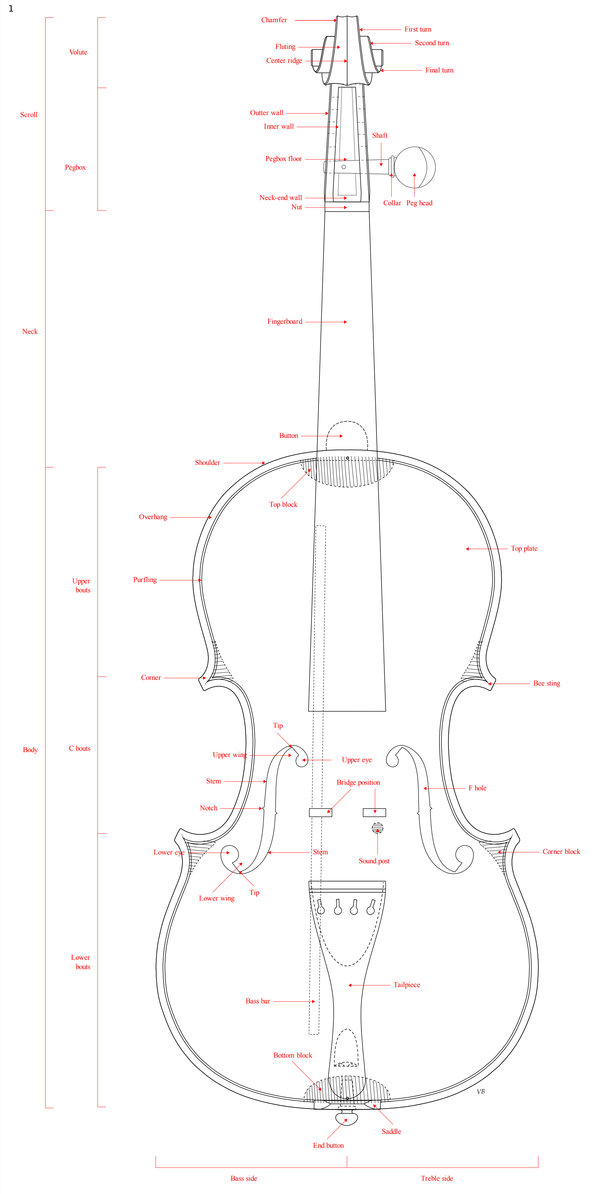

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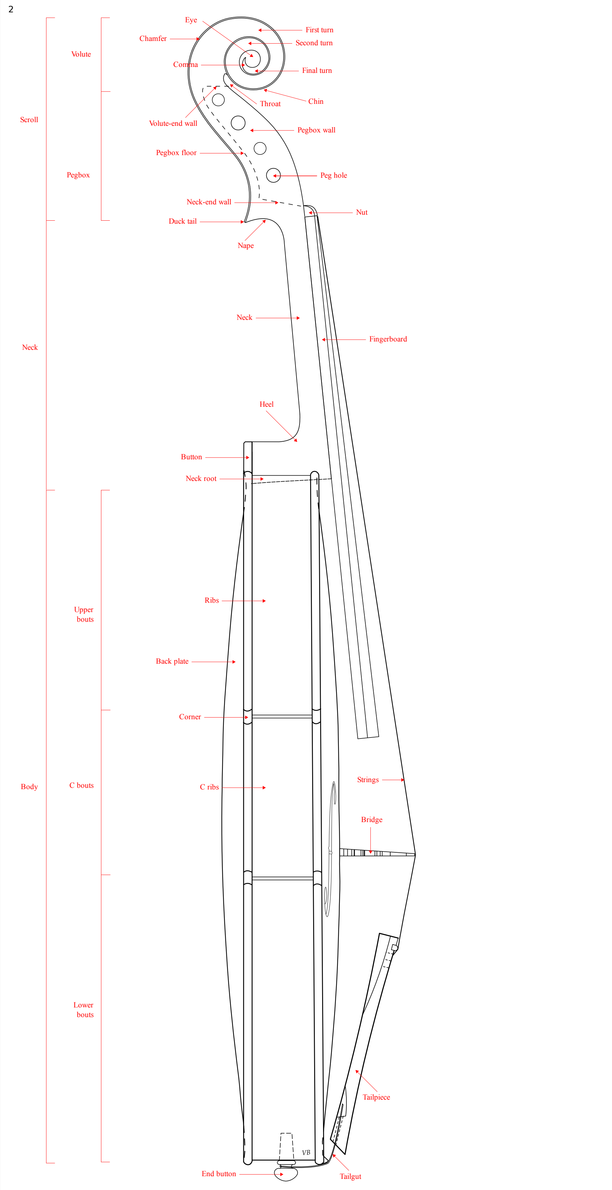

Category: Tools and materials

Tools

Apart from the usual assortment of wood working tools, you will need some tools and jigs which are used specifically in violin making.

1. Planes

Block plane
A flat sole block plane is used for finer work, ie. reducing the rib or fingerboard height. Any steep angle Stanley no. 18 or no. 9 1/2 or Record no. 9. block plane will do. For denser woods /ebony/ and when you need to work across the grain, ie. to trim the ends of corner blocks, types with lower blade angle are usually recommended, ie. Stanley 60 or 60 1/2 as depicted on the left right.

In the shaping of the ribs, the block plane is used as a scraper, with its blade ground to a steeper angle. Keep this in mind and if you think you may use it this way, get a spare "scraper" blade.

Jack plane
A jack plane, ie. Stanley no. 5, is an all purpose plane and is long enough to be used in the joining the plate halves.

Thumb plane
These are used almost exclusively with violin plates. Two or three sizes, round sole, should have you covered, see the image on the right.

2. Saws

Coping saw
Used for the cutting of the outline, a type with sufficient depth is recommended, if you can, get a light one, made of aluminum. The saw should be also equipped with screws allowing you to adjust the tension of the blade. The tension should be enough to allow for precision work.

Blades for this saw should be of sufficient thickness, ie. about 1.5mm. You may find that blades with a round profile are more suited for this type of work. When fixed in the saw, the teeth on the blade should always point towards the handle.

Gyokucho saw
A great Japanese razor saw with many uses around the workshop. Highly recommended all purpose saw. Two sides with finer and coarser teeth, used with denser and softer woods.

3. Gouges

Long handle gouges
One or two with long handles to ease the tedious carving of the plates. The depth of the blade should be around this ie. Pfeil 6/20. Anything deeper and bigger will make the carving more tedious.

Narrow chisel
Good for chopping off the block when carving the pegbox and scroll.

1.5 mm mortice chisel
This chisel is only about 1.5 mm wide at the end of the blade and serves to cut the mortices in the corner blocks for the lining.

Scroll gouges
Used to carve the various stages of the volutes of the scroll.

4. Spool clamp

A set of 30 of these is used when gluing the upper and lower plates to the rib structure. They can be easily made, for dimensions look at the image on the right side.

To make a set yourself, get a round stick of wood, 25 mm in diameter, cut 60 pieces, 25 mm high out of it.

Get 30, 10cm long screws, with as many nuts and 25 mm wide washers.

Cut 60 pieces of leather matching the radius of 25 mm, with holes in them. Glue these onto the wooden parts.

In each of these parts drill a hole the width of the screw.

Assemble as in the fig on the right.

5. Clamps

Lining clamp
The lining clamps, 40 of them, are used in the gluing of the linings. Again, these are usual wooden clothes pins, reinforced with standard rubber band and the tips removed, for a tighter, more precise grip.

Bass bar clamp
This wooden clamp is used to fix the bas bar in position while it is being glued onto the top plate. You can buy a set of metal bass bar clamps or you can make a set of five, as depicted in the fig in the middle.

C clamp
A set of about 5 of these is a must. You will use them in various tasks, ie. gluing the fingerboard, the neck, the plates, etc. Make sure these are quality stuff.

6. Measuring tools

Steel ruler
A 30 cm steel ruler serves as a all purpose tool.

Vernier caliper

Dividers
These are used along with the compass, to transfer some of the measurements onto the wood. I usually use the compass for this, but you may find that good dividers mark a spot more precisely and the marks don't wear off so easily.

Compass
The locked type with adjustable radius via a screw is preferable.

7. Thicknessing caliper

Used to measure the thickness of the plates during their graduation. On the right side, you have got the standard thicknessing caliper which you can buy or you can make one yourself, buying just the measuring unit. 1/10 mm precision is sufficient.

To make the thicknessing caliper yourself, attach the measuring unit to a wooden construction, positioning its tip against an adjustable screw. The base is 27 x 16 x 2 cm. The "arm" is 5 cm wide, 2 cm thick and 23 cm long and is positioned in the middle of the base, see fig.

8. Reamers and shapers

Peg hole reamer
Reams the peg holes to an exact angle.

Peg shaper
Serves to create the exact conical shape on the peg which must match the one reamed in the peg box using the peg hole reamer, see above.

It should have adjustable blades, and a fine adjustment is necessary to make sure the resulting peg, when inserted into the peg hole has maximum contact with it. Also, well adjusted blades prevent the tearing of the ebony wood while shaving the peg.

9. Bending tools

Bending iron
An iron heated to ca 300C, helps you bend ribs, the purfling and the linings. A type with a thermostat may be helpful, but with practice, you will recognize the correct temperature by yourself. The self-made bending irons are of great variety. You can go as basic as a 25-28mm diameter pipe, heated up by a heat gun or a welding iron.

Building a bending iron yourself, the resulting device should meet some minimum requirement. Should be able to get to the desired temperature relatively quickly, and should be able to stay there for reasonable time. The surface of the iron should be of optimal radius and it should not stain the wood.

Bending strap
Basically a strip of thin metal with handles at each end, helps you hold the piece of wood bended in place, wrapped around part of the radius of the bending iron.

10. Scrapers

Also one of the basic tools, it is used especially when finishing the rib stock, the plates, the neck and fingerboard.

The shapes on the right are considered basic and you may find other shapes suit your working style better. The rectangle one is used for anything flat, ie. finishing the rib stock.

You can get the material for these at your local hardware store, and cut the shapes out yourself, or you can order these finished.

Also see the sharpening section for the how-to on how to sharpen these.

11. Purfling & F-hole tools

Purfling marker
The purfling maker serves to mark the purfling channel, which goes parallel with the contour of the plates. As its name suggests, although it has one or two blades, it serves just to mark the channel, not to cut it. The cutting itself is done with your regular, or specially beveled knife.

Purfling pick
When the walls of the purfling channel are cut deep enough, you use the purfling pick to remove the waste wood between them. This is a rather simple tool which can be relatively easy made in the shop.

F-hole cutters
Some makers use it, some don't. I prefer the clean holes they produce, but if you decide to use them, you should have a range of diameters, for this to be flexible.

12. Graduation punch

This tool is used to punch holes in the plate. These holes serve as guides during the hollowing out of the plates.

13. Plate holder

A variety of jigs used to hold the plate while it is being carved hollow are used. Here you can find the plans for an universal holder, which can hold plates of any violin sizes.

14. Soundpost tools

Soundpost setter**
Used to put the sound post in position. Various types are available.

Inspection mirror
May assist you in the process of sound post setting, but also in the general inspection of the insides of the instrument.

Soundpost retriever
When the soundpost falls down and keeps rolling on the bottom plate, you can either try to get it out the same way you put it in, using the sharp end of the setter, or you can use this handy device.

Soundpost gauge
Used to measure the height of the area where the sound post is supposed to be installed, so that you know how long you cut it. Keep in mind, the ends of the soundpost are slightly angled.

15. UV cabinet

A UV cabinet can be used both for tanning of the wood and curing of the oil varnish.

Category: Tools and materials

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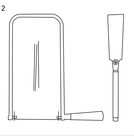

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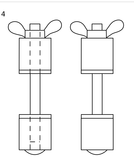

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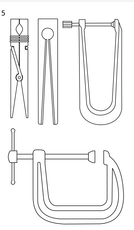

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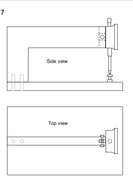

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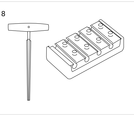

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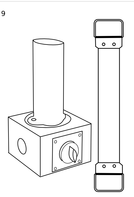

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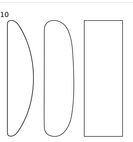

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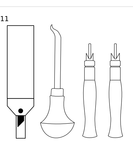

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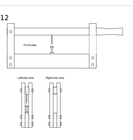

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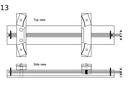

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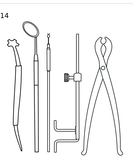

When sharpening any instrument, there are two important aspects. You want the edge to be as keen as possible and you also want it to be the ideal shape.

The sharpening of any tool takes generally two steps: Shaping and/or nick removal and Honing.

Terminology

See Fig. 1 for the basic bevel up tool geometry. Bevel up tools include chisels, gouges and block planes. "a" - Primary bevel angle, "b" - Cutting angle, "c" - Secondary bevel /micro bevel/, "d" - Back bevel.

See Fig. 2 for the basic bevel down tool geometry. Bevel down tools include smoothing and jointer planes. "a" - Bevel angle, "b" - Cutting angle.

1. Initial shaping or nick removal

In this step you decide the angle of the bevel. You also remove any nicks and irregularities making the shape of the tip perfect.

Shaping equipment you need

If you want the bare bones setup, get a bench dual water stone 1000/4000. It should measure at least 20 x 6 cm. Or even cheaper is a 600 grit sandpaper mounted on a block of wood.

If you want to go electric, for large mass removals, wet grinders are the best. There is no need to fear for overheating, but they are rather slow. Sides of the wheel can be used for flat surfaces. Cheap ones use vitrified stones which are less efficient but degrade more slowly.

When you use your normal dry grinder, overheating is a great risk. When that happens, the carbon in the steel combines with oxygen leaving you with just soft iron, plus you anneal the tip making it soft. The whole length where this occurs should always be removed. Also, quenching tips in water during dry grinding leads to tearing. The tip should be in contact with the coolant at all times, so don't use dry grinders unless you really know what you're doing.

If you must use a cheap dry grinder, at least change the wheel for something like Norton 38A80 and buy a separate tool rest. If glazing occurs, which can happen when you grind brass or with cheap grinders a diamond wheel dresser should be used to restore the wheel. It can also be used to remove any humps on the wheel.

Belt sanders can on many occasions be used instead of bench grinders.

Shaping

The shape and the bevel depend on the metal used but also on the use of the instrument.

Japanese instruments are usually harder 62RC allowing for a keener edge, so a bevel of higher 45° angle is needed to prevent breaking. With western blades which are a bit softer, and less prone to chipping, the bevel angle can be less, say 25°.

Cutting the denser sorts of wood requires blunter bevel angles, whereas softer woods allow for more sharply beveled tips. Ideally, the sharpest bevel should be employed which makes the tip still strong enough to withstand the pressure of the wood.

2. Honing

During honing you make the bevels smooth as a mirror. Then you create the micro bevel, making the tip as sharp as possible.

Honing equipment you need

The cheapest tools would be strops, leather or even better wooden. Cut a groove in a softwood, maybe basswood, apply chromium oxide compound and you have a perfectly shaped strop for honing. The same for the inner side. In seconds, you can make a wooden strop that fits perfectly the shape of your gouge.

For chisels and plane irons, if you can, buy a honing guide. It will help you make the bevels accurate and lead to consistent micro bevels.

An electrified alternative is the use of shaped felt wheels, which are ideal for honing the inside of gouges. They are a great substitute for the fine bench stones. The to of the wheel should rotate away from you. Belt sanders are great for honing with leather belts.

Micro bevels

Micro bevels save time, tools and energy. The finest possible edge in the shortest time. If you need fine angular control, use a honing guide. Only takes half a dozen strokes.

Sharpening tools specifics

Chisels

1. If new, remove the lacquer.
2. Lap the face so that the edge is not jagged. Make sure the stone is flat.
3. Fix the nicked chisels on your bench stone or wet grinder.
4. Hone.

A chisel should always be at the lowest bevel angle consistent with edge retention. Bevel angle should be higher for narrower chisels, say 30°, to prevent chipping.

Japanese chisels are usually made of hard steel face combined with an iron back which add toughness and flexibility to the chisel. The chisels are usually very hard 62-RC and therefore quite brittle. They are usually sharpened at higher bevel angles. Ideal for softwoods. Most of them are hollow on their face with just a couple of mm of a platform adjacent to the tip, to ease sharpening.

Planes

With a new plane you will probably need to lap the sole. It is usually hollow. You don't need to flatten the whole sole, but at the beginning, right before the mouth and at the end the sole must touch. Use 90 grit on a sheet of glass, iron plate or stone.

True the bed. Put some paint on the iron, insert in position, remove and see there it imprints. Carbon paper.

Dress the lever cap so that it is in perfect contact with the chip-breaker.

True the chip-breaker. At an angle that makes the point of contact at the very end. Have it set as close to the keen edge as possible, maybe 1mm, because the closer it is the smaller will the broken particles be resulting in smoother surface.

Sharpening the iron:

1. If new, remove the lacquer.
2. Lap the face so that the edge is not jagged. Make sure the stone is flat.
3. Fix the nicked chisels on your bench stone or wet grinder.
4. Bevel down bench planes Stanley no 7, have the usual grind angle of 30-35.

   Block planes such as the Stanley low angle 60 1/2 plane can be ground to 20° bevel and 5° back bevel to reinforce the tip. Make sure the iron sits in the bed perfectly.
5. Hone.

Knives

For your knives a bench water stone, double 1000/4000 is alright. The bevels can range between 10°-30° depending on the steel and application. If you are concerned about the consistency of your bevels, you can use a spine clamp from you local stationery store. Put the clamp on the back of your knife to serve as an angular guide.

Honing can be done the cheapest on a leather strap glued do a wooden block, dressed with chromium oxide.

Gouges

1. Bevel angle of 15 for soft woods and 25° for hard woods, 30°-35° with a mallet. All around 25°. In order to achieve the lowest bevel angle possible and the lowest gouge angle for the easiest cut, make the outside bevel 15° and the inside 10°. The inside bevel reinforces the tip and at the same time lowers the gouge angle required for a cut to 15°. This low attack angle requires less pressure on the gouge and makes your cuts more precise.
2. You may also decide to change the shape of the tip's end. Square end is good for most purposes, fingernail end may be better for the scroll.
3. To hone the gouges, either use a leather belt charged with chromium oxide on an electric belt sander. If you prefer manual, go with the wooden strop charged with chromium oxide.

   For the inside flute, a shaped felt wheel charged with chromium oxide is good. again going manual, cut the edge of a scrap wood which reflects the shape of the inside of the gouge perfectly. Dress with chromium oxide.

Scrapers

A well sharpened scraper should make clean shavings, not dust. In hardness RCs of up to 52 are now available. To create the edge, you need to burnish the scraper. Use a round burnisher or >RC60. Don't use the backs of you chisels, they most likely are not hard enough. Don't use screwdrivers as the chromium/nickel coating is thin.

1. Joint the scraper first to give it a smooth edge at 90° to the sides. A jointing jig can be used with square scrapers.
2. You can stone the surface, at the side of the bench stone. 1000x
3. Put some nose grease on the burnisher.
4. Clamp the scraper in the vice, and make a couple of strokes parallel to the scrapers edge with the burnisher slightly tilted as in fig. Hold it by the handle with one hand and by the tip with the other. Move the burnisher in a little to avoid using just one spot on it. In softer scrapers this will result in a small hook on both sides. With greater angles the scraper will have to be tilted more to the ground to bite. Use as few passes as possible. Try the scraper on the wood you intend to use it for.
5. If you need more hook, run the burnisher at a slight 2°-10° angle to the edge. Do that a couple of times. Check again.

To "pick up" the hook after it has become dull, reburnish again with a few strokes. If that doesn't help any more remove the hook with the jointing jig, stone and burnish again.

Scraper plane

The scraper plane can be used when thicknessing the ribs. A 45° bevel is usually used. On top of that, you can create a hook at the end with your burnisher angled at 15°.

Stone truing

After a while every stone will loose its flatness. This may not be a big deal with gouges, but when sharpening chisels or plane irons, the stone must be reasonably flat. To true your stone, you can sue a coarse diamond bench stone, silicon/carbide paper on glass or even coarser stones, which can true your finer one.

Wood cutting tips

When parallel grain cutting, always cut with the grain, that is when the grain is rising up away from you.

If cutting end grain, always consider the skew cut. It is less demanding of the edge and lowers the bevel angle further.

When planing keep the mouth just wide enough for the shaving. This also results in smaller particles, smoother surface. Take thin shavings, they also allow for tighter mouth. Skew the plane wherever applicable. This applies especially if you have to cut against the grain.

Use a low angle plane, when cutting end grain.

For the cleanest cut with gouges, roll-cut.

Category: Tools and materials

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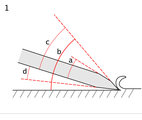

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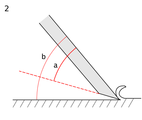

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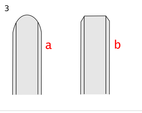

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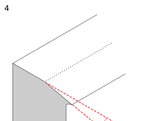

Hide glue and gluing

In the construction of violins only high quality hide glue should be used. Other glues, such as the white, yellow glue the cabinetmakers use, should be avoided. The main reasons for hide glue are reversibility /the joint can be taken apart and re-glued again/ and specific toughness of the joint with no creep and good acoustical properties.

What you need

1. Some hide glue. It can be in the form of small flakes, pearls or powder. Usually offered are strengths varying from 250 to 400 grams. Stronger sorts give you less working times so take the middle road and buy something of around 300 grams of strength. Usually small amounts of glue are used during building so you don't have to buy more than 100gr of dry glue to get you started.

   Avoid the hide glue that is offered liquid and premixed.

2. A glue pot/kettle. It should be rather small, ideally 8-10 cm in diameter, allowing you to prepare small amounts of glue quickly. Hide glue temperature must never exceed 70C, so you should be able to regulate the pot's temperature or its power output should be in the range of 10ths of watts. A regulated, double bottom pot with an insulating water-bed is perfect. See Fig. 1 and Fig. 2 for an example of the pot and hot plate.

   If you are pressed for money, or love to DIY, you can build a small glue pot yourself. It will work even without the water-bed, but you must make sure the wattage of the heating element is not more than 60 watts - a small halogen light bulb, such as the G9, can serve well here. The upside is that the heat up times are short and you will have a batch of hot glue ready in a minute. The downside: You will have to watch the pot like a hawk, keep stirring and turn it off before it overheats. It may seem complicated but when you get used to this, you can prepare small amounts of glue very quickly. See Fig. 3 for an example of such a setup.

   This glue pot is made of a round wooden base and a sheet of metal turned around a bell, which serves as a pot. The heating element is the halogen light bulb mentioned above. Use your imagination.

   The bottom line: You don't need anything fancy or regulated but a good thermometer before you get the feel for this is a must.

3. A set of brushes and knives. One smaller 5 mm wide all-purpose brush, one larger 20 mm wide for bigger jobs. A palette knife will be used to work the glue into the seams when gluing to top and bottom plates to the ribs.

Preparing the glue

1. For a start, put a teaspoon of hide glue in the glue pot and add about 100ml of fresh water.

2. Stir and let stand for 1-2 hours. When you see the glue has gelled and grown in size considerably, it is time to heat it up.

3. Turn on the glue pot and make sure the temperature never exceeds 70C for longer periods of time. Should your hide glue start to boil, don't use it, and prepare another batch.

4. Keep stiring until you are sure there are no undissolved pieces in the pot.

5. Check for the thickness of the glue. Visually, the glue is hot and thick enough if a film starts to form over its surface. You will learn to guess the right thickness by letting the glue drop from the brush. The medium thickness hide glue should feel oily between your fingers. The thin hide glue used for glue sizing should almost be the consistency of milk. Make sure the glue is about 70C when testing for thickness.

Application

1. Always try to work in a warm room with no droughts so that you have more time to make the joint.

2. Preheat the critical joints with a hair dryer, ie. center seam joints.

3. Make sure everything fits right without the glue first.

4. Have everything to hand, you need to act quickly and precisely.

5. Don't use more glue than necessary and always remove the surplus with a damp brush or towel. Sometimes it may be better to wait for the glue to gel a bit for easier removal. Be especially careful with the areas that will be varnished. Areas with hide glue blotches will not absorb the stain properly, leaving marks.

6. When you are using the palette knife, always have it preheated in hot water, otherwise the glue gels fast when in contact with the cold knife.

Drying times

Under normal humidity and temperature the hide glue should be left to dry for about 12-24 hours. Usually overnight should be enough time. More structurally important joints, such as the center joint or the neck joint, should be left undisturbed for the full 24 hours.

Hide glue shelf life

The dry hide glue should be stored somewhere... dry. Properly stored, it has an almost infinite shelf life.

The shelf life of the prepared hide glue depends on many factors: humidity, room temperature, possible contamination, thickness. It all boils down to how bacteria friendly your workshop is. The freshly prepared glue is the strongest, so for critical joints, ie. when joining the billets for the top and bottom plates, I would always use fresh glue. On the other hand, many violin makers may leave their glue in the pot for days without apparent loss of strength.

Some people prepare the glue, let it cool down, cut it up into small cubes and put them in a fridge.

The signs of bacterial degradation are the change in color, often turning brown, tiny watery pits on the surface and a bad smell.

So if you want to stay on the safe side, always prepare a fresh batch of your glue.

Category: Tools and materials

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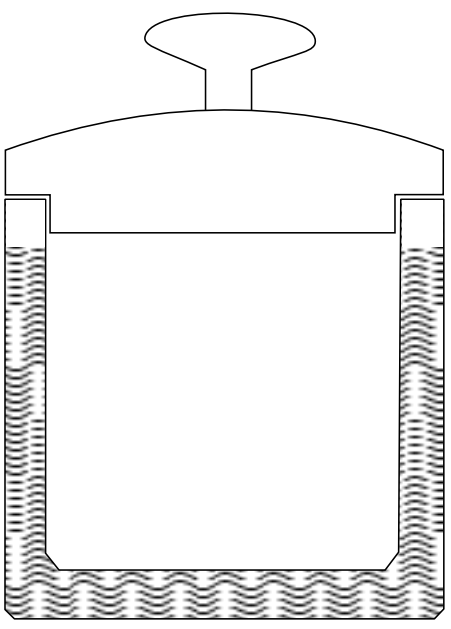

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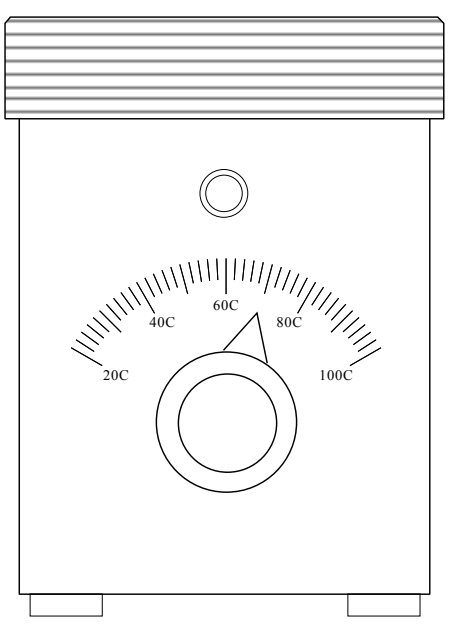

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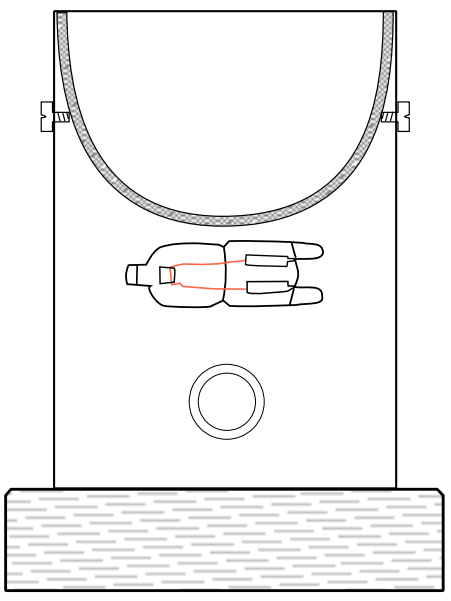


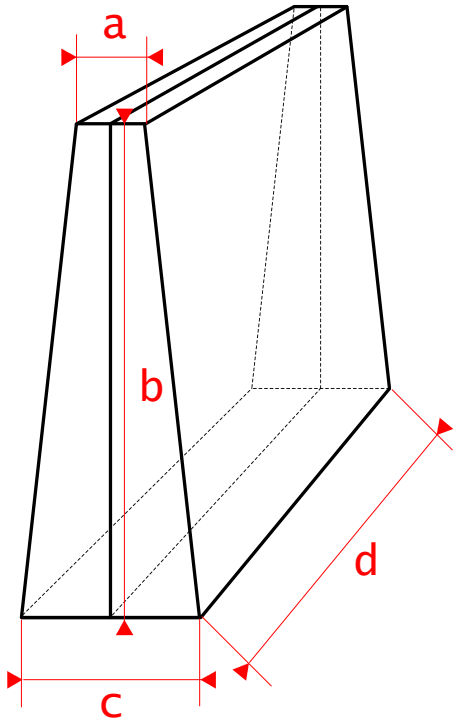
Determining the specific gravity of wood

A method of ascertaining the specific gravity of wood is to submerge the wooden billet in water and divide the length of the submerged part by the total length of the billet.

Alternatively, you can use the widget below to calculate the specific gravity for you. Be sure to measure the dimensions and weight as precisely as possible. Typical results range from 0.38 - 0.45 for spruce and 0.50 - 0.60 for maple.

The dimensions are input in millimeters , the weight in grams . The widget first calculates the surface = ((a+c)/2)*b, then the volume = ((surface +surface)/2)*d and finally specific gravity = weight /volume .

a	b	c	d	Weight	
					Calculate specific gravity



Category: Tools and materials

A few thoughts

The template is the basis of all your work on the violin, so a lot of effort should go into its proper execution. You have to decide whether you are building an exact copy of an existing instrument or an approximated interpretation of an existing instrument or an original construction.

In case of an exact copy, you will use a full size template describing the outline of the copied instrument to the greatest detail. If this instrument is of any considerable age and has been used, it will have at least some wear. That wear will get copied as well. The shape of the instrument itself changes over time, the wood shrinks differently in various directions. All that gets copied. Choosing this approach, if you want to arrive at something "right" you have to work very precisely, because you are at least 8 "generations" away from the original outline and every generation brings some amount of error with it.

In case of an interpretation, you can still use a full size template, which you will "correct" to some degree. You can remove obvious spots on the outline, where the wear has caused the shape to deteriorate and you can also correct some of the asymmetry.

Besides the full size template, you can use a half template, which you flip on the other side to get perfect symmetry. The downside of this is that you will have to choose which half of the original violin you will use. Without correction, if the original violin is very asymmetrical you will end up with a very differently shaped violin. To illustrate this, get a picture of someone`s face, and use just the left or right half to reconstruct the whole. The change may be quite dramatic.

Knowing all that, for a novice, who is very likely to introduce a lot of errors, the symmetrical template is almost always a better choice. Remember, errors tend to accumulate with iterations.

You may also decide that you want to construct the outline yourself, without it being directly based on any existing violin. There are many systems of violin construction out there but to me the most simple ones, based on the use of compass and basic geometry seem the most plausible. For an in depth approach to this, see the great François Denis` book Traité de lutherie.

Because this manual is meant mainly for beginners, we will take the full outline and convert it into a half template from which in the next chapter we will construct a perfectly symmetrical mould. The full size outline is based on the famous Messiah violin, built by Antonio Stradivari in 1716. This violin is in perfect shape with no discernible wear, so we will even out just the obvious irregularities which are the result of handwork.

The template

1. For the half template use a 2 mm thick sheet of plexiglass, or aluminium which is at least 15 cm wide and 38 cm long.

2. Get the outline of the violin you want to interpret. You can either copy the outline from an existing violin or, you can buy a Strad poster, which, on its back has the outline plus the arching curves and other measurements. The outline should look something like in Fig. 1 .

   If you decided to build the Messiah violin in this guide, you can take a short cut and print out the finished half template in Fig. 4 . This outline should be 350 mm long. If for any reason you cannot print the outline to scale from your web browser, save the svg image and print it from Inkscape (with proper margins). Now you can skip to the gluing as described in paragraph 9.

3. Copy this outline using a photocopier or print out the outline in Fig. 1 . You will need a printer, that is capable of printing on A3 size papers as the outline is over 35 cm long exceeding the A4 format.

4. Determine the centerline of the outline. Measure the widths in points A, B and C, divide by 2 to determine the true center of the violin. See Fig. 2 .

5. Mark out the points X1 and X2, about 8 cm in from top and bottom, see Fig. 3 . These will serve as fixing points for correct alignment later on the mould.

6. On the side, which you chose for the half template, construct the contour of the template. This contour is inferred from the plate outline, minus the overhang, minus the thickness of the ribs, which in our case makes, in total, about 3.3 mm. Use a compass to draw a parallel line inside the outline, see the red line in Fig. 3 .

   During this process of parallel tracing you also have a chance to correct anything you don`t like about the original outline of the violin. You want to even out the bumps without loosing the original.

7. The general 3.3 mm inset can be applied to all of the shape, except for the corners. There the inset gradually increases. The increase is steeper in the C bout and less so coming from the upper and lower bouts. Depending on the original model, the end of the ribs may be 0-4 mm inset from the end of the corners. The good common value here is 2 mm, see the dashed lines denoting the ends of the ribs in Fig. 3.

   It is therefore a good idea to try to draw the complete corners, including ribs, for reference. From this you can infer the inner outline of the mould. Study the corner construction in Fig. 3 .

8. Once you have the template outline complete, draw the remaining line which runs parallel to the centerline about 8 mm off the centerline, closing the template.

9. Glue the half template outline to the plastic or aluminium sheet as mentioned in Par. 1. It is preferable to use some sort of superglue, as other glues may tend to peel. This, of course, depends on the material you`re using. Avoid the use of water based glues altogether as those will cause the paper to spread, leaving you with a bigger outline.

10. Carefully cut out the outline of the template and finalize its contour with a file. About 3 cm from top and bottom cut out notches which will help you see the centerline when aligning the template to the mould.

    You can see the finished template in Fig. 4 .

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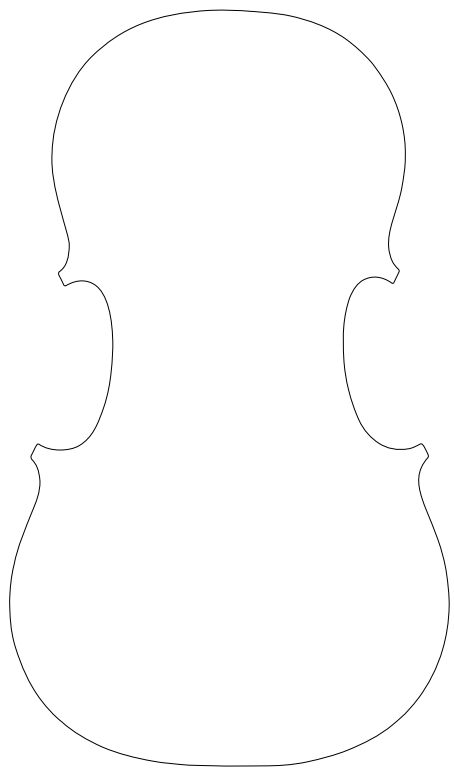

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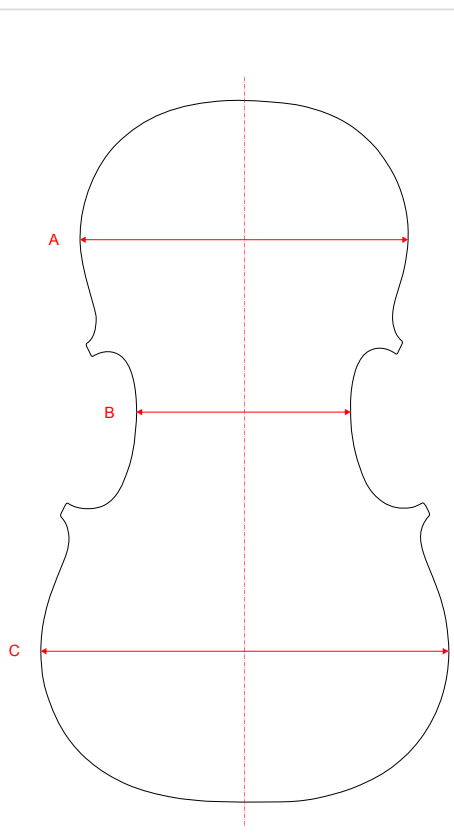

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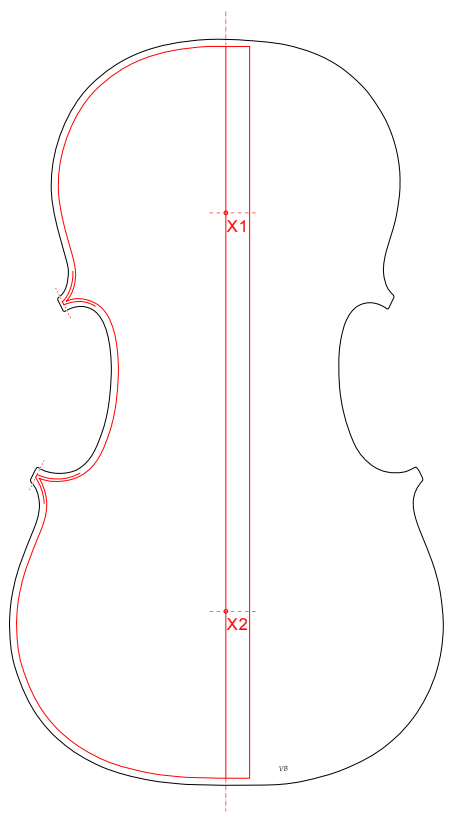

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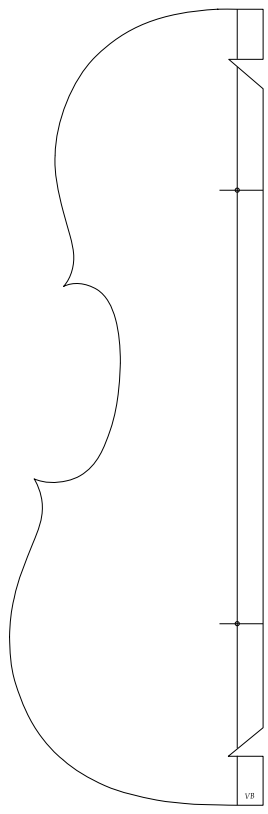

The outline and measurements

1. For the mould, use a 12 mm thick, 400 mm tall and 250 mm wide piece of wood. It is important that the wood is as stable as possible, so multi-layered plywood or battenboard are preferred.

2. After you have cut it to the right dimensions, you need to transfer the outline.

3. First, draw a centerline on the wood, then align the template with it.

4. Now you need to drill two holes, about 8 cm in from top and bottom of the template, on the centerline, drilling through the template itself as well as the wood. For this, a drill press is the best. See the Templates chapter for the exact location of the points.

5. Then get two wooden pegs, matching the diameter of the drill bit. Or you can use the drill bits themselves.

6. Securing the template in perfect alignment with the centerline in this way, scribe a line along its contour, flip the template on the other side and repeat. Repeat also on the other side of the mould, making sure the orientation of the template is correct.

7. Now you need to transfer the lines as in Fig. 1 , all measurements are in millimeters. The cornerblock recesses are drawn as follows: 1. Draw the "a" line, 2. Using a compass, from point x1, measure 26 mm and create the point x2 on the C bout, 3. from x2, draw the "b" line connecting it back to the "a" line.

8. Repeat on all remaining corners. Repeat for the other side as well.

9. It is also a good idea to mark the top and bottom side of the mould so that you always know which side is facing you. Also, add an inscription on the top of the mould about the name and author of the source violin you are interpreting.

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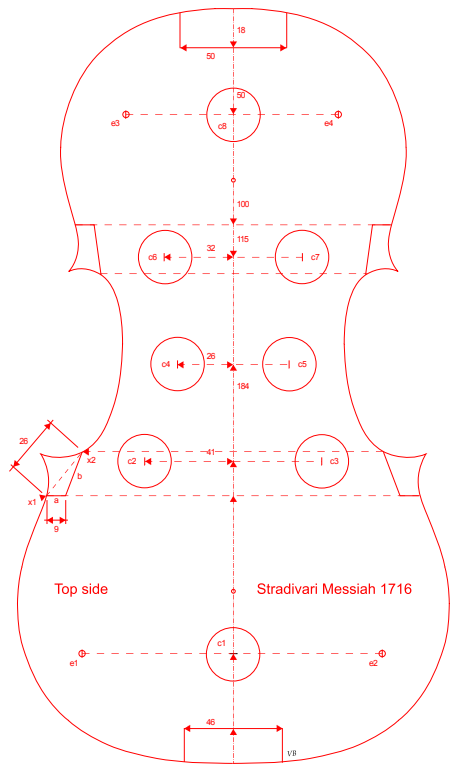

Cutting out the mould

1. After you have marked out those lines, you can proceed to cut out the actual mould. The best tool for this is the band saw, which will make it easy for you to achieve the perfectly perpendicular cuts. If you are cutting the mould by hand, make sure you stay well off the line and that you are not undercutting into the line on the bottom side.

2. Use a file to finish the contour.

3. For the clamp openings "c1-c8", a press drill again is the best tool. Predrill all the holes with a 3 mm bit. Then, using a 25 mm drill bit, to avoid splitting, start a hole on the top, drilling about 1/3 in, then flip the mould and finish.

4. The four "e1-e4" holes should now be predrilled with a 2 mm bit. Four screws will be later used here to elevate the mould above the workbench surface a bit when attaching the blocks.

   You can see the finished mould in Fig. 2 .

5. Dry soap should now be applied on the perpendicular side walls of the mould, excepting the areas the blocks will be glued to. This prevents accidental gluing of the ribs to the mould, should you spill some glue where it does not belong.

6. The areas where the blocks should stick - the longer sides of the recesses - should be glue sized with thin hide glue.

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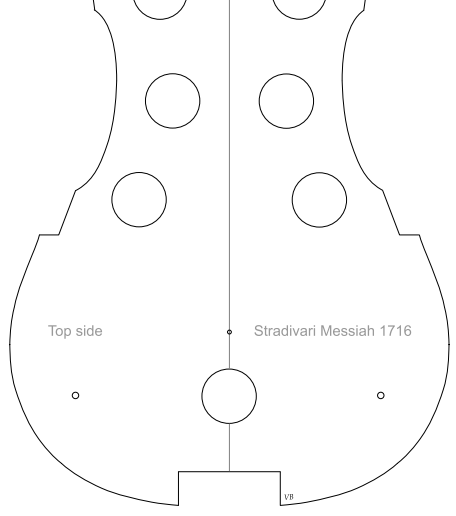


The blocks

1. Cut spruce blocks to the following sizes: Top "A": 32 x 50 x 22 mm , Bottom "B": 34 x 46 x 20 mm , Upper corners "C, D": 33 x 25 x 28 mm , Lower corners "E, F": 33 x 25 x 28 mm . The grain should run perpendicular to the bottom plane on which they "sit", allowing for easy, precise cutting {from top to bottom} later on.

2. At the bottom side of the mould, screw in four screws into the predrilled holes so that the mould gets lifted evenly by approximately 9 mm . Make sure that all four screws make contact with your flat workbench and that no rocking is present.

3. Fit the blocks in the mortices in the mould. The gluing surfaces are the thick red lines in Fig. 3 It is important that these surfaces are in perfect contact with the mould. The top and bottom "A, B" blocks should have a slight gap at the sides allowing them to be inserted easily. Make sure the annual rings are directed away from the mould as in Fig. 3 .

   With most violins, the height of the ribs decreases gradually along the length of the body. Therefore, in the finished violin, the bottom block may be 32 mm tall, whereas the top block may be 30 mm in height. This, of course, affects the upper and lower cornerblocks as well. For Messiah, the final heights in the finished rib structure is as follows: A 30 mm , B 32 mm , C 30.5 mm , D 30.5 mm , E 31.5mm , F 31.5 mm .

4. With these numbers in mind, if necessary, trim the blocks to their final heights leaving them about 2 mm taller.

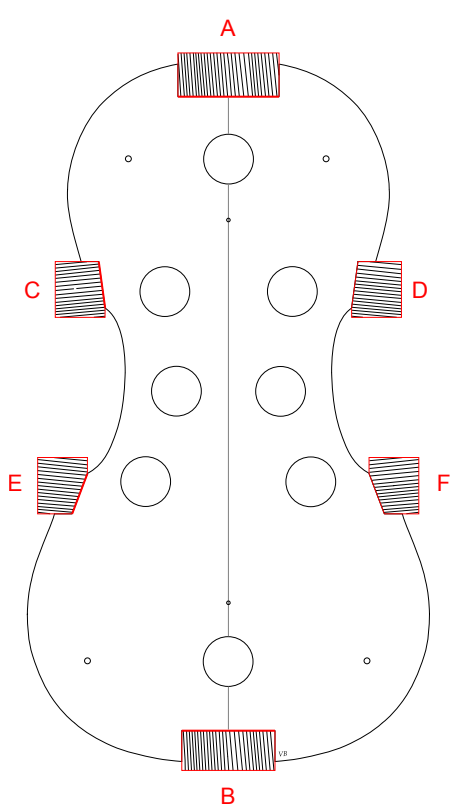
5. Glue the blocks to the mould using medium thickness hide glue. Apply the glue to the longer side of each mortice only. Remember, you will have to break the blocks off the mould when the ribs are finished, so avoid applying too much glue. Hold in position with your hands for about 30 seconds. Let dry overnight.

6. Once the glue is completely dry, sand the blocks down on both sides, bringing their height to about 1 mm above the final numbers. For this, use a long belt of sanding paper clamped down on both ends to your workbench or glued onto a flat /ie. 6-8 mm thick glass/ plate. Later on you will finalize the heights of the ribs using this method again, but this time with the ribs already glued on.

7. Take the template, realign it with the mould, mark the contour on all the blocks with a pencil or a scribe. Mark the true center of the violin on the top and bottom blocks. See the red lines in Fig. 4 .

8. Flip the mould over and repeat the marking on the other side.

3



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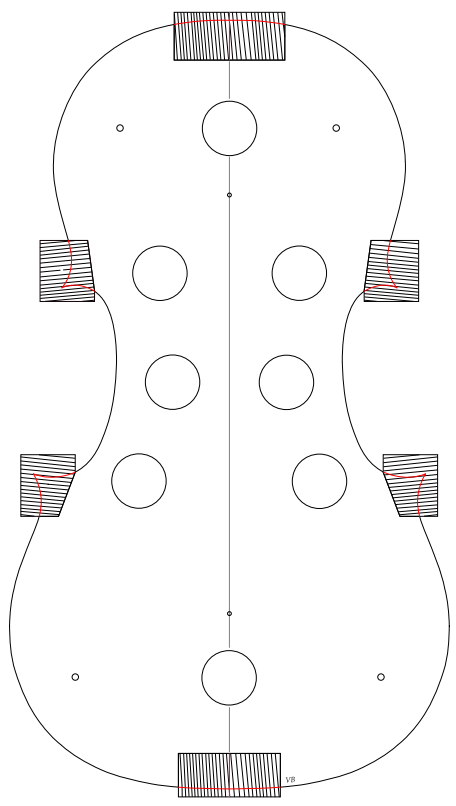

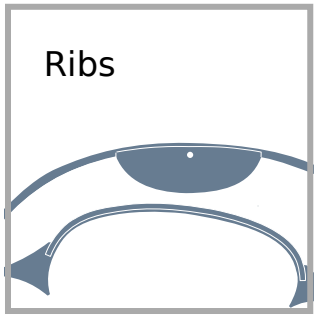

Preparing the ribs

1. Choose good maple, which will satisfy you both visually and physically.

   The wood should probably be flamed and flexible and the flame should match that of your back. Remember though, that more flame means the maple will be more difficult to work with because its structure is more complicated with some parts denser than others. This may prove problematic especially if you have no previous experience in wood bending. So if this is your first violin, use plainer, less figured wood.

   Look at the cross section in Fig. 1 . The growth rings should run as parallel to the sides of the ribs as possible, to ensure greatest stability. Also, the height "b" should be sufficient for the violin you are building, plus about 4 mm . (36 mm for the Messiah)

2. Decide whether you are going to make the ribs for the upper and lower bouts in one or two pieces and cut the ribstock accordingly. See Gluing the top and bottom ribs if you don't know how long the upper and lower bout should be.

3. Fix a jack plane upside down in your vice, carefully hold the ribstock in your hands, and plane the "a" side of each of the ribs so that its level and straight. Alternatively, you can use a shooting board for this.

4. Draw the maximum height "x" line parallel to the "a" side you have just planed. This line denotes the maximum height of the ribs, usually in the back of the violin, ie. 32 mm + add 4 mm as safety margin.

5. Cut through the line using a knife and a steel ruler, or use the mounted plane again to remove material to the line.

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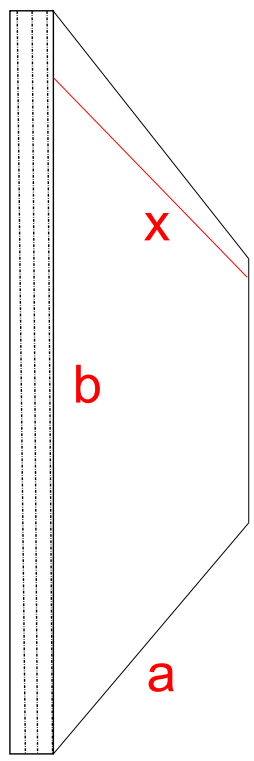

Thicknessing

1. Now that you have all the ribs trued and cut to the correct height you need to adjust their thickness to approximately 1.5 mm .

   It is best to use a rectangle scraper to remove most of the thickness. To make the surface even it is advised to use a block plane with a blade reground for scraping as in Fig. 2 . Blade "a" is the normal block plane blade, which doesn't work well with the dense, flamed ribstock. On the other hand the "b" blade, which when reground works as a scraper, is perfect for the job.

   You can, of course, instead of the scraping plane, use your regular scraper, but in that case you will need to keep a keener eye on the evenness of the thicknessing and the whole process may prove more cumbersome. It all depends on the initial thickness of the ribstock.

   The thickness and its even distribution may be checked with a thicknessing caliper or more efficiently, the target thickness can be punched into the ribstock using a graduation punch. Set the punch to the final thickness and make a network of holes covering the whole ribstock. Working with the plane scraper, when all the holes are gone, you have arrived at the correct thickness. See the dots in Fig. 3. for reference.

2. Clamp the rib down to your workbench and start scraping away from the clamp, as in Fig. 3 . To remove wood as evenly as possible, tilting the scraper a little may help, as the flamed pattern consists of patches of softer and harder wood.

3. As mentioned previously, during this stage, also employ the scraper plane to remove any unevenness.

4. After you have reduced the thickness to 1.5 mm , continue removing material down to 1.2 mm . Again, make sure the thickness is evenly distributed along the whole length of the rib.

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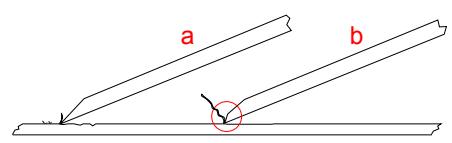

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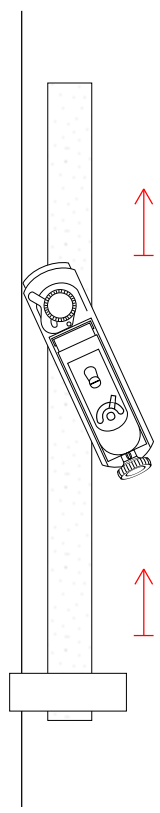

Category: Ribs

Cutting the C blocks

1. First, take a sharp chisel and remove all the wood about 3 mm beyond the projected tips of the corners. See the red dashed lines in Fig. 1 for the approximate position of the cuts.

2. Using a suitable gouge, start paring away the wood on the upper and lower corner blocks where the C ribs will be, see the contours in red, "a, b, c, d ", in Fig. 1 . As in the image, naturally extend the curvature past the tip of the cornerblock.

   Make sure the bottom of the block you are working on is resting securely on your workbench and that the only pressure applied is to the block itself, otherwise the block might snap off as it is only lightly glued.

   Make frequent checks of the lines on the other side of the blocks to make sure you`re not undercutting.

   Also, with the help of a small square, keep checking everything is perfectly perpendicular.

3. Finish with sanding paper on a stick of suitable diameter, making sure that the point where the blocks meets the mould make a transition as smooth as possible. Run your finger over it to check for smoothness.

4. Check the contour again by realigning the template with the mould.

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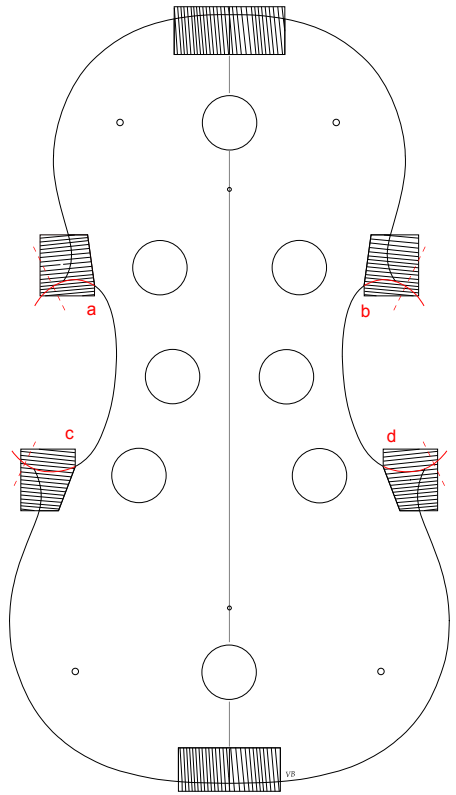


Category: Ribs

Preparing the mould and the ribstock

1. Screw the four screws in the mould again so that they rise the corner blocks about 1.5-2 mm above the surface of your workbench. Put the mould on your flat surface and put the rib stock right next to the corner blocks checking that it overlaps by 2 mm at the bottom and 2+ mm at the top.

   Don`t forget that the height of the ribs is decreasing along the length of the violin body, so with a 2 mm overhang at the bottom block, you will get 4 mm at the top block.

2. Choose the ribstock pieces for the C ribs. Decide the orientation of the pieces with regard to the slant of the flames. They usually slope down towards the player on both sides (the flames on the neck later on should match that). Make sure their surface is perfect, especially on the outside, correct with a scraper.

3. Prepare the clamping blocks used to hold the C ribs in place as in Fig. 2 . These can be made of some harder wood to the dimensions of 110 x 35 x 15 mm . Two pieces are needed. For the exact angles, you can print out the Fig. 2.

Bending tips

The temperature of the bending iron should range between 200-250 Celsius . You can get a thermostatically controlled bending iron, or you can learn to estimate the temperature by moistening your finger in the water and touching the iron briefly. This takes experience.

Also, practice bending on scrap rib stock first. You need to learn how much pressure to apply, how fast to proceed, how the heat in the iron is distributed and what is the best temperature for the actual wood you are bending. Too little heat and too much pressure and you will break the rib. This applies especially for highly flamed maple. Too much heat, on the other hand, applied for too long will vaporize all the water and you will scorch the rib.

Bending

1. Put a sufficiently long piece of rib stock in water and let soak for a few minutes.

2. Heat up the bending iron and bend the C ribs so that they fit the mould as closely as possible. No excessive force should be needed. You should be left with C ribs that have no gaps along their inner side, like in Fig. 1 .

   When driven home, looking from the side, they should be in contact with the workbench, extending beyond the elevated corner blocks by about *2 mm*, as mentioned above. Also, using a small square, check that they are at right angles to the workbench.

   Clean the bending iron after each bending with a damp cloth to reduce the staining of the wood.

3. Shorten the ends of the ribs, if necessary. They should extend only 3-4 mm beyond the point of the corner block. Make sure they are still at right angles.

4. For a test, put on the C clamping blocks and make sure they sit well, are perpendicular to the surface and that they end up a couple of millimeters proud of the tip of the corner. When pressure is applied they should be "opening" the C rib slightly, see Fig. 2 .

   If needed, file down the ends of the ribs to ensure good contact with the clamping blocks, and the proper "opening" action.

5. Also, the clamps you will be using in the gluing, should be put on for a try. Only mild force from the clamps should drive the C ribs fully home, closing all gaps. The red arrows in Fig. 2 show where the action of the clamps should be.

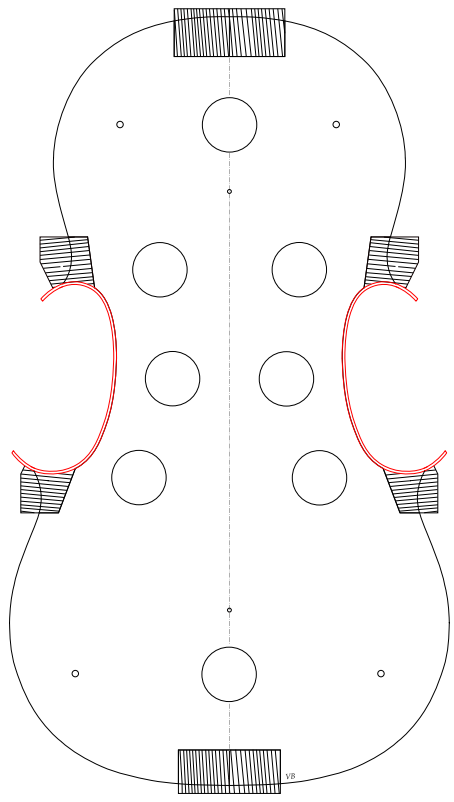
6. If there is any moisture left on the ribs, let dry.

7. If necessary, reapply soap on the mould, in the vicinity of the blocks, where it might have been removed by sanding.

8. Glue in using medium thickness hide glue, putting it on the blocks only.

Category: Ribs

1



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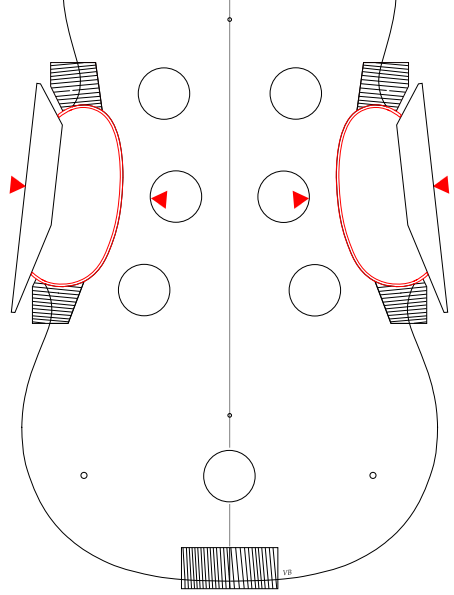


Cutting the upper and lower bout blocks

1. Remove the four screws from the mould.

2. Remove the excess height of the ribs leaving them just a little proud of the blocks. For that a small sharp block plane can be used. While planing, try to follow the shape of the rib to avoid splitting the ends. Repeat on both sides.

3. Use sanding paper on a flat surface to make the ribs flush with the blocks but don't remove any material from the blocks. Now the mould should be sitting on your flat surface without rocking.

4. As with the C ribs blocks {in the previous article}, using a suitable gouge, pare away the wood on the upper and lower corner blocks to the contour line depicted in red in Fig. 1 .

   The difference here is the need to create a feathering at both ends of each C rib, see how the red line cuts into the rib.

5. Shorten the tips of the ribs to a distance where the final tips will be, in our example, the finished tips will protrude about 2 mm from the tips of the template. Observe the template outline and determine where it will naturally cross into the tip of the rib, creating the feathering. If you have the original or its photograph, try to determine where the tips of the ribs end there and approximate. See the red dashed lines for suggested tips in our example in Fig. 1 .

   When cutting, make sure the tips end up at right angles to the bottom plane. For this, you can use the sanding paper glued to a square block of wood.

6. Using a suitable, sharp gouge, create the feathering, cutting across grain from top to bottom.

7. Make the rest of the outline in the corner blocks flow naturally into the newly created feathering.

8. You can finish the surfaces with sanding paper on a stick making everything very fluent and smooth.

   Again, the transition between the block and the mould must be as smooth as possible. Use your fingers to check for that.

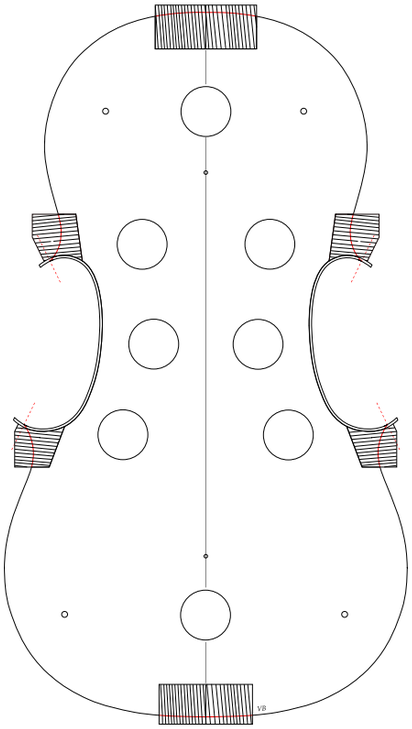
   Check often that the newly created walls are perfectly perpendicular to the workbench.

9. Cut the top and bottom blocks, again to the red line as depicted in Fig. 1 . Finish using sanding paper on a square block of wood.

10. Reapply soap where it might have gotten sanded off.

See Fig. 2 for how everything should look like when finished.

1



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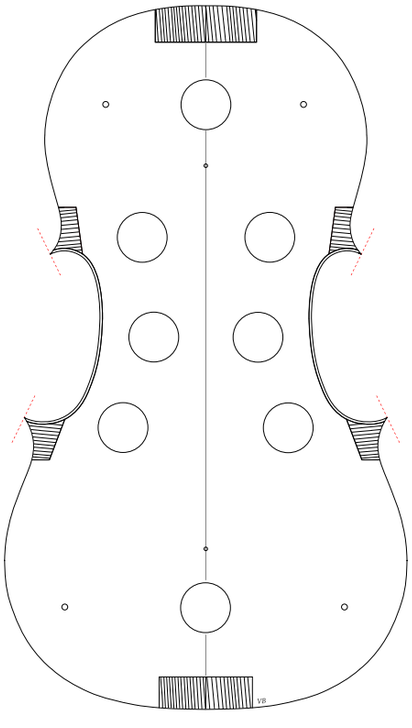
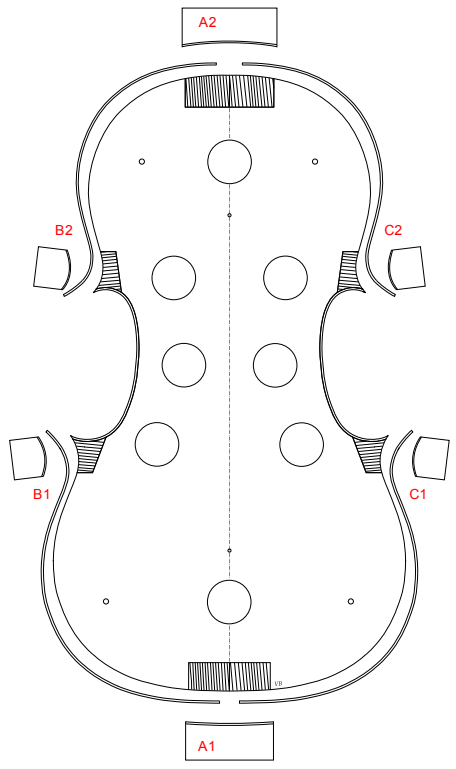


Category: Ribs

The top ribs can be made of two parts and there is no need to precisely pair them as with the bottom ribs. The ensuing gap at the top should not exceed 9 mm though. See the small gap at the top underneath the top clamping block in Fig. 2 for an example. Also see the exploded view in Fig. 1 to realize by how much the top and bottom ribs extend the feathered ends of the C ribs at this point to get an idea how long you should cut them before bending.

1



Bending the ribs

For the bending itself the same rules as for the C ribs apply. If you need bending tips, check the chapter Bending the C ribs.

1. Screw the four screws again in the mould again so that they rise the corner blocks about 1.5-2 mm above the surface of your workbench. Again try to put the rib stock right next to the corner blocks checking that it overlaps the corner blocks by 2 mm at the bottom and 2+ mm at the top.

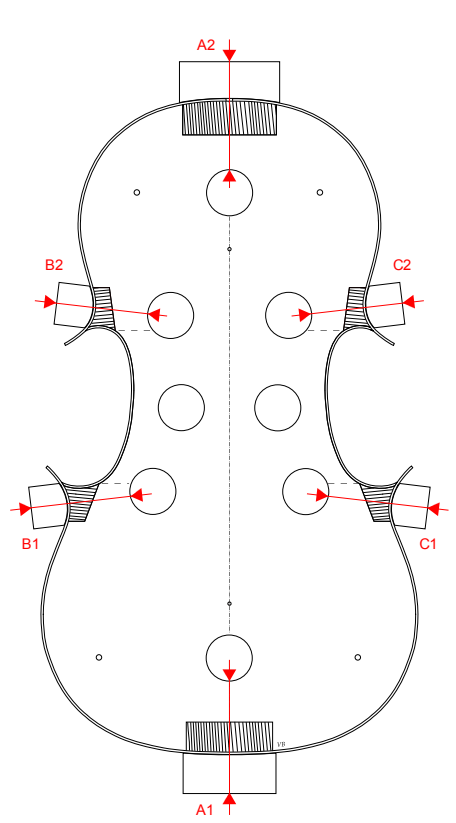
2. Cut the ribstock to correct lengths and decide the orientation of each piece, depending on the flame. With the bottom ribs, if the flame is slanted, you need to make them in two pieces to match the slant of the rest of the ribs on both sides {mirroring}.

3. Bend the ribs. Again, for bending tips, see Bending the C ribs.

4. Let dry.

The bottom seam

2



If you chose to make the bottom ribs in two parts, before gluing, you will need to make them fit as perfectly as possible. The seam must be at right angle to the bottom plane and must be aligned with the centerline of the violin.

1. Let the ribs be clamped at the lower corner blocks (B1 and C1) and mark the center plus 1 mm at each of the two ribs.

   If you have a perfectly flat surface to rest the mould on, use a square to mark the lines where the ribs will be trimmed.

2. Trim the ribs and check how the ends align with each other. The goal is to make a seam that is barely visible. To make adjustments, you can use a small shooting board and a block plane, your knife or a flat file.

3. Keep aligning until the ends meet well.

The clamping

For the whole job you will need 6 C-clamps in positions marked in red, see Fig. 2 .

1. Notice the 6 clamping blocks "A1, B1, C1 and A2, B2, C2" in Fig. 1 which are made of hard wood with the sides touching the ribs following the curvature as closely as possible. Also, the sides touching the ribs are padded with something soft {ie. leather} to ensure the best contact possible without harming the ribs.

2. Again, as with the C ribs, the red arrows in Fig. 2 denote where the clamps` action should be. Before gluing, try to clamp down the ribs in their final positions to ensure that everything sits well and that there are no gaps anywhere.

Gluing the bottom ribs

1. Optionally, preheat the block you are about to glue to get more working time.

2. Put some medium thickness glue on the bottom block "A1" , align the left rib with the violin center and hold down with your thumb. Take the right rib along with the clamping block, position quickly to create the perfect seam, hold with both your thumbs for about 10 seconds, slide the clamping block in position and clamp down. Check that the ribs still match perfectly and that they stand firmly on the workbench overreaching "A1" block on both sides by at least 1-2 mm .

3. The same goes for the "B1, C1" corner blocks. Put some glue on the "B1" cornerblock and running your fingers from the already glued "A1" block up to the "B1" block make sure there are no gaps between the ribs and the mould and that the rib rests on the workbench. Clamp swiftly.

4. Repeat with the "C1" block.

Gluing the top ribs

1. Here you can start the gluing from the upper corner blocks "B2" and "C2" going up to the top "A2" block. The procedure is otherwise the same as with the bottom ribs.

Category: Ribs

Finishing the corners

1. Remove the four screws from the mould again.

2. Plane down the heights of all the ribs on both sides, leaving them just a little proud (.5 mm) of the blocks. When planing, follow the outline of the ribs with your block plane to get a smooth cut.

3. Measure the span of the upper "A-B" and lower "C-D" corners and compare it to the original violin. If you have got the original plate outline printed out you can also now try to align the ribs over it and check this way how close you are to the original. See the red plate outline in Fig. 1.

   The final ends should ideally be where the feathered C bouts end.

4. Determine where the final tips should be and mark them at the top of the ribs. See the red dashed lines in Fig. 1.

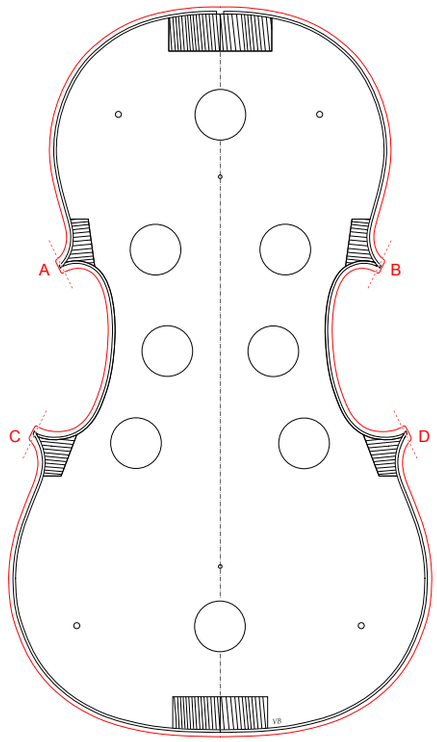
5. Using your razor sharp knife, trim the upper and lower ribs` protruding ends so that they extend beyond the previously made marks by about 1 mm . See Fig. 1. Be very careful not to chip the ends - when you are getting near the end of the cut, stop and finish the cut from the opposite direction.

6. If the final ends don't coincide with the feathering, see the paragraph below for possible solutions.

7. Make the ends of the ribs flush with the feathering using an abrasive paper block. Make sure the tips are at right angles to your flat surface (workbench).

8. Use the sanding pager of your flat surface to make the ribs level with the blocks, on both sides. You should still be left with the rib height a little (.5 mm) higher than the final heights.

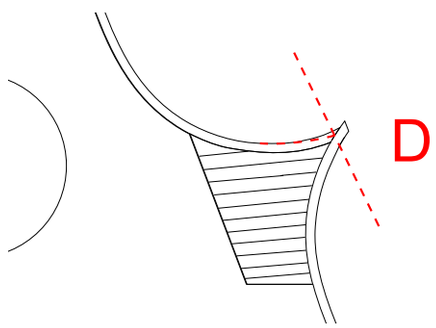
1



In case you're a little off

If the tips of your ribs are still too wide and you have already reached the feathering, you can still reduce their width but the thickness of the C bouts at their feathered ends will also have to be reduced, because at the very ends of the corners, the thickness must still remain that of the ribs, which is about 1.1 mm, not more. In Fig. 2. you see this done for the lower right corner "D" . The red dashed lines denote the material removed.

2



If, on the other hand, the feathering is inset too much and it doesn't reach your projected tips, you will need to shorten the tips further to reach that feathering even if it means the resulting violin will be a little narrower at the corners.

Category: Ribs

Creating the strips

1. Create spruce or willow strips 7 x 2 mm , ideally about 40 cm long. The wood grain should run parallel with the length. Both horizontal and vertical grain can be used.

   To thickness the strips, use your regular blade block plane, clamping down the one end of the strip to your workbench. See the Thicknessing section in Preparing the ribs for thicknessing tips.

   Make sure the thickness of 2 mm is maintained all over the strip, as thicker strips are difficult to bend and thinner aren't firm enough.

Cutting the mortices

The mortices are to be cut 2 x 7 x 7 mm into the top, bottom and C bout side blocks. For this, use a sharp knife and also preferably a 1.5 mm wide chisel. Notice that the mortices are cut for the C linings only, see Fig. 1.

1. Mark the 7 mm length and 7 mm depth lightly on the blocks using a compass.
2. Cut the wall of the mortice opposed to the one adjacent to the rib to about 3.5 mm depth, using your knife.
3. Cut the end wall of the mortice using your narrow chisel.
4. Cut the bottom of the mortice using your narrow chisel and scoop out the material.
5. Cut the wall again to the final 7 mm depth.
6. Cut the end wall of the mortice using your narrow chisel, finishing it.
7. Cut the bottom of the mortice using your narrow chisel, scoop out the material and finalize the mortice.
8. Repeat with the remaining C blocks and on the other side.

Bending, fitting & gluing

1. Bend the strips on your bending iron as you would the ribs and cut them to required lengths. If the outline of the ribs is perfect, the linings should be a perfect fit, no gaps whatsoever should be present. Any gap will tend to alter the rib outline quite significantly.

   This can be used to your advantage, if the outline of the ribs needs correcting. Leave a small gap where the ribs need to be less curved, clamp with your fingers and see how it affects the outline. See Fig. 2. for correctly fitted linings, here in red.

1. After you have fitted all the linings, clamp them using rubber band reinforced clothespins and let dry. Take a look at Fig. 3. to get an idea of the distribution of the clothespins.

Gluing

1. Work in parts, remove the clothespins holding one lining.
2. Preheat the part to get longer working times.
3. Apply medium thickness glue to just the lining. In case of C linings apply also some glue in the mortices.
4. Put the lining in, make sure it is perfectly flush with the ribs and reclamp with the clothespins as quickly as possible. Again, make sure the lining remains flush with the ribs.

Category: Ribs

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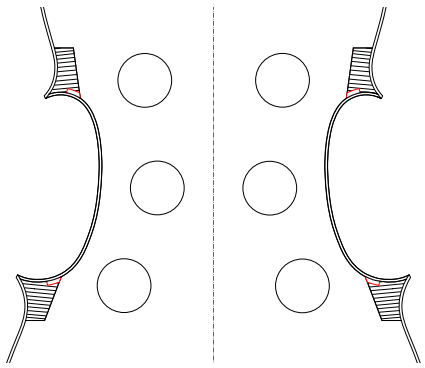

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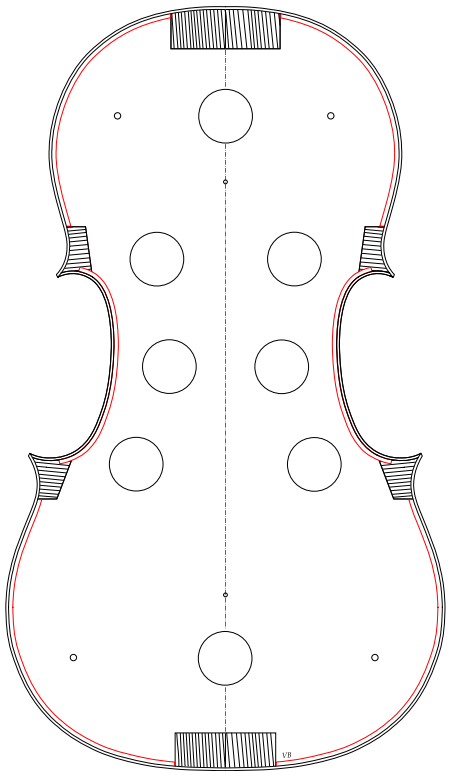

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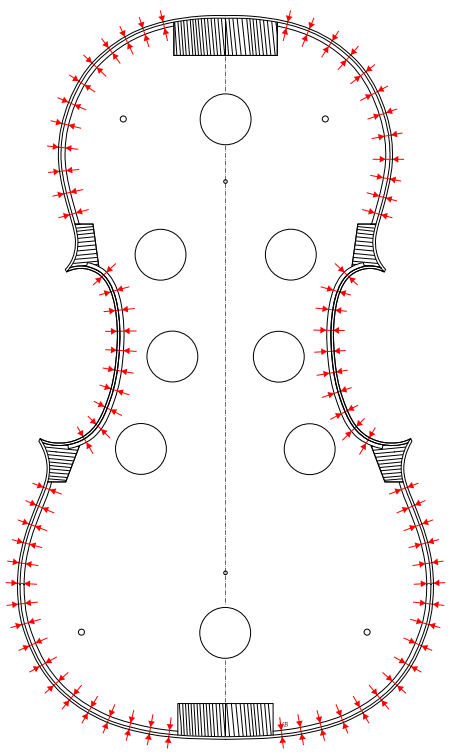


Finishing the rib structure

1. When the linings have dried, sand the whole rib structure down on both sides to the final heights, ie. 32 mm at the bottom and 30 mm at the top /Messiah/.

2. Glue size the ends of all blocks with thin hide glue.

3. Finish the corners up to the tips using a fine file and sandpaper on a stick.

The rib structure is almost finished. F or now , you should leave it on the mould to prevent warping. The remaining steps in this chapter are carried out after the top and back plates have been finished. If you are ready to start on the front plate, refer to the next chapter called Front .

Removing the ribs from the mould

1. Mark distinctly the top of the rib structure, so that later you are able to tell the top-bottom orientation.

2. To snap the blocks free of the mould, put your fingers where the red ellipses are in Fig. 1. to serve as a kind of safety bed and tap lightly with a small hammer on the opposite side, on the block, see red arrows in Fig. 1 .

3. Repeat with other blocks, until the whole rib structure is unglued.

4. To slide the ribs off the mould, hold the ribs in the waist and spread them so that the upper and lower corner blocks are completely outside their mortices, resting on the edges, see the red arrows pointing to those places in Fig. 2 . Of course, you need to be careful not to break the rather fragile structure, the top and bottom spruce blocks are sometimes also prone to splitting.

5. Now you should be able to remove the ribs from the mould starting with the bottom block, working your way up.

6. Inspect and carefully remove any excess of glue. Check the ribs for any missing parts/splinters that may have broken off/gotten stuck to the mould. Reglue if necessary.

Trimming the blocks

1. Put the ribs on a flat surface and take a look at the shapes of the top and bottom blocks in Fig. 3. . If you want, you can mark the round outlines to guide your cutting.

2. Using a sharp chisel trim the top and bottom blocks. Work gradually, the first cut being always small to read the splitting angle, to allow for corrections in case the wood splits unevenly a make sure the newly created walls are perfectly perpendicular.

   The final thickness of the top block "a" is 18 mm , and of the bottom block "b" is 16 mm .

3. Use a shallow gouge for the cornerblocks.

   See Fig. 3. for how the finalized blocks should look like.

4. Inspect the blocks again making sure there are no splinters or loose parts that might cause buzzes later on. Finish with sanding paper, if you wish.

Shaping the linings

1. Take a pencil and draw a guiding line in the middle of each lining along their length.

2. With a suitable sharp knife start cutting the lower half of each lining leaving the bottom about 0.5 mm thick. See the "1" profile in Fig 3. for reference.

3. Smooth the resulting "hump" with a scraper to create a good beveled surface as in "2" . Finish with sanding paper, if you wish.

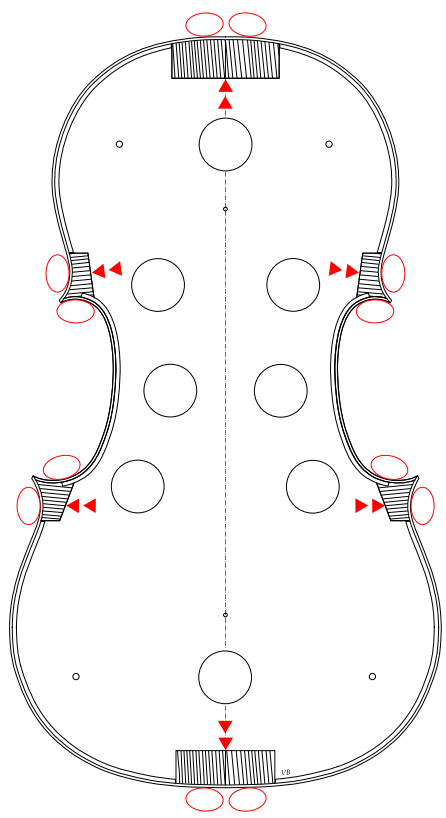
You should inspect the whole structure again to see there are no loose pieces of wood or splinters which might later cause buzzes in the finished instrument. Also check that everything is glued together and that there are no gaps.

If you need to store the ribs elsewhere, put it somewhere with constant humidity, preferably about 50 percent, and room temperature.

The weight of the finished ribs should be about 50 grams .

Category: Ribs

1



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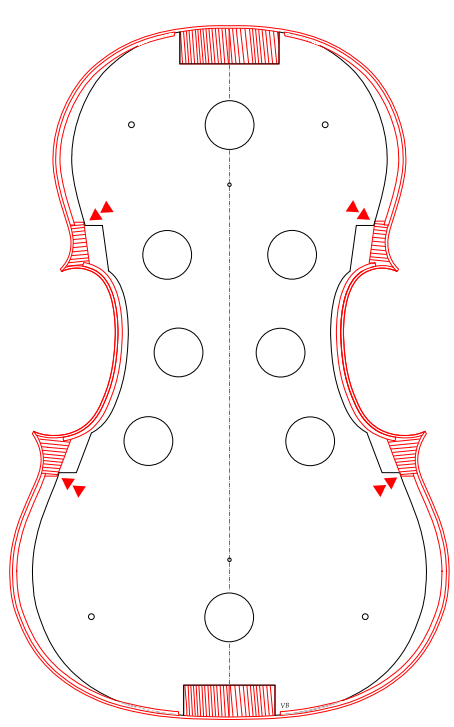

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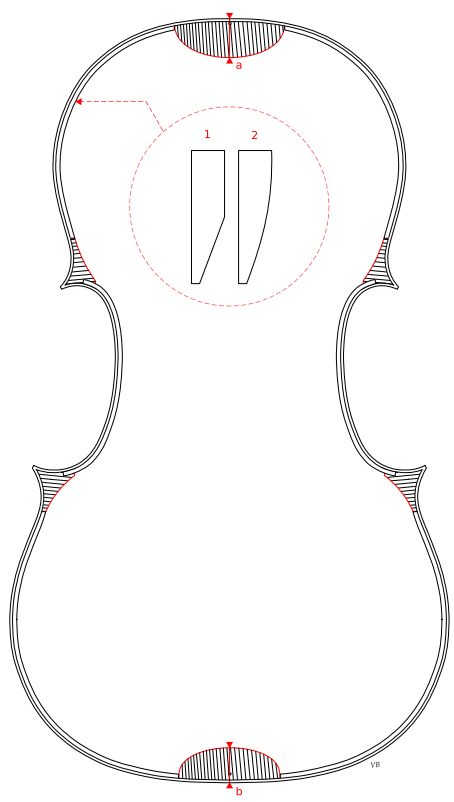

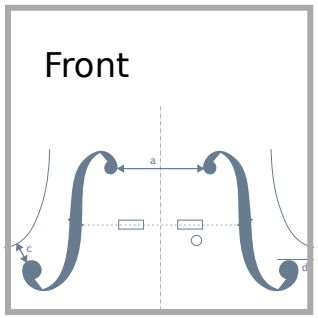

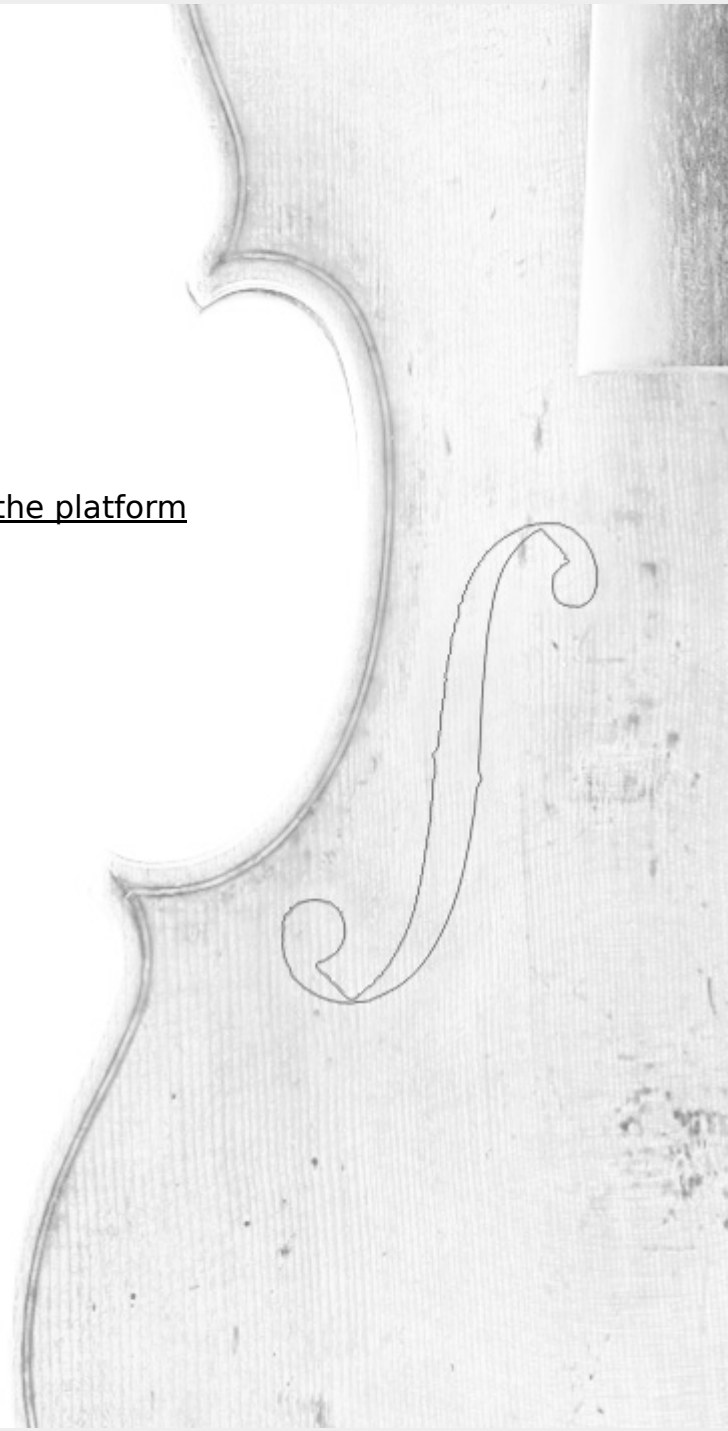

Choosing the wood

The wood for the front plate should be as flawless as possible.

1. Check that the wooden billets have sufficient dimensions for the violin you are building.

2. Check for the following errors: Fig. 1. , points "A-C" for possible errors.

   a) In point "A" you see an assortment of twists and warps as well as a resin streak.

   b)In "B" the growth lines are straight but the gluing surfaces have to be planed to make the lines parallel with them.

   c) In "C" you see the staining caused in most cases by oxidation. You may or may not be able to planed it off depending on location and size.

   d) In "D" everything is correct.

3. See that the billets are correctly quartersawn, which means that the growth lines should look like in Fig. 2. when looked at from the side. (sometimes the cutting marks from the circular saw may interfere with the reading of the growth rings. Shave off the marks with you block plane to get a clear view of the rings) Making sure the wood is correctly quartered is especially important if you get the wood in precut billets where any corrections are almost impossible. Badly quartersawn wood with growth lines not going at right angle to the bottom plane is structurally much less stable.

4. The runout is a deficiency in wood which is one of the most difficult to indicate. It happens when the cut of the wood is not in perfect alignment with the natural run of the grain. That is why the best wood with no runout should always be split rather than cut. See Fig. 3 for illustration. The red planes depict the natural grain. In "A" the natural grain is misaligned with the billet, indicating that there is a runout. If there is no runout, the billet should split through its center, along the red plane as in "B" . A little runout is usually not a problem, but more of it may negatively affect the structural integrity of the wood.

5. If you want, you can also check the growth line density. It can vary throughout the piece. Some great violins have it ranging from medium {1-1.5mm distance} at the edges of the plate to dense {0.5 mm} at the center. Dense growth lines all over usually mean denser wood which you should probably avoid. Look at the growth lines in the wood of the violin you are copying and try to find similar wood if you are aiming for similar sound.

It is also helpful to make a note of the specific gravity of the pieces you chose and better yet, make a table which will list the parameters of the woods used as you progress from one violin to the next for reference. Check the Specific gravity calculator in the Materials section. You can create a table like this one:

Violin no.	Wood	Source	Date	Specific gravity
1	Spruce	Andreas Pahler	2003	0.41

Numbers around .42 for spruce and 0.55 for maple are considered good.

Preparing the wood

If you decide to cut the bass bar from one of the halves before joining them together, refer to the chapter on the Bass bar for the dimensions.

1. Plane the chosen pieces flat on the bottom side, check for rock on your flat workbench.

2. Put the pieces together and plane the upper tops to see clearly where they meet. Be careful not to remove too much wood as at the top the plates should still be thick enough to accommodate the height of the finished plate. See next Fig. 4. Make sure that the pieces put together have sufficient height both at the sides and at the projected center joint. The violin we are building here has the finished belly height of about 16 mm, so with a safety margin, the pieces should be about at least 20 mm high.

3. Plane the sides at right angles to the bottom surface using preferably a jointer plane {no. 6 plane}. To do that, clamp one end of the piece in the vice and support the other with a block of wood to make sure the piece won`t bend while planing. See Fig. 5.

   Check the edges with a square. Both edges must be at right angles to the bottom surface along the whole length. No twist.

4. Make sure the growth lines run parallel at the center. Make any corrections now, before you finalize the joint in the next step.

5. Bring the two edges together and check for gaps and rock. Use a source of light positioned behind the joint to see how the surfaces match up. If the surface is a little convex (lengthwise), push down during planing a little more at the center to correct that. Special attention should be paid to the extremes, which should be in perfect contact up to the ends.

6. Optional: Put your sash clamps in place and test clamping down the billets. The join surfaces must be in perfect contact, with no visible gap, when the billets are fully clamped. If they aren't its either you didn't prepare them well enough or the action of the clamps may be wrong. In that case, try to correct (by planing) the outer sides of the billets (those which run parallel with the gluing surfaces), to compensate.

7. Lastly, before gluing, make two vertical marks on both pieces, crossing the joint, using a pencil. This will help you correctly align the top piece quickly and precisely when the glue starts "biting". See the two short horizontal lines in Fig. 6.

Because the wood tends to "move" with the changing humidity and temperature in your workshop, it is recommended to glue the pieces together right after you have achieved a good fit.

Gluing the pieces together

1. Put one piece in the vice with its gluing surface up. See Fig. 7.

   You should rise the temperature in your workshop or use a heater to heat up the pieces, to prolong the working time of the glue. Do not heat up the pieces too much or unevenly, as that will cause the glue to penetrate the wooden surfaces unevenly, with very high penetration in hot areas, resulting in a starved joint. So a joint that has 30C evenly distributed is ideal.

2. Using a larger brush, apply ample medium thickness hide glue all over the gluing surface on both the clamped piece and the other one (you are holding in your other hand) as fast as possible.

3. Put the gluing surfaces together and rub vigorously back and forth, while still maintaining full contact of the surfaces, pressing down, squeezing out the glue. See Fig. 7.

4. When you feel the glue starts "biting", finish the move and align the surfaces as precisely as possible (make the previously made marks meet).

5. Optional: Let dry for 30 seconds, then carefully lay down on the prepared sash clamps and clamp down lightly as in Fig. 8.

6. Clean up and let dry over night.

Category: Front

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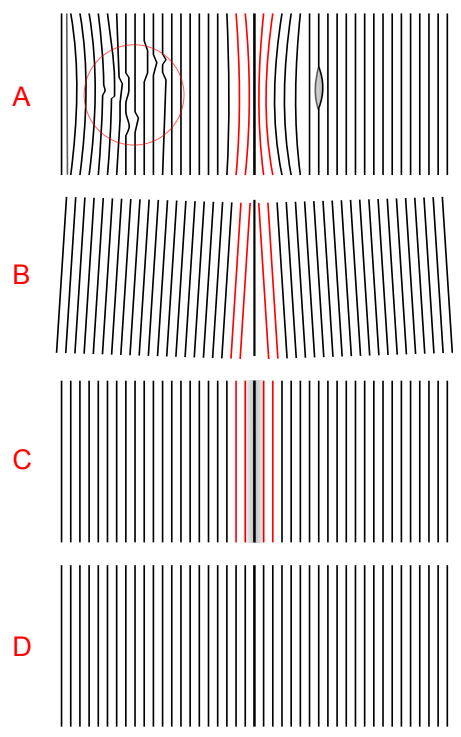

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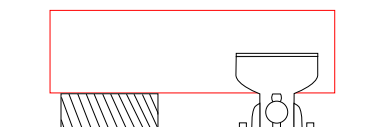

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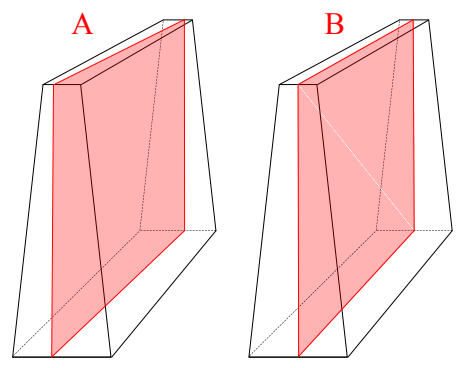

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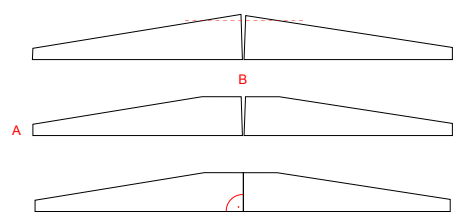

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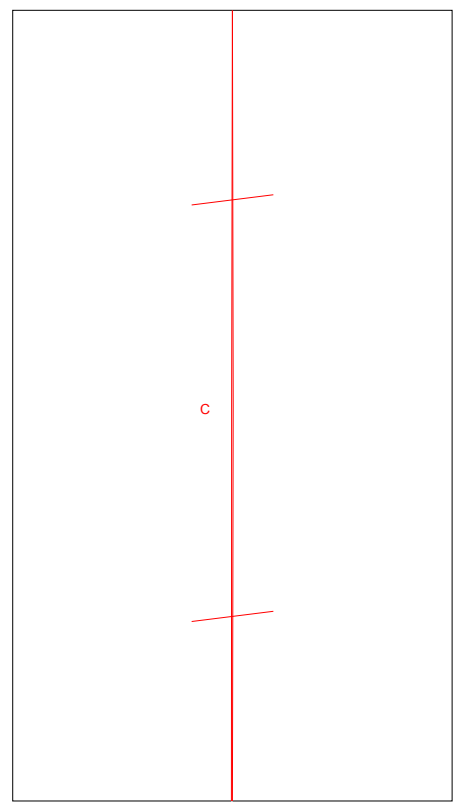

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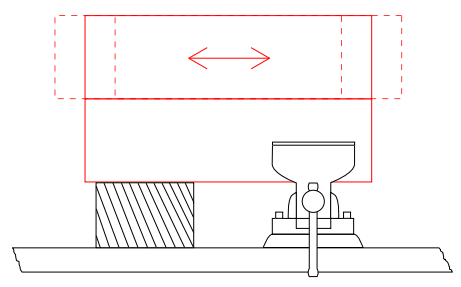

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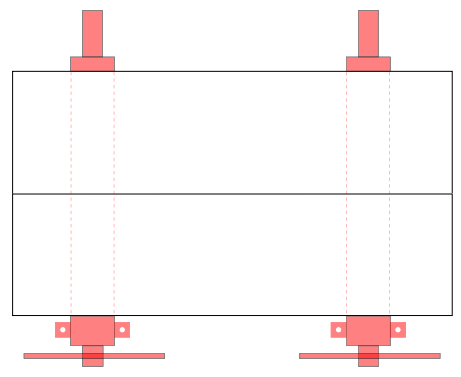


After the plate had dried, check the bottom side with your straightedge. If the bottom is uneven, you will have to plane it perfectly flat so that the ribs are in full contact with it.

1. Remove all excess glue and clamp the plate down on your workbench. If you have a workbench with dogs, use those to fix the plate upside down. Or you can use sash clamps to hold the plate and clamp the sash clamps down to your workbench.

2. Make the bottom perfectly flat using your long plane. Be careful of the wood grain. The two billets' grain runs in opposite directions so you will need to keep flipping the plate frequently to go with the grain to avoid tearing. The tearing is more likely with highly flamed maple. Tilting the plane sideways a little or going accross the grain should help too. If nothing helps, use the scraper blade.

3. To remove little tearing caused by planing and achieve perfect flatness, you can sand the bottom on your flat sandpaper glass surface (you used this to finalize the rib height).

Fixing the ribs to the plate

Now you need to fix the ribs to the plate in order to transfer the actual outline. If at this point you are also transfering the outline to the back plate, do not forget to include the button. See the Back chapter for its dimensions.

1. On the ribs, remark the centerline, if necessary.

2. Take the ribs and put them on the front plate facing upside down. Align the centerline on the ribs with that on the front plate. See Fig. 1.

3. Mark out the very top and bottom of the ribs, drawing a 1 cm long line, at the centerline of the plate. See points "A and B" in Fig. 1.

4. Remove the ribs and on the centerline of the top plate, scribe another pair of marks, about 4 mm inwards from the top and bottom marks "A and B" you have just made. See Fig. 2. The red dashed line just shows for illustration where the ribs were placed.

5. At those two points, drill through two holes, 1.5 mm in diameter, at right angles to the plate.

6. Put the ribs back on the front plate in exactly the same position as before {par. 2}, clamp down sufficiently and drill two 5 mm deep holes into the top and bottom rib blocks using the previously predrilled holes as guides.

7. You can now plug into the holes two 1.5 mm drill bits as locating pins to keep the ribs positioned on the plate. With the bits in place, you can remove the clamps and start with the outline.

Marking the outline

Make sure the outline of the ribs is flawless, the corners are finished.

1. Using a sharp scribe, mark the whole outline of the ribs on the plate. Make sure you also mark distinctly the ends of the ribs at the corners, but don't make the mark too deep as this will stay on the finished plate. See "A" in Fig. 3.

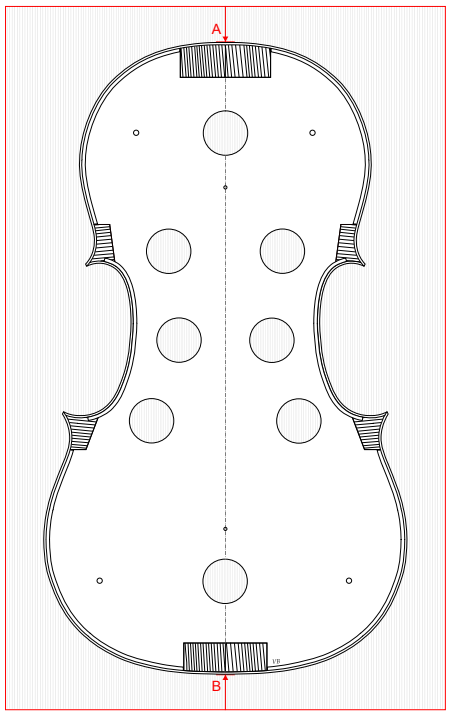
2. Now you need to draw the second outline which will delimit the shape of the top plate and which should be outset by about 2.5 mm from the ribs, depending on the overhang on the original violin. For this choose a washer, which you know will offset the contour by the distance needed. Using a sharp pencil draw this parallel line around the ribs, but always stop about 1 cm short of the tips of the corners. See "B" in Fig. 3.

   Make sure you hold the pencil at a constant angle as different angles may produce different distances. Make a couple of tests, to get the idea as to what kind of line the washer and the pencil produce.

3. Remove the locating pins and take the ribs off the plate.

Category: Front

1



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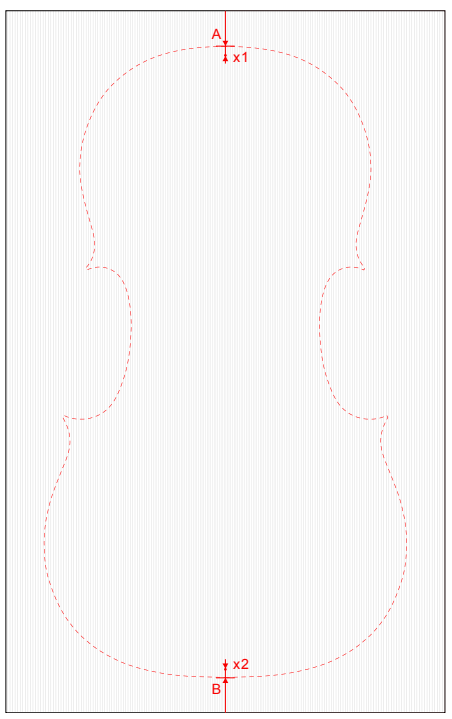

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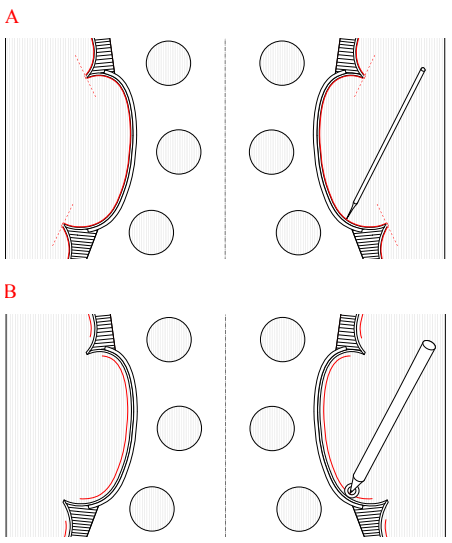

Shaping the corners

The shapes of the corners must now be reconstructed by hand. They are one of the focus points on the violin and naturally they attract a lot of attention. Their proper execution is therefore very important.

1. It is helpful to construct for each corner a guideline by projecting the angle of the original violin corner`s tip towards the centerline at points X1 and X2. These points can then be transferred to the new plate to help project the new corners. See the red dashed lines in Fig. 1.

2. Mark the tips about 2 mm beyond the tip of the rib.

3. Finish the radii in accord with the original width and general shape of the corners.

   Notice how the distance of the outline from the ribs increases especially with the wider lower corners.

   The newly created corners are depicted in solid red in Fig. 1.

Category: Front

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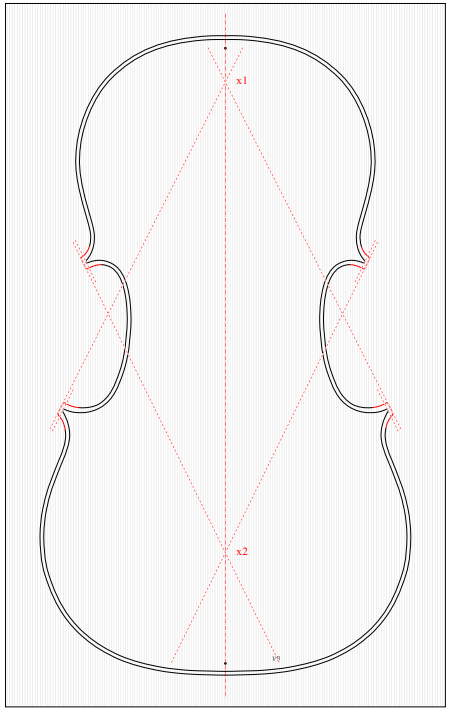
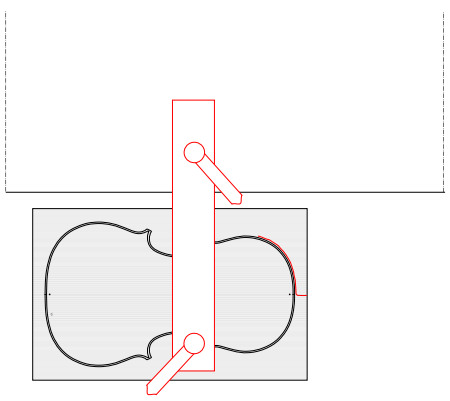


Fixing the plate

1. Fix a wooden plank (in red in Fig. 1.) of approximately 60 x 7 x 5 cm to your workbench making sure its protruding by at least 30 cm .

2. Clamp your front plate upside down to the bottom of this plank. See the top-down view of the setup in Fig. 1.

1



Cutting the plate

1. Using a coping saw, cut within 2 mm of the outer pencil line. Make sure the saw is tilted a little away from the outline so that you avoid undercutting. Keep rotating the plate as necessary.

2. Correct the outline using a rasp, downstrokes only, so as to avoid tearing off the fibers at the bottom of the plate. Get to about .5 mm outside the outline.

3. Using a marking gauge, scribe along the whole length of the contour a line 6 mm in height.

The plate holder

Now is the time to attach the plate to the plate holder. It serves to hold the front and back plate while you carve the outside arching and do the purfling.

1. Get a piece of wood about 60 x 30 x 2 cm.

2. Mark the centerline, take the template you started the violin with and scribe the full violin outline on the plate holder.

3. On the centerline drill two holes about 12 cm in from the top and bottom edges of the outline. Refer to Fig. 2. for their position.

4. Find two screws and insert them in the holes from the bottom side to find out by how much they protrude. They must not stick out more than 8-9 mm but also not much less in order to securely hold the plate. Use washers to reduce the length of the screws if necessary.

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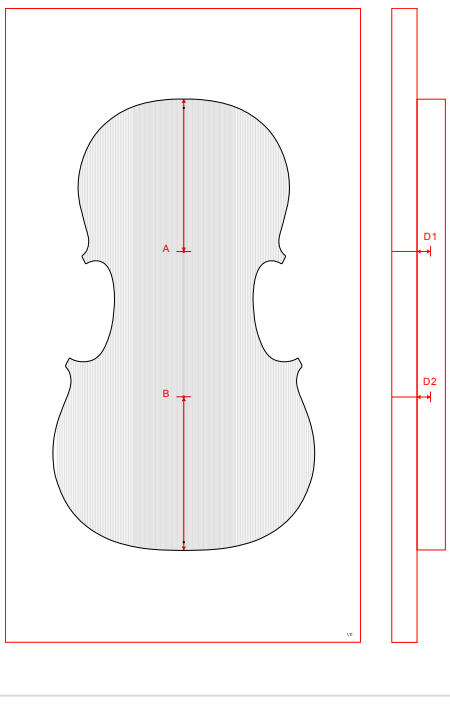


Fixing the plate to the plate holder

1. Put the plate bottom down on the plate holder and align it with the centerline. Refer to Fig. 2. to see how the plate is fixed to the holder.

2. Clamp down securely with a few clamps.

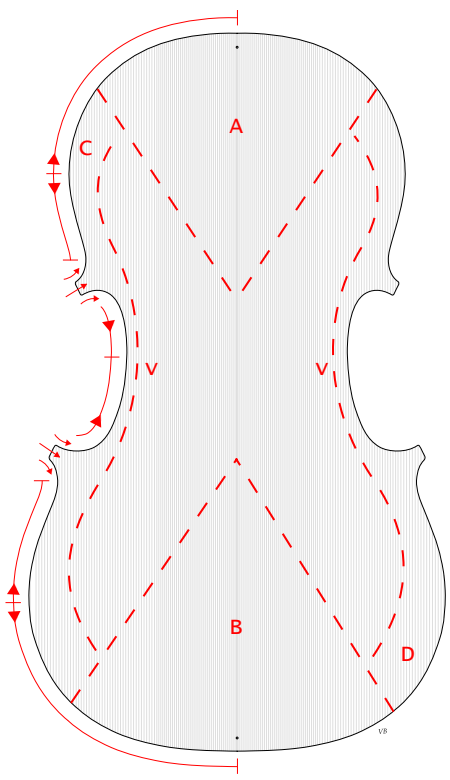
3. Flip the holder and screw in the two screws.

   Make sure again that the screws will not enter the wood farther than 8-9 mm to avoid penetrating into the wood that will be in the finished plate.

   The holder must hold the plate firmly but avoid over-tightening.

4. Remove the clamps and clamp down the holder to the workbench.

3



Removing wood

1. With a pencil, mark out the outer "A , B, C, D" areas as depicted in Fig. 3.

2. Using a suitable gougle, pare away the wood down to the 6 mm height-line, you previously created. Make sure you do not "enter" the waist "v" of the plate more than 15 mm.

   Take a look at the red arrows in Fig. 3 to see the general direction of carving.

   As you continue removing wood be extremely careful in the area of corners, as these are easily split off. Be extra sensitive of the grain in those areas and apply only very limited force. See the red arrows near the corner in Fig. 3 for the direction of carving. Also make sure your gouge is razor sharp.

Category: Front

Finalizing the outline

1. Now is the time to finalize the outline of the plate. Clamp upside down onto the plank as when you were cutting out the outline and using a file {downstrokes only}, make sure the outline is even, smooth and true to the overhang, about 2.5 mm in our case. Leave the corners a little wider than marked.

2. Again, using the marking gauge, mark the height, this time of 4.5 mm , all the way around the plate.

3. Using a shallow gouge remove the wood along the edge farther down to the marked line. As previously, be very careful in the area of corners. Always go with or across the grain, never against. Refer to the Fig. 3. in the previous chapter for cutting directions.

4. According the Fig. 1 mark a line along the whole circumference of the plate, see the red dashed line, 7 mm in at the waist and 9 mm in at the upper and lower bouts. This line will serve to limit the scope of the platform. The marking is best done with a compass, its needle following the edge of the plate.

Creating the platform

1. Using a narrow chisel, make a series of vertical incisions along the red dashed line in Fig. 1 not going too deep into the wood. Be careful in areas where the grain runs parallel to the incisions allowing the gouge to enter the wood easily.

2. With a shallow gouge and finally a flat chisel remove the wood and create the platform. Also, see the profile of the finished platform below.

3. Even out the platform using a file, if necessary. Check for flatness and also for consistent thickness of about 4.2 mm.

4. Take the purfling cutter and make sure its passage is unblocked by any wood, especially in the waist area.

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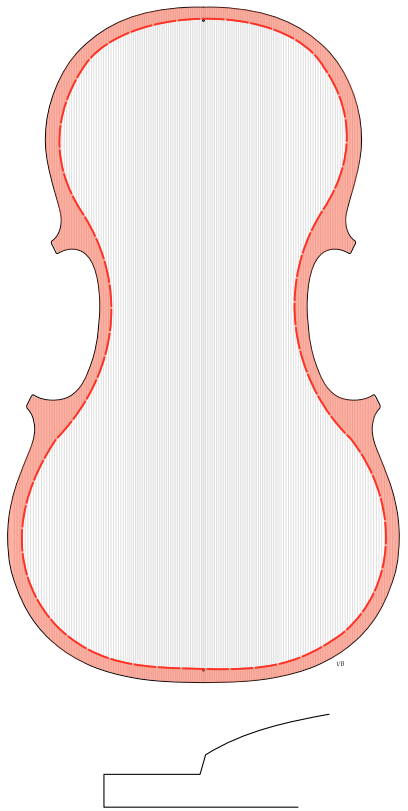

Category: Front

The purfling

The purfling is the inlay which runs around the edge of the top and bottom plate. It is usually a "sandwich" of three sheets of wood glued together. Other materials such as hardened paper are also used today as the cheapest options but these should generally be avoided. In Fig. 1. you can see the three distinctive layers comprising the inlay of total thickness of 1.2 mm . The "A" layers are 0.3 mm and the "B" layer is 0.6 mm thick. In the olden days, the bright layers might have been maple and the dark one ebony shavings. Today, most makers buy the purfling strips premade.

1. Make sure the thickness is even, typically about 1.2 mm and the height is about 2 mm throughout.

2. Create a slight bevel at the bottom edges to allow for and easier insertion into the channel. See Fig. 1.

Marking the purfling channel

1. Make sure again that the plate outline is perfect, without any bumps and that it flows gracefully and naturally in accord with the violin copied as well as with what you consider natural.

   This outline will now serve as the guideline for the purfling marker and therefore for the purfling channel itself. Remember that the final overhang is about 2.5 mm for the violin we are making, except for the corners, so finalize the outline just a little over that.

   If you leave the overhang too large now, the purfling will follow it, making any reduction later very difficult.

2. Carefully observe the distance of the purfling channel from the edge in the copied instrument. Normally it is about 4 mm in but its final position is also influenced by the length and width of the top and bottom corners. The purfling mitres must meet at just the right position to form the tip and the bee sting.

   The corners are constructed as in Fig. 2 and 3. The red line indicates the outline linearly inset by 3.7 mm . The green line shows the lines altered so that they form a sharp tip and meet at the correct distance from the corner`s end. The black line is the final approximation taking into account the preference that the purfling in the corners should be leaning a little, following the bee sting. The bee sting itself is in blue and flows naturally towards the corner of the corner.

3. Now you need to set up your purfling marker based on the previous observations. If using a double edge marker, make sure the width of the resulting channel is enough for the purfling to slide in easily. When gluing, especially with spruce, the wood tends to swell, and any tight fit now will become impossible then. To test for that, use a piece of spruce, make a series of marks and cuts, scoop out and see if the purfling strip fits in nicely.

   The position of the purfling channel in relation to the edge and the corners can be tested first on the opposite side of the plate.

4. Everything adjusted, you can start marking the purfling channel. Especially with spruce, it is important to first go very lightly, otherwise the blades tend to get misaligned by the wood grain having the tendency to go along with it. It is also important that you hold the purfling marker at a constant, perpendicular angle.

   Bear in mind that you are just marking the channel, not actually cutting it, so create a rather shallow cut but with great precision which will later serve as a guideline for the cutting knife itself. Again, go light, or you will loose precision. Repeat, until you are sure the groove is deep enough to guide the knife.

Now the corners. Measure the distance the tips of the purfling in the corners ends from the tip of the corner itself. With the Messiah this is about 3.5 mm . Lightly Mark this distance on each corner. Start lightly marking the channel in each corner always starting from the C bout side. The lines should meet at the marked distance from the corner's tip. If they don't, adjust so that they meet there. Remember that the tip leans a little towards the C side so the oposite side can be shaped accordingly.

Cutting the purfling channel

The cutting itself is done with a knife. You can use your regular knife with bevels on both sides, or you can try a knife with just one side bevelled, which makes the cutting of flat, perpendicular walls a little easier.

Go with light strokes followed by heavier ones. Avoid undercutting - the resulting walls should be perfectly perpendicular.

At this stage the purfling channel should be about 2 mm deep, assuming the thickness of the plate edges is a little over 4 mm , so make controlled cuts going no deeper than that. This depth will later get reduced, because of the fluting to about 1 mm . Consult Fig. 4 to get an idea about the channel's position.

1. Start cutting at the top or bottom of the plate where the grain orientation makes it easier to make precise cuts. You will cut the channel along the whole outline except for the corners, which will be dealt with later.

2. Use a purfling pick to remove the waste material.

3. After you have finished the outline, start working on the corners. I would suggest using a smaller knife, because it allows more control in the tight curves and the bee sting.

   Be extremely careful with the inner tips at the corners, which are easily chipped off, especially in spruce.

In Fig. 5. you see the finished channel.

Category: Front

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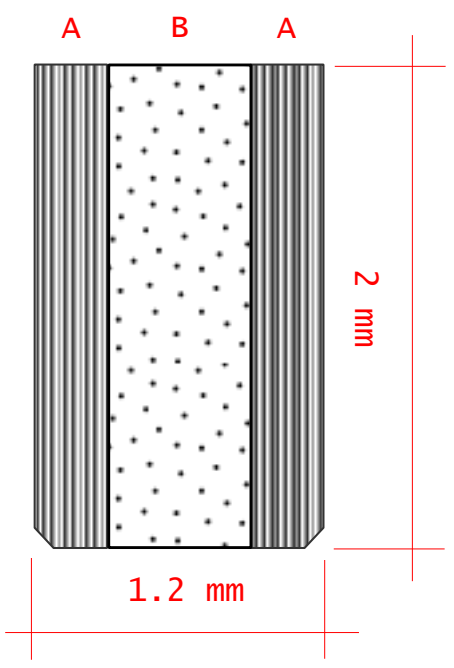

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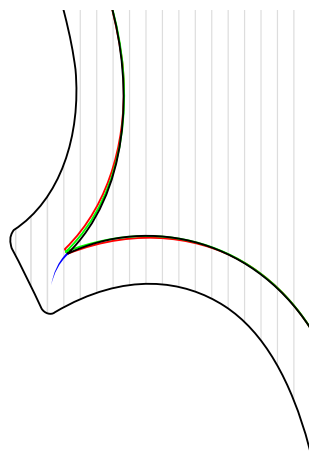

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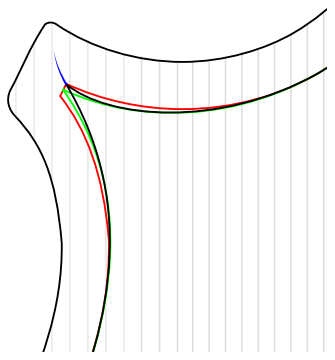

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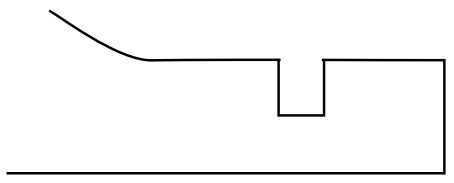

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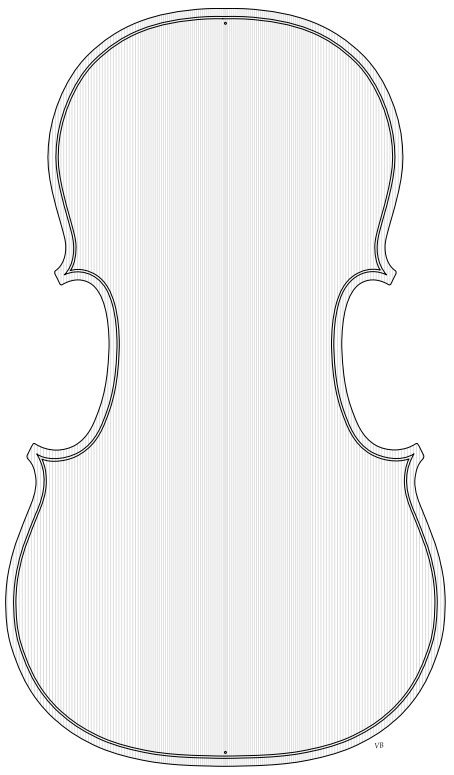


Bending and fitting the purfling

You bend the purfling material as you would the ribs, using the bending iron. You can moisten the strip slightly if it helps prevent cracking. Precaution must be taken not to overheat the strip because the glue binding the layers together then melts and swells causing them to separate. If possible, try the bending on scraps first.

Also, the tight curves in the upper parts of the C bouts must be bent with utmost care as here cracking will easily occur.

On the front plate, in the upper and lower bouts, the purfling can consist of 2 parts, because at the center it will be removed anyway. The gap must not exceed 8 mm on each side off the center, though.

On the back plate, the upper and lower bouts should be made in one piece.

1. If you haven't already, check that the purfling stock you will use is of correct width and thickness throughout its whole length.

2. As mentioned earlier, for an easier fit, remove the edges on the bottom side of the purfling, making its cross section look more like the letter U. See Fig. 1 in the previous chapter for reference.

3. Start bending the strips. Once the strips are bent correctly and they fit perfectly, choose one corner, trim the ends of the strips so that they meet and fit the corner naturally. See Fig. 1 for the detail on how the ends meet in the corner.

4. Run your finger to check that the purfling "sits" evenly along the whole outline. If not, you may need to scoop out some more wood here and there. When removing material from the corners, again, be very careful when cutting next to the inner corner tip.

Gluing the purfling

Have a suitable smoother (something that will allow you to push the purfling into the channel), a small hammer and a damp cloth handy. Prepare a sufficient amount of medium to thin hide glue. As always, a warm room considerably prolongs the setting times for the glue.

Work in steps, applying hot glue into the channel first and putting in the purfling as quickly as possible, because in a manner of seconds, the channel starts to swell making it difficult to insert the strip. If that happens, use the small hammer and a smoother to drive it home.

The corners are always the starting points as it is crucial that the tips meet precisely. See Fig. 2 for the gluing sequence.

1. Work in the following order:

   a) Glue the upper left corner, put in the upper left corner "A" ,

   b) Glue the the upper bout, put in the upper bout "B"

   c) Glue the C bout, put in the lower corner, put in the remaining C bout "C, D"

   d) Glue the lower bout, put in the lower bout "E" .

2. Go over again with a smoother to make sure the purfling is fully in everywhere.

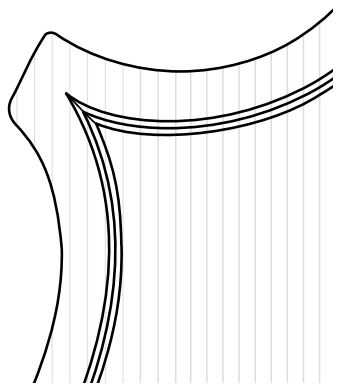
3. When finished, remove excess glue with a damp towel.

4. Check again that the purfling is fully in everywhere.

See Fig. 3 for the finished purfling.

Category: Front

1



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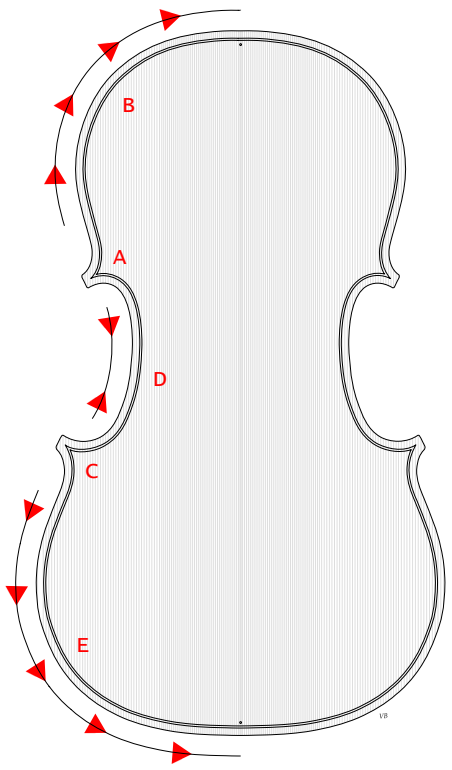

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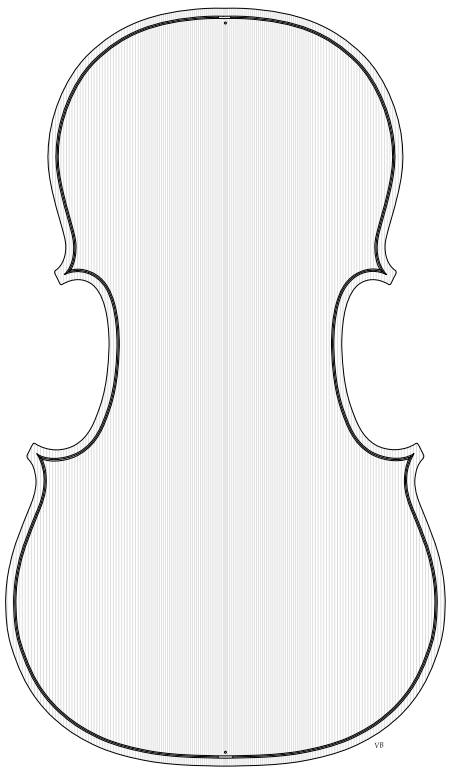


The original and the ideal

Depending on the source model, you can either use the archings as they are, or you can correct them. And why would you think Stradivari`s archings need any correction?

a) Structural deficiencies in the original creation. As it is in the case of Messiah, the top plate is unusually low /only 13.8 mm/, so not copying it verbatim and making it a little higher, 15-16 mm, is a good idea.

b) Distortions happening over time. With older instruments the wear and tear over the centuries may have caused a drop in the height of the top and bottom and subsequent distortions may occur. You don't want to copy those, you want to give your instrument a sound arch, which will withstand the ravages of another hundreds of years.

c) Generation loss. If you feel, like I do, that you should start with a perfect design, rather than with something that is a Nth copy of a design, think about this: 1. Concept on paper, 2. Transfer to templates, 3. Transfer into the wood, 4. Distortion over maybe hundreds of years, 5. Tracing the old instrument`s arching on paper, 6. Transfer to templates, 7. Transfer into the wood. As you can see, with your finished violin, you are as far as 7 generations away from the original concept, with every generation introducing inevitable errors.

The long arch

Take a good look at Fig. 1.

For the construction of the long arch in the back, a section of a circle can be used. For the top, you can also use a circle, with the exception of the topmost platform, which should be formed with the help of another, flatter circle /in blue/. The red lines, offset to make them more visible, denote the original arching. The highest point on both the front and the back arching is at the midpoint.

The cross arches

The cross sections of both the top and bottom plates can be derived from curtate cycloids. They create perfect curves which are very close to the ones found on many Cremonese instruments and are easily generated both by software or a simple use of a wheel, ruler and pencil. Curtate cycloids software download (mirror).

See Fig. 2. to see a typical cycloid shape overlaid on the existing cross arch in red /Messiah/.

Putting it all together

For the complete "remodeling" of the Messiah`s arches, according to the aforementioned methods, see Fig. 3. The red curves denote the original arching, the black is the idealized form.

The total body height should be somewhere about 61-64 mm .

Making the templates

Templates, especially if this is your first violin, may be of great benefit to you. They make you work with precision you could hardly attain if you worked just by eye.

For an example of a long arch and cross arch template, see Fig. 5. These should be made of a rigid and at the same time easily workable material. Good examples here are aluminum or plastic, both in sufficient thickness, 1.5-2 mm depending on the material used.

In Fig. 5. , in red, you can see the physical shape of the templates. The half templates shown here are easier done and more flexible to use than their full size counterparts.

1. Print out the templates in Fig. 4 or photocopy the ones for your violin.
2. Glue the printouts onto the sheet of material used for the templates.
3. Cut out the templates and assign a number to each.

Carving the arching

1. Mark all the positions in Fig. 6. for the cross templates so that you know where to place them during the carving. The positions "A-E" are for the cross arching templates, the "F" positions are for the long arch template.

   You can print out the positions in Fig. 6. or use those provided with the archings for your violin. If you want, you can also mark out these positions on your outline (half)template.
2. Mount the plate on the plate holder and fix the holder to the workbench.
3. First you need to make fit the long template. Use a small round thumb plane across the grain and create a sort of a plateau for the long template. When the template roughly fits, you can move onto the cross arching templates.
4. Now with frequent reference to the cross templates, start removing the wood using a thumb plane. Blend the different positions with one another. Be aware of the general shape of the plate. Be sensitive of the wood grain, and work with it.
5. When all the cross templates broadly fit, you can start with the fluting.

Fluting

Fluting creates the re-curve in the arching. It is important both aesthetically and acoustically. The re-curve helps the plate to vibrate more freely. See Fig. 7 . "A" is the ideal arching based on the cycloid, "B" is the arching without the fluting, "C" is the finished cross arch.

The depth of the fluting is based on the overall height of the arch. Make only as deep a fluting as will "land" the arch at its correct final height. See Fig. 7 .

The outer position of the fluting is somewhere in the middle between the purfling and the edge. See Fig. 8 for reference.

Don`t try to create the fluting in one pass, work gradually instead.

Especially with spruce, be aware of the grain and always go with it.

1. Before fluting make sure the thickness of the overhang is correct, in our case it is to be 4 mm. Go over the whole platform with your marking caliper set to 4 mm and remove any high points using your thumb plane and a file to carefully finalize the thickness.
2. Check the height of the arch at the center point with a caliper. Here its 18 mm . Checking with the arching template, I realize I will have to go another 2.2 mm lower to make the template fit. That's OK as the target height is 15.8 mm . The depth of the fluting therefore will be about 2 mm . See Fig. 7 for reference.
3. Mark a line using your pencil along the edge, half way in to the purfling. From this high point line the fluting will slope towards the purfling. See Fig. 8 for the line, here in red.
4. To create the fluting use a small gauge, ie. Pfeil no. 7, tilted as in Fig. 8 . The gauge's tilt allows for more precise cutting, most of the time allowing you to go even against the grain, if needed.

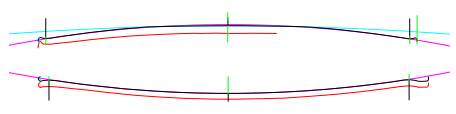
   Make multiple precise passes, removing tiny shavings from the line down to the purfling. The deepest point of the fluting (and of the arching) is usually placed at the purfling or a little bit more in. The final shape of the fluting will be defined during the scraping.
5. See Fig. 8C for the extent of the fluting.
6. When all templates almost fit and the height of the arch is at about 1-1.5 mm higher than the final height, stop using thumb planes and move over to scrapers. For various scrapers and their sharpening see the Tools and materials section.

Finishing

1. Start cleaning up the whole surface using a scraper.
2. If you want, you can use a way to visualize the arches better with a marking caliper. Using a marking caliper create a number of contour lines to help you better see the irregularities in the arching. See the lines in Fig. 9 for an example. Your lines will differ based on your archings but they should flow gracefully.
3. Clean up the area of fluting. It is often more precise to go around the outline, touching it with your middle finger (to keep it in fixed position), while holding the scraper by the rounded tip between your index finger and thumb (kind of like holding a pen).
4. Clean up the whole surface again using a scraper, then use abrasive paper to create a surface as smooth as possible. (The surface will later be scraped lightly yet again to bring out the grain.)

Category: Front

1



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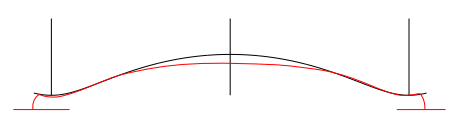

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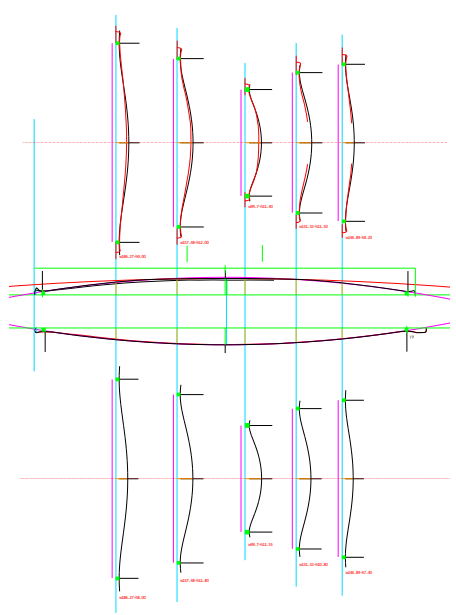

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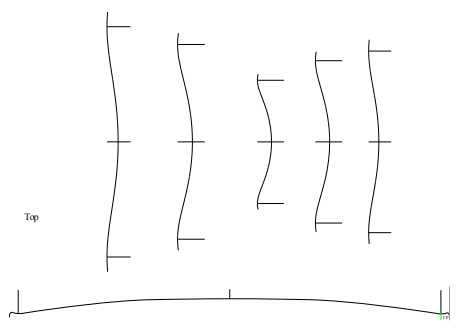

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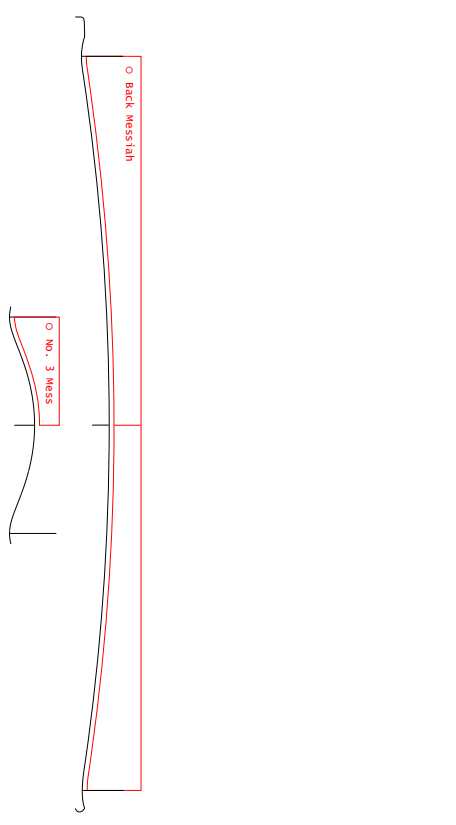

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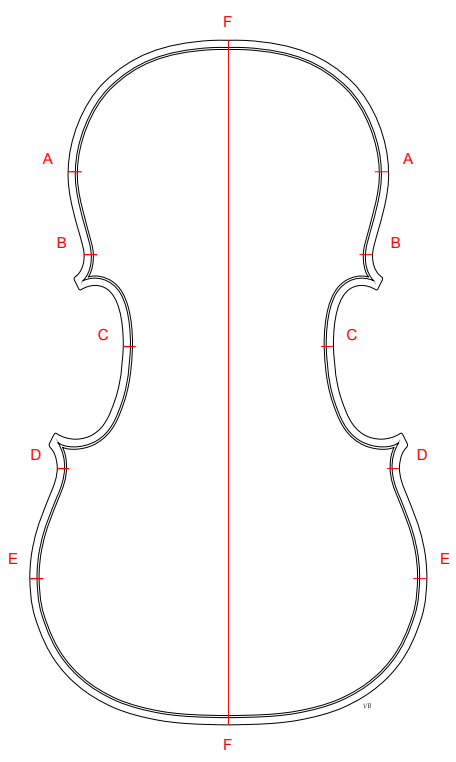

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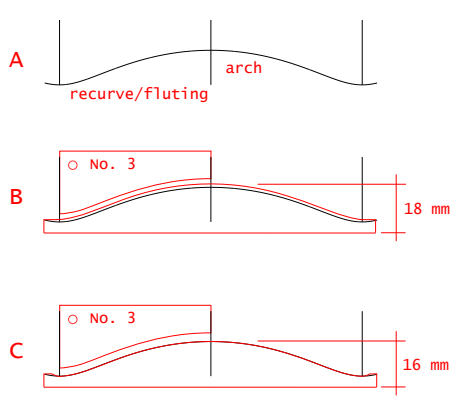

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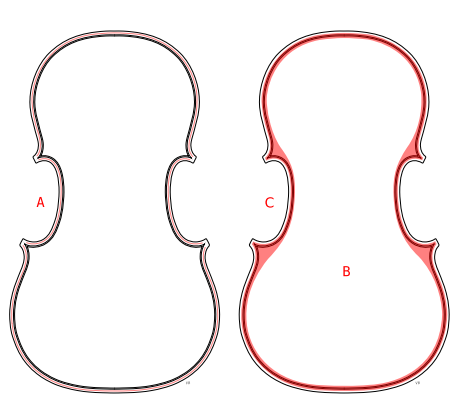

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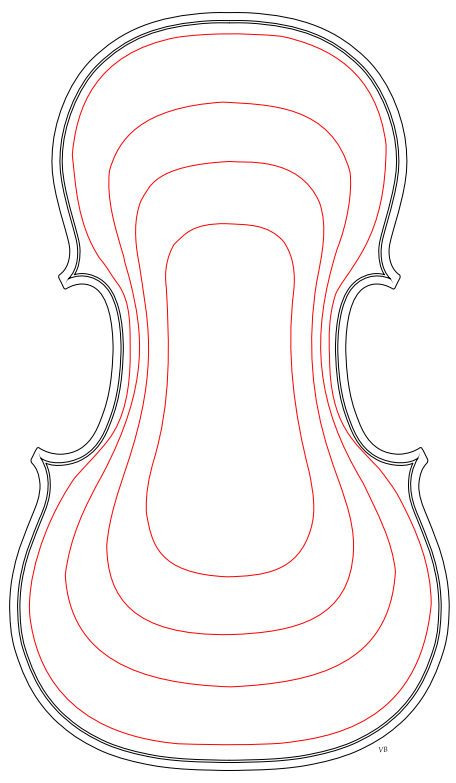
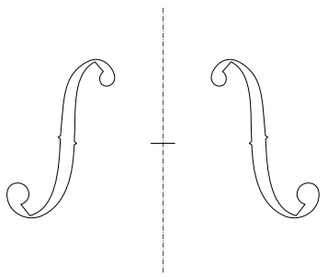


Transferring the outline

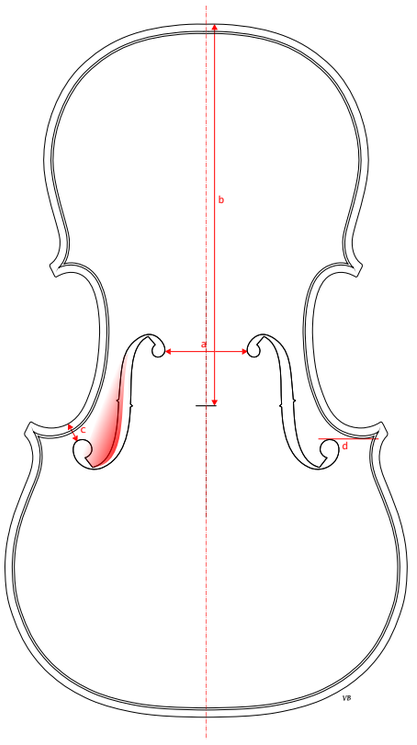
1



After the arching on the top plate has been finished, the shape of the F holes should be transferred onto the surface. The shape of the F holes in our example is a slightly modified shape of the Messiah violin.

1. Print out or otherwise transfer the outline of the F holes on a sheet of plastic foil. See Fig. 1. for the outline for the violin we are building.
2. On the printout, check that the physical measurements are correct. Ie. 42 mm distance between the upper eyes.
3. To finish the template, take a sharp knife and carefully cut out the outlines, including the nicks.
4. Lightly mark the stop length on the top of the violin plate, for our violin it is 196 mm . See "b" in Fig. 2 for its location.
5. Align the centerline of the new plastic template with the centerline of the top plate and align the inner nicks of the F holes with the stop length mark. See that the position is correct in regard to all measurements in Fig. 2 . "a" is the distance of 42 mm , "b" is the stop length of 195-6 mm , "c" is the distance of 11 mm and "d" means the top of the lower eye should be level with the purfling.
6. Fasten the template in this position, with two pieces of a sticking tape, up and down, but only lightly so that you don't tear out wood fibers when removing the template.
7. Using a sharp pencil, transfer the shape of both f-holes onto the surface of the wooden plate. When finished, remove the template.

2



Fluting the f -hole wings

In order to make the f-holes look more integral to the arching, the lower wings are fluted. Note that the fluting gradually rises to the corner of the wing. See the red area in Fig. 2 for reference. The red color intensity denotes (approximately) the volume of material removed. In the area of the wing tips, you may cut as deep as 1.5 mm , depending on how "intensive" you want your fluting to be.

1. Use a shallow round gouge, pare away the wood in the direction away from the tip of the wing.
2. Smooth and blend the newly created surface with the rest of the arching using your scraper.
3. Repeat on the other f-hole.
4. Put the template in its proper place again and remark the parts of f-holes which got removed during the fluting.

Category: Front

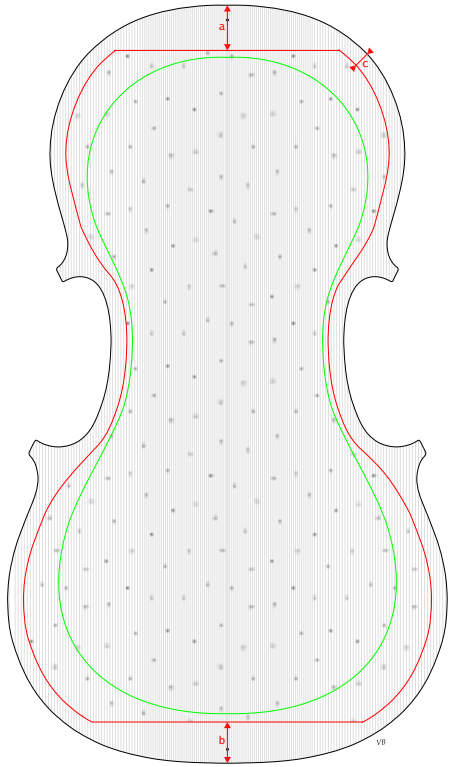
Hollowing and thicknessing

1. Mark out an outline on the bottom side of the plate, see the red outline in Fig. 1 . "a" is 21 mm , "b" is 19 mm , "c" is 7 mm .
2. Mark a second green outline using a marking caliper set to a 5 mm thickness. This will create a safety margin.
3. Mount the plate bottom up in the plate holder. See Tools section for an example.
4. Start removing material within the green outline. Work across the grain. Keep checking the thickness with a caliper or your fingers.
5. When you are getting closer to about 6 mm thickness, use a graduation punch set to 4 mm . For graduation punch schematics see the Tools section of the site. Beware that this only applies to the front plate. The back plate has different thicknesses.
6. Remove material all over the surface up to the red line, down to 4 mm , which means that the holes from the graduation punch will start disappearing.

Now you should move over to the Plate tuning section to read up on how you might want to tune the plate.

Category: Front

1



Cutting the f -holes

1. Mark the center of the four circles with a point.

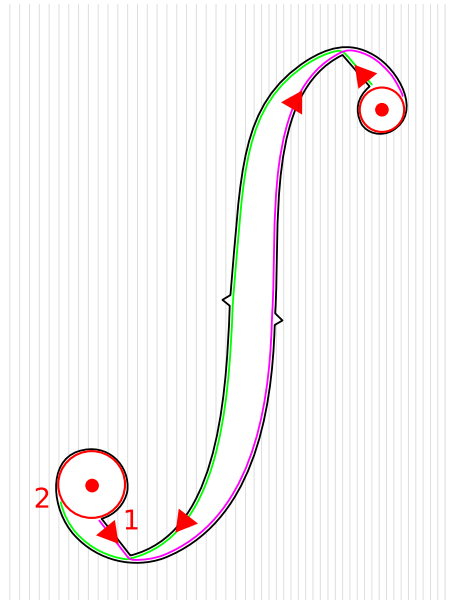
2. Drill the four leading holes using a small, 2 mm drill bit at right angles to the arching.

3. Use a f-hole cutter of suitable diameter to cut out the four holes. To make the cut as smooth as possible, with each hole, start at top of the plate, cut half way, then continue from the bottom and make the finishing cuts again from the top. Make sure you are cutting at right angles to the arching in place. Apply only moderate pressure to make a clean cut.

4. With the f-hole eyes cut out, use a coping saw, with a fine-toothed blade, to cut out the rest of the shape /the stem and the wings/. See Fig. 1. for the cutting order. Again, cut at right angles to the arching. Start in the no. 1 position and end in no. 2 . It is good to lay the plate down onto the fixed plank you used to cut out the plate outline before. This allows for easy access and support while you rotate the plate as needed.

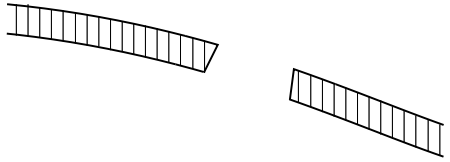
5. Using a sharp pointy knife, start cutting the f-hole walls to their final dimensions. Always work with the grain. Make sure the broadest area at the notches is at least a little over 6 mm wide, so that the sound post /6 mm wide/ can be inserted through there.

1



The angle of the f-hole walls depicted in Fig. 2. is more or less the modern standard and it can vary depending on the violin model. The gaps at the wing tips should have the width of about 1 mm .

2



1. Sharpen your knife extra sharp and finish both f-hole outlines to perfection because later, you won't have the free access when the plate is glued to the ribs.

Cutting the notches

To cut the notches, first make a cut in the middle, then two cuts at angles to the first one. It is always better to make the initial incisions small and work towards something bigger. The size of the notches on the template in Fig. 1. can be considered ideal.

Category: Front

The bass bar serves to prop up the arching as well as tune the plate and put it in balance.

The blank

1. Split a piece of spruce 350 x 20 x 8 mm , ideally the same spruce you used for the top plate.

2. Plane down the sides so that they run perfectly parallel to each other and the thickness if the bar is about 6 mm for a flatter arch or 5.5 mm for a higher arch and tighter grain. The sides can be planed down to the desired thickness by putting the bar down on the workbench and using a small C-clamp as a stop for it.

Positioning

A good position is crucial for both the sound and structural integrity. The bass bar runs right under the bass foot of the bridge. Notice the slight tilt, causing the bar run a bit across the grain, reinforcing the arch even more.

1. Mark out the position of the bass bar on the plate, see the circles in Fig. 1 for where to put the marks. "a1" and "a2" are 40 mm , "b" is 196 mm , or precisely at the f-hole nicks (bridge position), "c" is 19 mm . In our case, the half upper bout width is 84 mm , half lower bout is 104 mm . To compute the "d" and "e" positions, the upper and lower bout widths are divided by 7. Therefore 84/7=12 mm and 104/7=14.8 mm. The thick red line shows where the bass bar will be eventually.

2. Put the bass bar in position and trim its length so that it extends the "a1" and "a2 marks at each end by about 5 mm .

3. Using your knife, trim the spots where the bass bar touches the plate to roughly fit it to the arching there. Make sure the center of the bass bar is not elevated more than 6 mm from the plate on the left side as you will use a 6 mm washer to transfer the arching onto the bass bar. Also make sure the bar is at right angle to the plane of the plate.

4. Spot glue the bar in those two spots. Check the position again. Wait 5 minutes for the glue to set.

5. Using a washer that will offset the line by about 6 mm , draw a line copying the arching on both sides of the bass bar. When finished, break off the bass bar being careful not to damage the surface of the plate.

6. Pare down the wood between the two lines using a knife, then perhaps a flat thumb plane and a scraper until the bass bar fits quite well and most of all is at right angle to the plane of the plate.

7. Lastly, if you use the wooden clamps, as in Fig. 2. , create a profile of the top of the bar as in Fig. 4. to prevent the clamps from tilting the bar.

Studs

To hold the bass bar in position while being chalk fitted and glued, you need five wooden studs. We put paper on the gluing side to make the later removal easier.

1. Cut a piece of soft wood to 60 x 10 x 8 mm and glue a strip of paper onto the 8 mm (bottom) side. The grain orientation should be vertical, the same as the bass bar, to allow for easier removal by splitting later on. Let dry.

2. Cut the five identical studs, about 10 mm wide, from this piece of wood.

3. Use four wooden clamps or C-clamps as in Fig. 2 to clamp the bass bar in position. Make sure the bass bar is again perfectly vertical to the plane of the plate, when looking from both ends. Also, check its overall position and make sure it stays within the marks, as in Fig. 1 .

4. Start fitting the studs on alternate sides of the bass bar as in Fig. 2 . A well fitted stud sits snugly against both the plate and the bar.

5. With all studs fitting, start gluing them one by one, holding each in position with your fingers for about 20 seconds. Make sure the glue gets only on the paper bottom of the stud, not the bass bar itself, avoid applying too much glue.

6. Wait 5 minutes for the glue to set, remove the clamps and carefully shuffle the bar a little to ensure it didn't get stuck to the studs. Let dry for a few hours.

Chalk fitting

Chalk fitting helps you achieve the best joint between the bass bar and the plate.

1. Remove the bass bar, take a piece of white chalk and rub it on the plate, where the bass bar is supposed to be glued in.

2. Put the bass bar back in place and move it about 2 mm up and down, as in Fig. 3 a few times to highlight the peaks to be removed on the bass bar, moving it more than that would lead to inaccurate imprinting. It is important not to put too much pressure on the bass bar as the plate has a tendency to warp easily, resulting in inaccurate imprinting.

3. Use your thumb plane, scraper or knife (as a scraper) to remove the chalked peaks from the bass bar. Repeat, keep removing the peaks, reapply chalk, if needed, until the whole bass bar fits well. The finest adjustments are again done best with your sharp knife used as a scraper.

4. To remove the excess height of the bar to a necessary minimum, at the bridge position, first make a mark at the 15 mm height on the left wall of the bar. Then, extended that mark, drawing a line up to the ends, making sure the height at those is not less than 7 mm .

5. Plane off the excessive height, keeping the top at right angles to the sides. This is best done with a no. 7 mounted in your vice upside down. If you need to, trim the studs so that they stay below the top line (they snap off easily so be careful).

6. Again, if you use the wooden clamps, recreate the top profile as in Fig. 4.

Gluing

To clamp the bass bar for gluing, you can use the same clamps you used to hold the bar in position for the studs, only 5 instead of 4 should be used. See Fig. 5 for the positions of the clamps.

1. Using your coarse brush, remove the chalk left on the plate.

2. Dry fit the bass bar again and try to put all five clamps on to see if everything fits well.

3. Prepare fresh medium hide glue, put some on the bass bar, insert the bar in place.

4. Quickly remove all excess glue with a coarse brush and clamp down as in Fig. 5 .

5. Let dry overnight.

Trimming and shaping

Trimming and shaping integrates the bass bar into the plate finalizing its tuning.

1. Pare away the studs with a knife or a chisel. Work from top down, along the vertical growth lines cutting away thin slices. Be careful close to the bass bar as the stud may have been glued to it. Moisten the remaining paper patches and remove them with a knife.

2. Plane the bass bar evenly so that at the bridge position it has the height of about 13 mm , measured from the side close to the center line.

3. Refer to the bass bar diagram in Fig. 6. to see what the finished bar looks like. The overall shape depends much on the arching and plate tuning. Less stable arching, ie. low and or with long straight central part, needs more support at the center. The bass bar brings the M5 frequency back to where it was before the cutting out of the f-holes. The plate becomes more rigid again so pay attention to that.

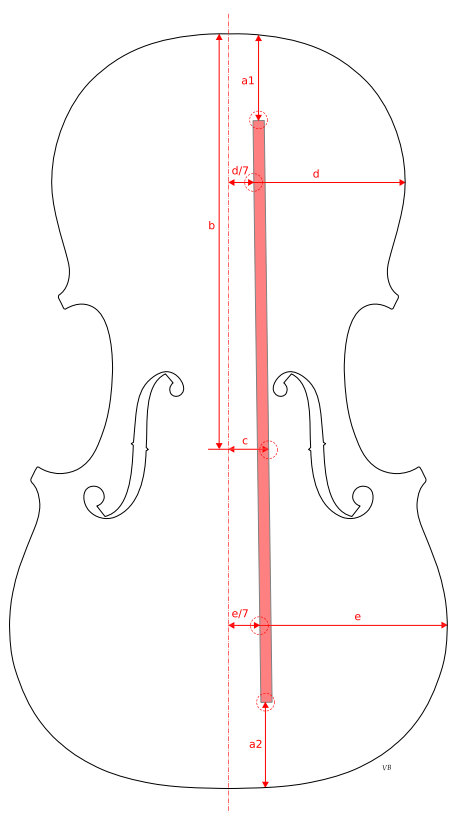
4. During shaping keep measuring the M5 frequency and the weight of the plate.

5. When the general shape is achieved, the cross section as depicted in the upper half of Fig. 6. is to be worked out. Use first a thumb plane, then an abrasive paper. When fine-tuning the bass bar bear in mind that just a few strokes, especially at the ends, can lower the M5 considerably.

6. Trim the ends of the bass bar to the final length at an angle of 45 degrees as in Fig. 6. The final length should not be more than 7/9 of the plate length. So for a plate that is 360 mm long, the bass bar should be (7/9) * 360 = 280 mm or less.

Category: Front

1



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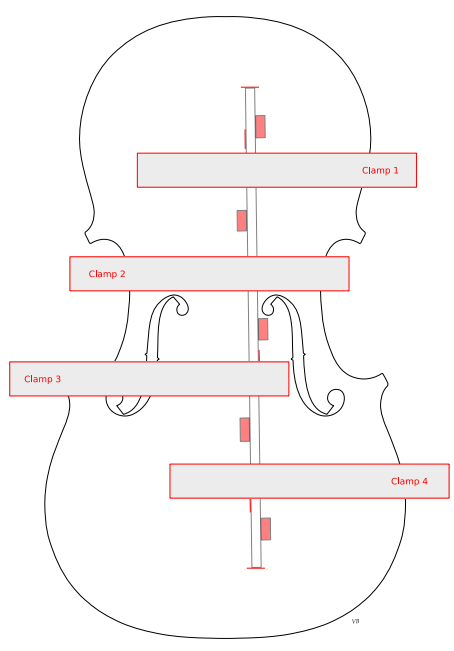

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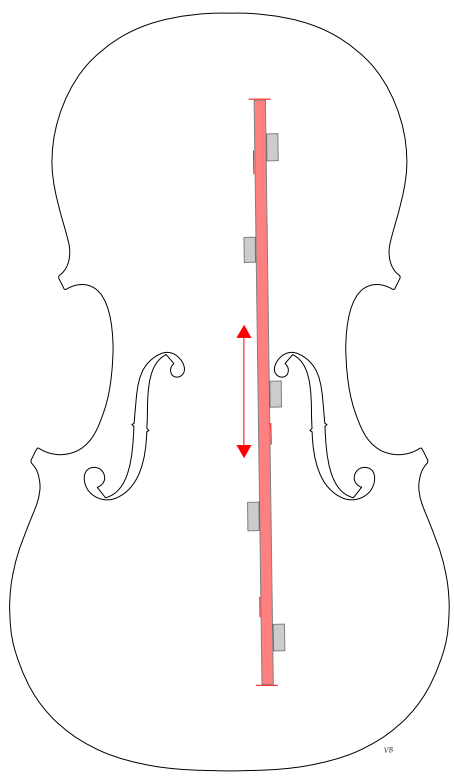

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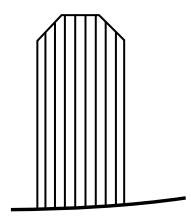

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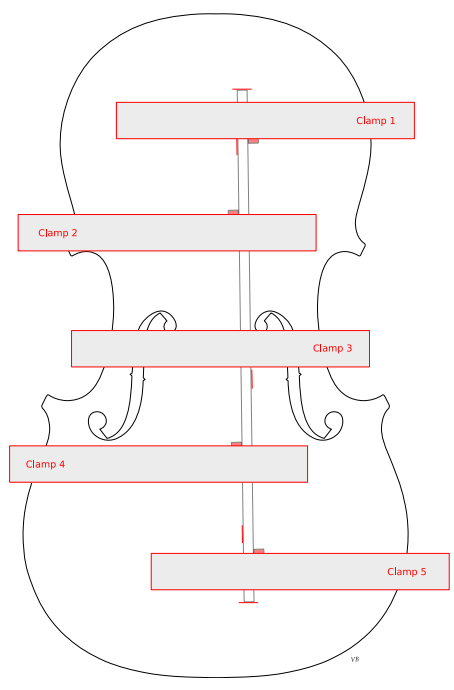

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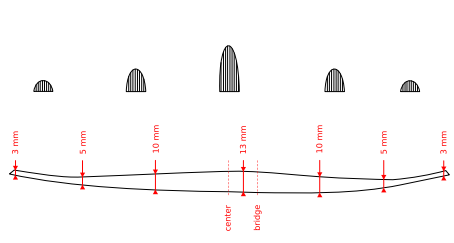


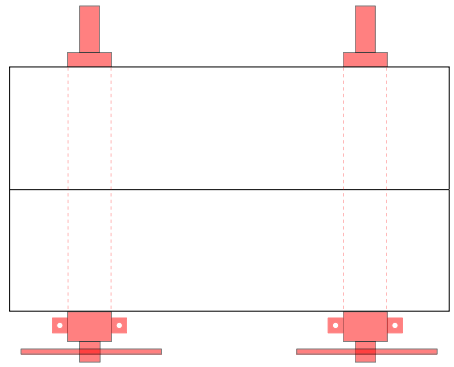
Almost all that applies to the front can be used when creating the back.

The wood is harder and carves differently. Bear in mind that deeply flamed wood is more difficult to plane. To prevent tear-out, a razor sharp plane with the mouth set to a minimum and the chipbreaker set very close are recommended. Also, for different parts, different planing directions may be needed. For me a 9 1/2 block plane works best.

Also, check the density of the block and make a note of it for future reference. Go for lighter wood {ideally maybe .55 density} which will allow you to end with a plate which has not more than 110 gr of weight.

The joining of the two halves can be a rubbed joint as with the front, but it is more difficult to make a perfect joint this way, so two sash clamps as in Fig. 1. are employed after the rub joint has been carried out.

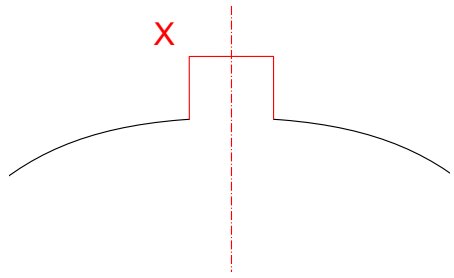
1



Button

The outline is identical, except for the place where the button will be. There, create a platform 22 mm wide and 15 mm tall. See Fig. 2. The final shape of the button will be finished later when the neck root is in its correct position.

2



Purfling

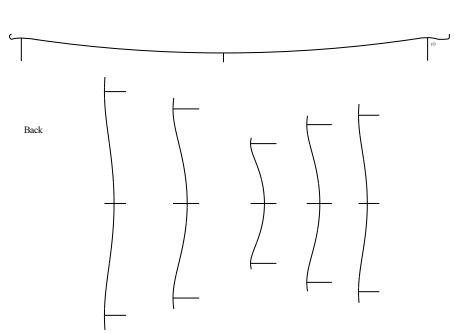
The purfling for the back should be made of one piece for the top and bottom bouts.

Arching

The arching of the back may or may not differ from the front. In our case it is 16 mm high.

1. Look again at the arching construction in chapter Arching, Fig. 3 .
2. Print out the arching templates for the back in Fig. 3 . The template positions for the back are identical to those for the front.

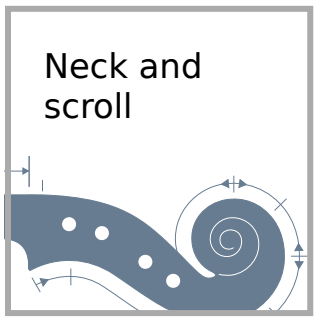
3



Thicknessing

The thickness in the cheeks is often half the thickness in the center.

1. Bring the thickness down to 6 mm at the center and 3 mm in the bouts, see the chapter Graduations - back_plate for an example of final thicknesses and their distribution.

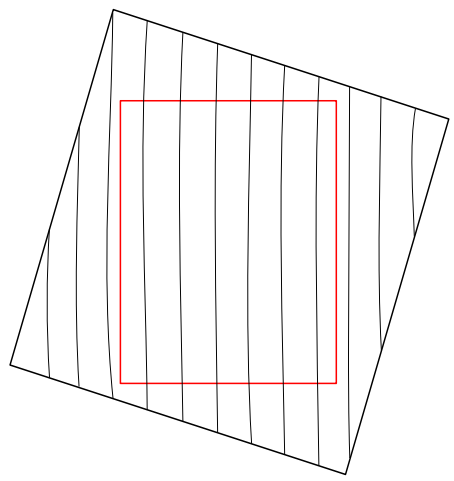


Preparing the wood

1. Choose a piece of maple, that matches in flame your back. The medullary rays should be at right angles to the top plane, the growth lines parallel with the top plane /fingerboard gluing surface/. If you need to reorient the wood grain along the longest axis, you can use a simple template 55 x 42 mm in size, made of plastic, as in Fig. 1.

2. True the block of wood to the minimal measurements of 250 x 42 x 55 mm . Check the maximum width of the scroll you are copying, from eye to eye, and make sure it fits into the 42 mm width of the block, the block being only about .5 mm wider.

1



Neck construction

In Fig. 2 you can see the general side and top overview of the finished neck and scroll. Note the length of the fingerboard gluing area, which is 136 mm and the angle of the neck root at 85 degrees .

Neck template

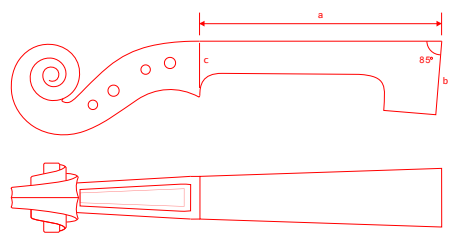
For the neck template, you can use the same material as for the body template.

1. Print out the template in Fig. 3 or use your own. The template here is again a slightly corrected version of the Messiah neck and scroll.

2. Glue on and cut out in the same manner as the body template.

3. Drill the small holes using a 1 mm drill bit. They will allow you to mark the scroll, peg holes and the end position of the fingerboard.

2



Marking the block

Use the neck template to transfer the neck outline on both sides of the block. Make sure the top of the block is straight and without flaws as it will with no alterations serve as the gluing surface for the fingerboard. For correct placement of the template see Fig. 4 .

1. Clamp down the template in the correct position.

2. Using a pencil, mark the template outline as well as all the holes denoting the scroll, peg holes and fingerboard end.

3. Repeat on the other side of the block. Make sure the template is in perfect alignment with its previous position on the other side.

4. Draw a line "c" square to the top of the block, at the fingerboard's end position. See Fig. 2 .

5. If you have a drill press, you can now drill the four pegbox holes using a 6 mm drill bit. Try this first on a block of scrap wood to see if you can drill precisely at right angle to the top and bottom surface. Again a block precisely trued is necessary for this.

   If you don't have access to a precise drill press or you for some reason must work with a block of wood that is not perfectly square, don't worry, you can drill the peg holes later by hand.

3

4

5

Cutting the outline

1. Use a coping saw or a belt saw to cut out the rough form of the neck. Avoid undercutting constantly checking both outlines.

2. Remove excessive material with a knife close to the outlines on both sides. Then, remove the wood inbetween using a gouge or a rasp or a file.

3. Using a sharp flat block plane and/or a file, make the back wall "b" , Fig. 2 , of the neck root flat. At the same time make sure the resulting fingerboard gluing area is precisely 136 mm and the neck root is at right angles to both sides of the block.

4. Size the neck root with thin hide glue.

See Fig. 5 for the resulting neck block at this stage. The red line is the template, the black is the actual cut out block.

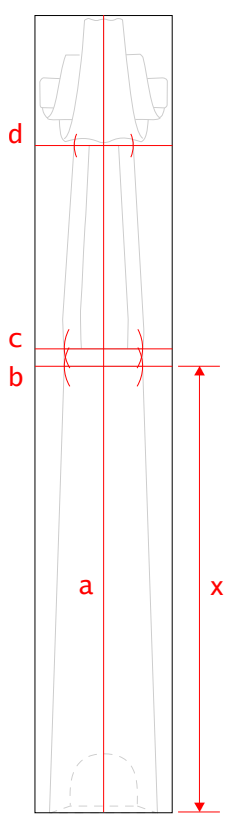
Category: Neck and scroll

Marking the top of the neck blank

While marking the top of the neck block, refer to Fig. 1 .

1. Using a marking gauge make a centerline "a" on all four sides of the neck blank.
2. On the top side, at the distance "x" of 136 mm from the heel, mark the line "b" which will determine the end of the fingerboard.
3. Continuing from the previous line, mark another line "c" , 6 mm forward in the direction of the volute. This line determines the end of the nut and the beginning of the slopping wall of the pegbox.
4. Set your compass to 12 mm and on each side, from the centerline on lines "b, c" make a mark which will denote the width of both the fingerboard end and the nut, in total 24 mm .
5. Use the same method, setting your compass to 10 mm , to mark the width of the begbox at it lowermost side, line "d" , under the volute.

1



The scroll and pegbox template

Now it's time to create the scroll and pegbox templates. You can decide not to do the cardboard templates which are good for reuse and instead go for the paper thin ones just to quickly transfer the outlines. In that case, just print out the outlines in Fig. 2 , cut them out using scissors and skip the following paragraph.

1. Prepare two pieces of cca 1 mm thick cardboard, one 220 x 40 mm for the "A" scroll template and the other 100 x 40 mm for the "B" pegbox template.
2. Print out the outlines in Fig. 2 and glue them onto the respective cardboard pieces.
3. Cut out the outlines as precisely as possible.
4. Wet the paper and impregnate it with thin hide glue. Remove the excess of hide glue. Let set for and hour.
5. Put the templates in their correct positions, shape them around on the neck blank and clamp lightly in position so that they don't get stuck to the wood.
6. Let dry.

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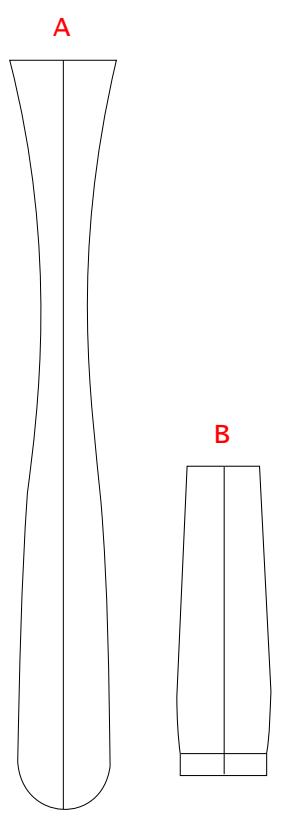
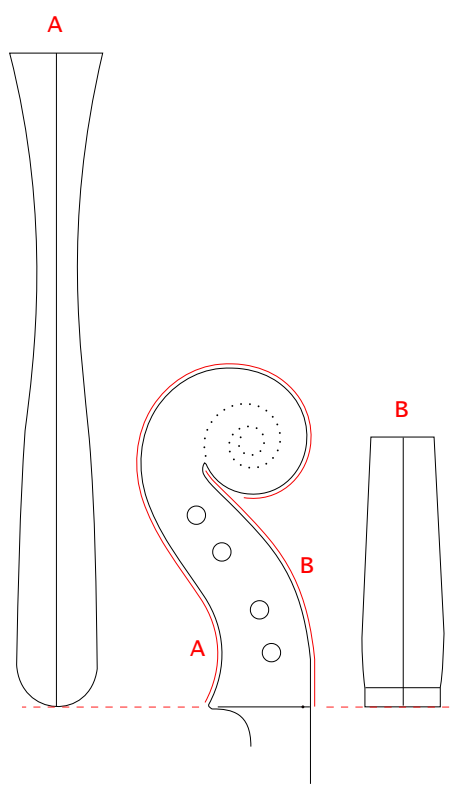


Marking the outlines

1. Correctly align the paper templates. See Fig. 3 where the starting point for both templates is at the heel and fingerboard end {red dashed line}.
2. Using a pencil, mark the outlines of both the pegbox and the volute on the neck blank.

3



Category: Neck and scroll

First of all, it is great to have a good finished neck at hand for reference. If you do not have it, study the photographs of the neck you are copying.

Cutting the sides of the peg box

1. From the fingerboard end line "f" in the direction of the volute, start making incisions using your saw, about 1 cm apart, stopping 1 mm short of the marked template lines. End in the area of the throat. See Fig. 1 for more information.

2. The little blocks of wood can now be removed with a chisel. Be careful to read the wood grain, do not try to chip away the whole block, work gradually in slices and from both sides.

3. Saw off the little pieces forming the basic contour of the heel. To avoid undercutting, angle the saw slightly away from the heel. See the "c" cuts in Fig. 1 .

4. Using a flat rasp/file, reduce further the width of the pegbox up to the lines, make the heel round.

Cutting the volute

Look at the Fig. 2 and Fig. 3 to see the way in which the volute will be cut. The red lines denote incisions. The order of the cuts is not important but it makes sense to proceed as numbered. Always stop a mm from the template lines.

1. Make the incisions no. 1-6 along the lines as in Fig. 1 and remove the resulting pieces of wood using a small shallow gouge.

   Notice that incision no. 7 has no boundary line at one end, as the template ends there.

2. To make the cut no. 7 and to proceed on to the second set of incisions as depicted in Fig. 4, you need to draw a line in the middle of the volute, as in Fig. 3 /the red lines/, naturally extending the template lines.

3. Make the cuts down to the lines as in Fig. 4 and remove the resulting pieces of wood using a small shallow gouge.

4. Now the final part of the volute, leading to the eye, remains to be carved. Start creating the slope from the tip of the eye using a suitable gouge. See Fig. 5 .

5. Correct the volute so that it flows naturally and gracefully.

6. Using a file, create a bevel on both edges of the volute and the heel.

7. Use small gouges to give the volute an increasing depth, as it approaches the eye.

See the finished scroll in Fig. 6 .

Category: Neck and scroll

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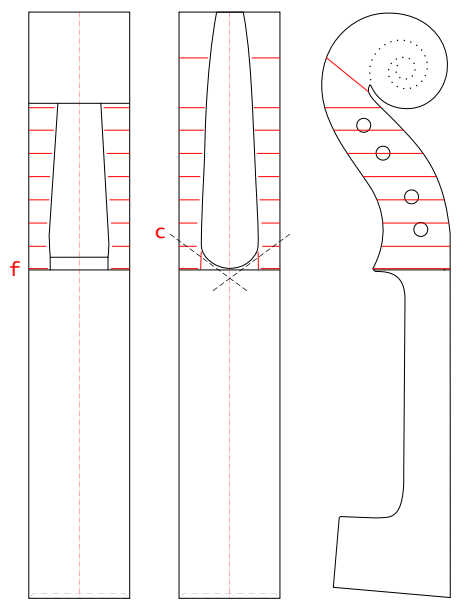

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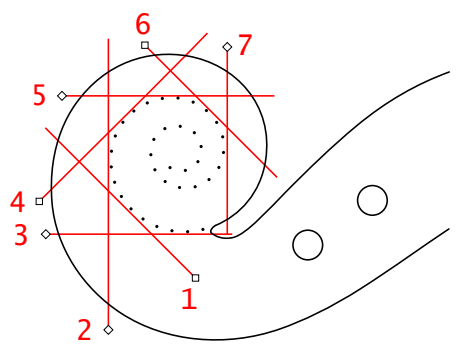

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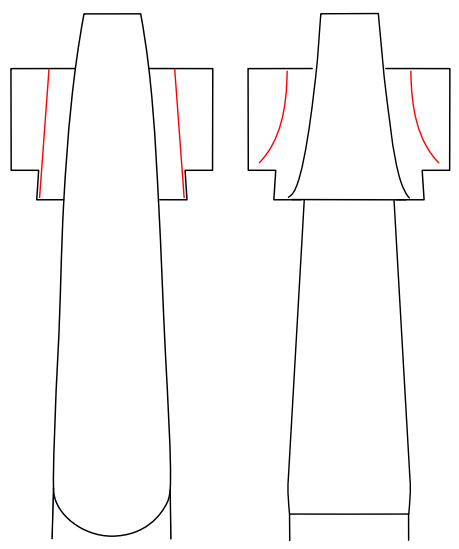

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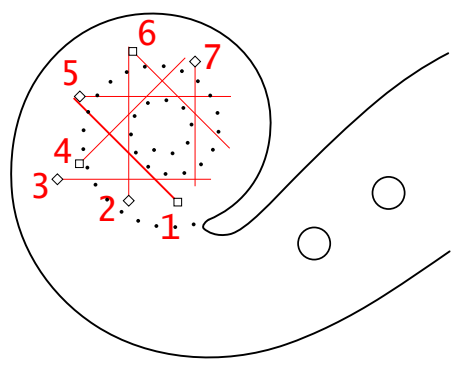

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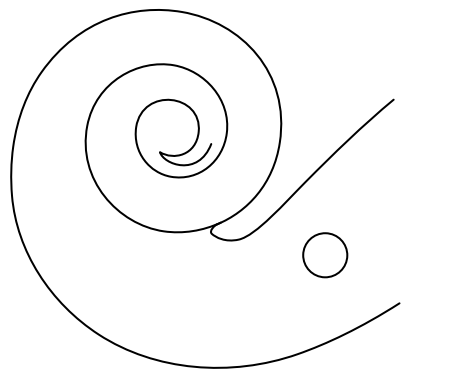

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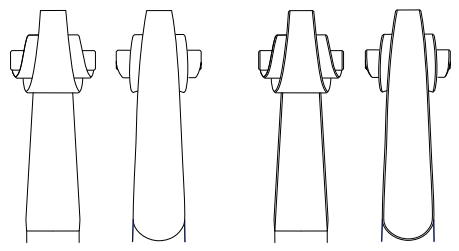

Drilling the peg holes

1. In case you have not predrilled the pegholes, realign the neck template and remark the four peg holes with a scribe (needle). Check the positions of the marks and make corrections where necessary.

2. Drill the four 6 mm wide "r" holes starting first on one side, drilling half way. When the four holes are half drilled, drill them from the other side. Do not drill more than half the length on each side.

   A good technique is to clamp a hand (of power) drill in your vice and hold the pegbox in our other hand. Drill slowly constantly checking on the position of the drill bit.

Carving the peg box

1. Mark the extent of the pegbox by drawing parallel lines to the pegbox walls inset by 5 mm , "t" , as in Fig. 1.

   Note that the walls are getting thicker towards the floor of the pegbox, see the dashed red line. The front wall, forming the extension of the nut "b" , runs at an angle of approximately 105 degrees , "x" in Fig. 2 . The bottom of the pegbox should be of consistent thickness at the same time allowing sufficient space for the strings, placing it normally about 4 mm , "t" , below the pegs, see dashed line defining the bottom in Fig. 2.

2. Start removing wood using a suitable (preferably U shaped) gouge. Make sure you are not removing too much wood - the pegbox sidewalls should not be thinner than 5 mm at the top and 7 mm at the floor.

Category: Neck and scroll

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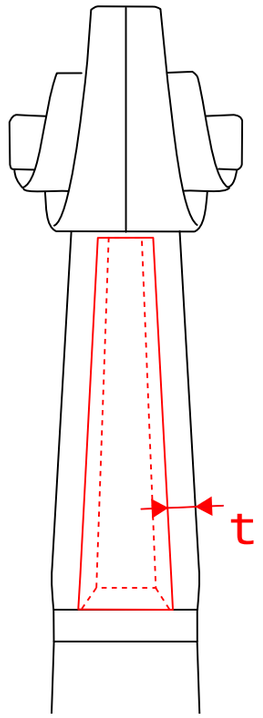

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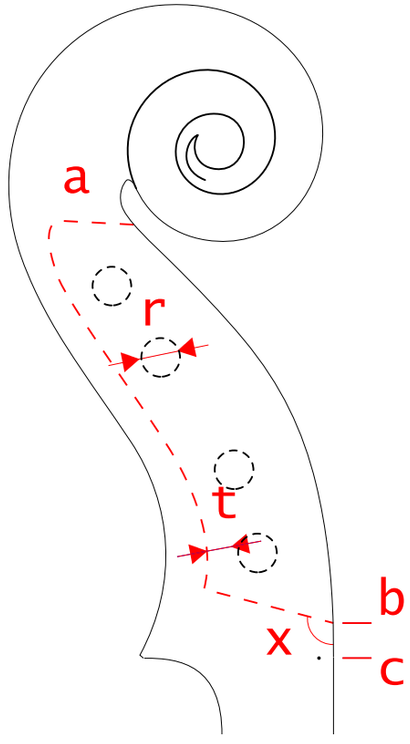

Chamfering the scroll edges

With the general shape of the pegbox and scroll finished it is now time to chamfer the edges.

1. Check again the scroll and pegbox for errors.
2. If all flows naturally, chamfer the edges as in Fig. 1 using a file. The red dashed lines denote the angle of the file.

The fluting

Before the the fluting is carved, make sure again that the general outline is flawless. At this point, it is great to have a variety of gouges to choose for different shapes of the fluting. The gouges should have the edges ground in a round shape, like the bottom of the letter U. Again, it is great to have a finished neck at hand for reference.

1. If necessary remark the center-line from the heel to the end of the volute.

   Look at Fig. 2 to see the directions you should follow when cutting the fluting. These should make the cutting easiest and most efficient with regard to wood grain.
2. Start at point "a" with a small no. 7 gouge and go down the slope, right next to the chamfer.
3. When the spade widens make another cut right next to the first one, this time getting close to the centerline.
4. Using a wider, shallower gouge, unite the two paths.
5. Continue in the opposite direction from the heel, point "b" , and connect to the "a" path. While cutting the "b" path, right at the heel, consult Fig. 3 for how the shape of the fluting looks at the heel.
6. Continue with the "c" path and connect the "d" , starting at the top of the scroll, to it. At points "d and e" it cuts slightly differently as the grain orientation is at right angle to the cuts. Use a small gouge with an edge fitting the fluting groove here.
7. Start the "f" path and connect it to the "e" path. At "f" the path is again wide enough for two cuts.
8. The "g" path ends just above the peg box. See Fig. 4 for the shape of the ending.
9. Repeat all steps on the opposite side of the centerline.
10. Use scrapers to finish the fluting. Again, follow the grain as when you were cutting.
11. Redo the chamfer where necessary making sure the outline of the scroll when viewed from all angles remains natural.

Category: Neck and scroll

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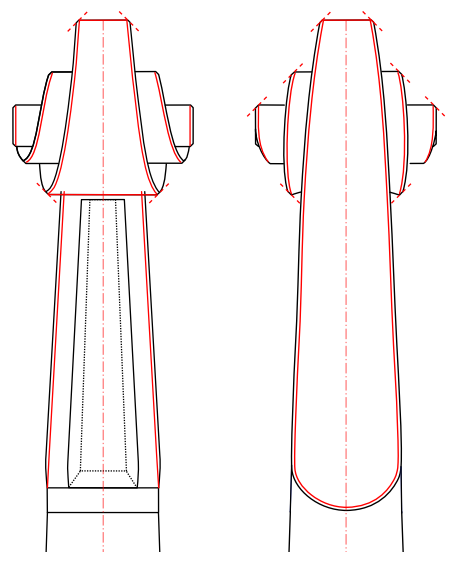

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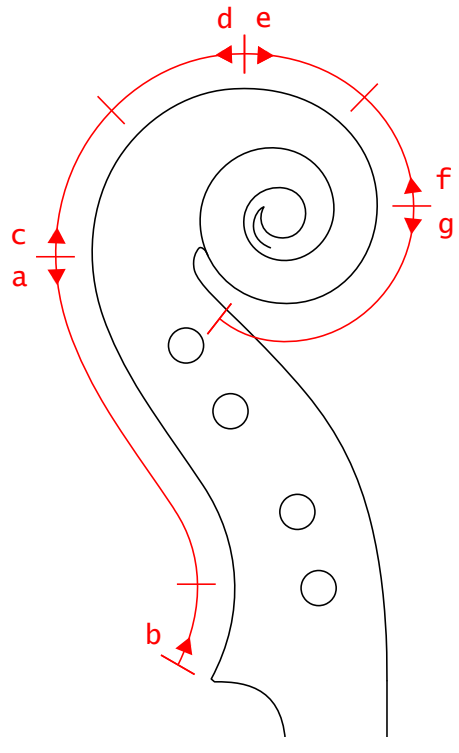

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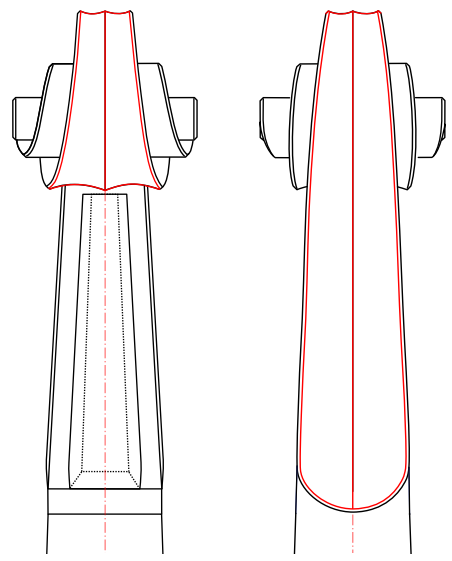

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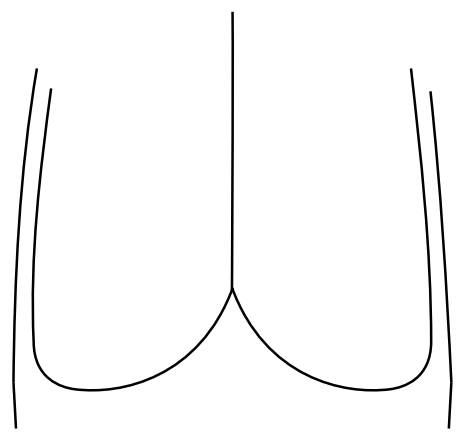

Preparing the fingerboard block

This method can be used, when you want to create you fingerboard from scratch. When using a premade fingerboard blank, you can skip this section.

1. True a suitable block of ebony to get a piece that is approximately 280 x 50 x 15 mm .
2. Make a centerline "c" on the bottom of the block. See Fig. 1.
3. Now you need to mark out the outline of the fingerboard "o" . Alternatively, take a suitable fingerboard blank, align with the block and mark its outline with a scribe. Highlight the lines with chalk.
4. At point "x" use a compass to mark the upper arc of the hollow area "h" , starting at the distance "d" from the top end of the fingerboard, which is 142 mm . Allow "t" 3 mm for the sides. Again, highlight with chalk.
5. Saw off the sides, staying about 1 mm outside the lines.
6. Plane the sides down to the lines making sure the top 24 mm and bottom 42 mm widths are met and that both sides are perpendicular to the bottom.
7. Using a block plane, create a small concavity along the length of each side of max. 1 mm at the center of the fingerboard. Check with steel ruler.
8. Make a line on both sidewalls with the height "h" of 6 mm from the bottom, apply chalk. See the side view of the fingerboard in Fig. 1. Use a block plane and plane down the edges to the lines on both sides, see Fig. 2.
9. Make a template as in Fig. 2. Use that template to achieve the radius with the height "h" of 6 mm at the sides, throughout the length of the fingerboard.
10. Now is the time to carve out the hollow area "ha" as in Fig. 1. The thickness "t" , except in the area of the arch should be about 6 mm , see Fig. 2.
11. Trim the length of the fingerboard blank to 271 mm .
12. Make sure the top /24 mm/ and bottom /42 mm/ widths still apply. If not, remove more material from the sides.

You have got your fingerboard blank.

Category: Neck and scroll

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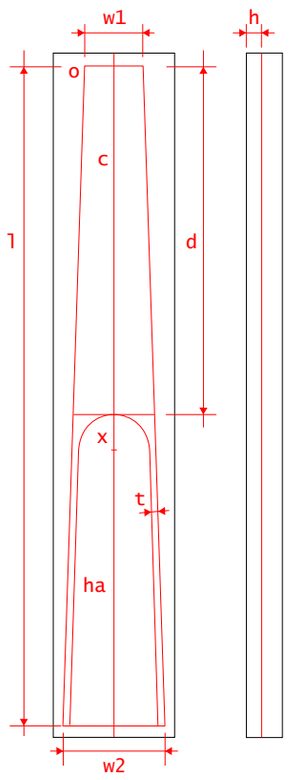

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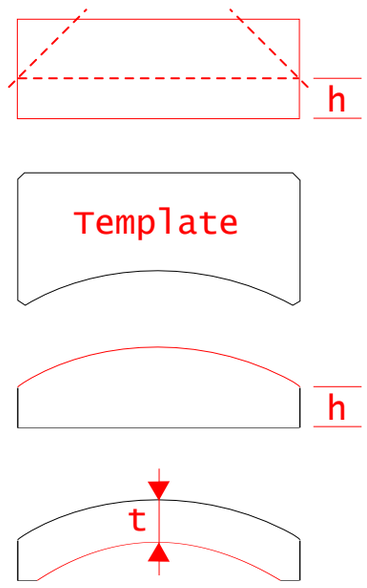

Making the fingerboard holder

1. Prepare a precise block of hardwood measuring 270 x 60 x 30 mm , see Fig. 1. for its simple construction.
2. Make two strips of hardwood measuring 5 x 9 x 270 mm .
3. Get a fingerboard blank, put it on top of the block
4. Glue on each side of the blank the two strips.
5. Clamp down the strips.
6. Remove the blank.
7. Carve out the material between the strips according to the top radius of the fingerboard blank, see the bottom of Fig. 1. for the finished holder's wider end profile.

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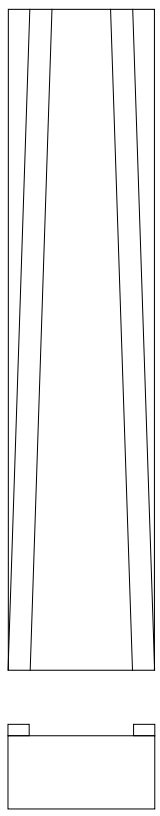

Shaping the fingerboard blank

Ebony is both very hard and prone to chipping.

1. Place the fingerboard blank into the holder and clamp the holder in the vice.
2. Plane the whole underside of the fingerboard down so that the sides are about 5 mm thick.
3. At the bottom, mark the w1 24 mm and w2 42 mm widths and create lines from these marks using your scribe. The lines may be made more visible by the application of white chalk.
4. Plane the sides down to the lines making sure that both sides stay at right angles to the bottom. If necessary readjust the height to 5.5 mm .
5. Remove the thickness on the underside of the fingerboard, gradually, starting at the 139th mm , removing about 0.5 mm at the very end of the fingerboard, see the dashed line in fig. This way, because the top of the fingerboard will later be planed a little concave as well, the final thickness of the sides of 4.5 mm can be retained.
6. You may now, using a block plane, create a small concavity along the length of each side of max. 1 mm at the center of the fingerboard. Check with steel ruler.
7. Mark the hollow area ha , starting d 142 mm /6 mm from the neck root/ from the top end of the fingerboard, allowing t 3 mm for the sides. Use your compass at point x to create the arch, trace with a needle. Highlight with chalk.
8. Remove some material with a gouge, getting down to about 5.5 mm thickness, from point x up to the end. The final thicknessing is done with the fingerboard glued on the neck.
9. Mark a height line h of 4.5 mm on both sides of the fingerboard. That will be the final height of the fingerboard sides. Highlight with chalk.
10. Last, check whether the new underside of the fingerboard sits perfectly on the top of the neck. Sometimes the neck may twist a little as it dries and that must be corrected /plane/.

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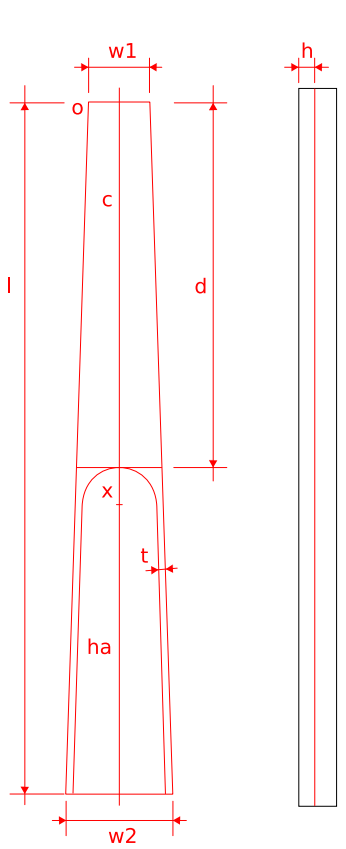

Trimming the fingerboard's ends

If you started with a premade fingerboard blank, which was already cut to the correct length of 270 mm and those cuts are clean, you can skip this chapter altogether.

1. Inspect the ends and decide which end to cut, if just one or both. Mark the correct length l of 270 mm .
2. Cut with your fine-toothed saw. Be extremely careful to prevent chipping.
3. Finish with sandpaper on a block of wood and/or a file. Make sure the new ends are at right angles to the underside.

Category: Neck and scroll

The clamping blocks

To hold the fingerboard in position with the help of C-clamps, you need three clamping blocks. You can see the the cross-section of such a block in Fig. 2 . The size is 40 x 30 x 25 mm . They are made of hard wood, their bottoms padded with something soft, ie. cork or rubber. They go between the C-clamp and the board, see neck C in Fig. 1 for their position.

Adding fingerboard fixing blocks

The fixing blocks help hold the fingerboard in the correct position during gluing. Consult Fig. 1 as to the fingerboard, fixing blocks and clamps placement.

1. Create 8 blocks of maple, 10 x 5 x 5 mm in size.
2. Fix the neck in the vice and clamp down the fingerboard using three C-clamps and the clamping blocks, in the correct position. See "A" in Fig. 1 .
3. Adjust the blocks so they fit perfectly at the same time not conflicting with the projected position of the three clamps.
4. Glue the fixing blocks onto the maple neck, holding each one for about 30 seconds. Again see "A" in Fig. 1. for their approximate positions.
5. Let dry for a few minutes and then carefully slide out the fingerboard to prevent it getting glued to the blocks.
6. Let dry thoroughly.

Gluing the fingerboard

1. Reinsert the fingerboard between the fixing blocks and make sure it slides right up the marked red line, 6 mm before the sloping pegbox wall. See "B" in Fig. 1 .
2. Prepare thin hide glue, quickly apply to the underside of the fingerboard and slide in position. The move must be a precise one as there is usually little time for correction before the glue "bites". It is handy to have a small hammer at hand so that if the fingerboard "bites" short of the marked line, you can tap it at the end lightly to get it home.
3. Apply three clamps with padded clamping blocks, see "C" in Fig. 1 for their positions. Use moderate force to tighten them. Make sure the fingerboard remains in the correct position.
4. The 8 maple fixing blocks can be removed either after 10-20 minutes , provided you don't remove the clamps, or when completely dry, at which time you must be careful not to chip away the ebony fingerboard, removing the blocks in layers, gradually with a chisel.
5. Let dry overnight.

Finishing the fingerboard

To check the fingerboard radius, you need to make the radius template as in Fig. 3 .

1. On both sides, use your block plane to reduce the height "h" , Fig. 4 , of the fingerboard to the marked line of 4.5 mm .
2. Continue removing wood from the top as well, occasionally checking the arching with the radius template.
3. When you are getting closer to the final heights, try to create a slightly concave surface, with 1 mm at the G side and 0.75 mm at the E side at the center of the fingerboard.
4. Finish with your scraper.

Hollowing out the bottom side

1. Insert your neck fingerboard-down into the fingerboard holder and clamp the holder in the vice.
2. Using a suitable gouge, start working across the grain, within the limits of the marked out area.

The final thickness "t1" starting at about 30 mm down from the neck root up to the end of the fingerboard should be 4 mm . The width of the edge "t2" is 3 mm .

1. Finish with your scraper.

Category: Neck and scroll

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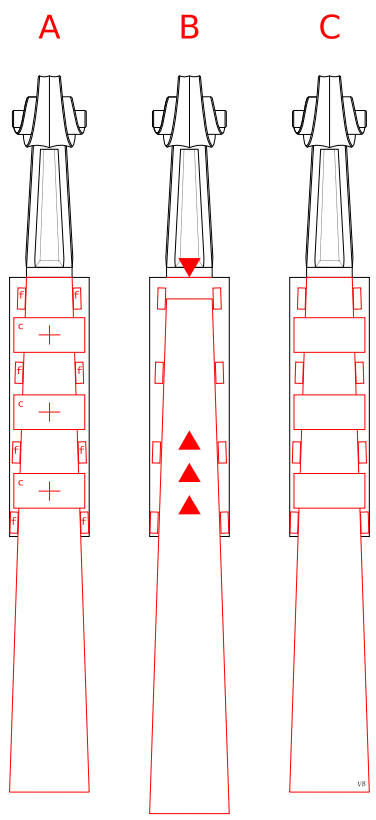

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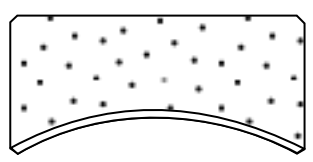

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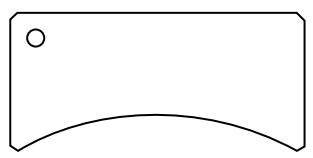

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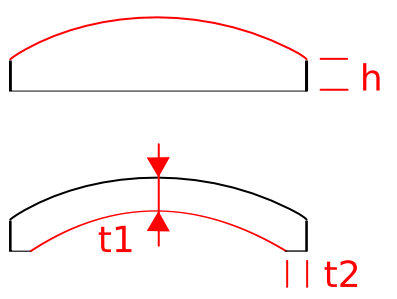

Marking the neck root

First, you need to calculate the final height of the neck root. To do that, you need to measure the height of the whole violin body /ribs+top+bottom plates/ where the neck root is inserted. The measurements are taken from the violin you are copying.

It is helpful to create a table summing up the measurements. See Fig. 1. for an illustration of a finished neck root. For our violin the numbers are as follows:

Overstand "a"	6.5 mm
Top plate thickness "b"	4.0 mm
Rib height "c"	30 mm
Bottom plate thickness "d"	4.0 mm
Total "x"	44.5 mm

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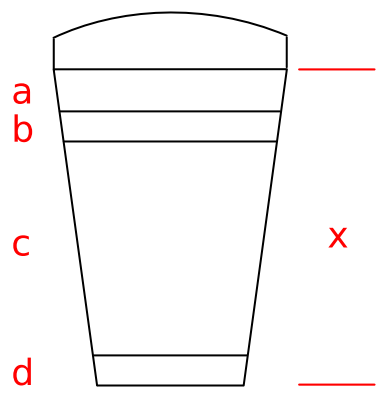
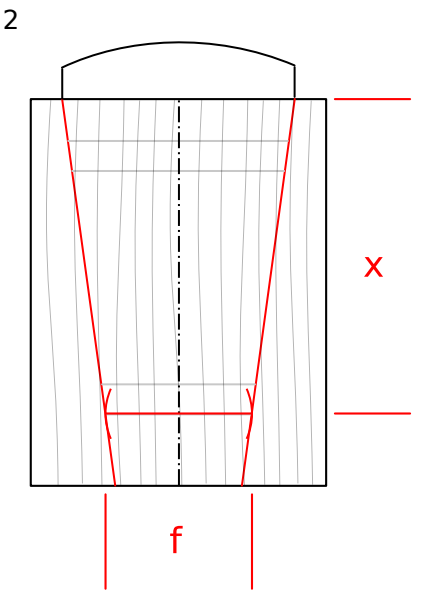


Take a look at Fig. 2. First, you will need to mark the red lines.

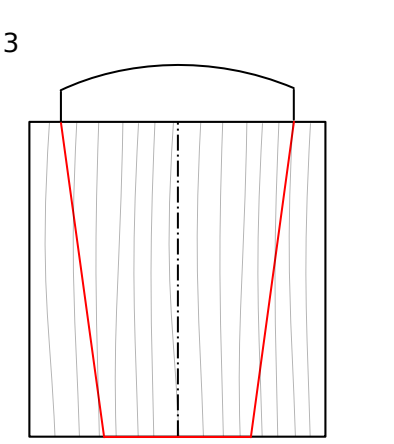
2



1. Mark the total height "x" , starting from the fingerboard underside down the neck root wall, using a scribe.
2. On this line, use a compass to mark, from the centerline, the width "f" of the button +0.5 mm . The button width for the Messiah is 17.5 mm plus 0.5 mm , 18 mm in total.
3. Using your steel ruler mark the sides of the neck root wall. See the red lines marking the walls in Fig. 2.
4. Trim the height of the neck root to the bottom line, retaining the angle, as in Fig. 3.
5. Extend the side marking lines to the bottom side of the neck root as well as to the neck's underside. See Fig. 4 for reference.

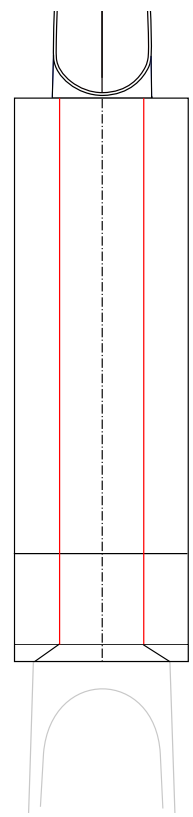
Adding the nut

3



1. Clean the nut bed of any remnants of glue.
2. To create the nut blank, get a block of ebony and cut it to the dimensions of 8 x 7 x 26 mm . The grain direction should be that of the fingerboard.
3. True the back and bottom sides, which will be glued to the fingerboard and neck so that they are at right angles and the nut sits well in its projected gluing position.
4. Using your block plane and a file, create the front wall, sloping flush with the pegbox wall.
5. Put the nut in place and trace the radius of the fingerboard, including the sides, on the back wall of the nut.
6. Trim the width of the nut so that it stays only a little proud of the fingerboard width. Be careful when sawing off the ends as they easily split.
7. Using your knife, trim the nut above the line of the traced radius, but stay 1 mm above it. Finish roughly with your file.
8. Glue the nut with thin hide glue and holding in place with your hands for about 30 seconds .
9. Remove excess glue and let dry.
10. After the glue has dried, you may reduce the width of the nut further, so that it extends only fractionally beyond the width of the fingerboard.

4



The nut will be finished later after we have shaped the rest of the neck.

Category: Neck and scroll

Shaping the root and the sides of the neck

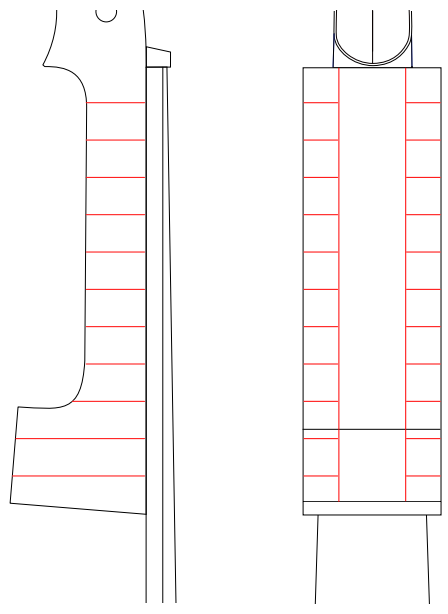
1. Using your saw, start making incisions at both sides of the neck, about 1 cm apart, starting with the neck root on up to the heel. Make sure you stop 1 mm short both of the fingerboard and the line on the underside. See Fig. 1. for reference.

2. With a chisel chop off the resulting blocks of wood, working away from the fingerboard. To keep the splitting under control, work gradually, removing slices rather than whole blocks.

3. Finish the 10 mm wide part "a" in Fig. 2. , adjacent to the fingerboard, with a file. The file should be slightly angled away from the fingerboard. Be careful not to cut into the fingerboard too much. Create a surface that flows smoothly into the fingerboard sides. See Fig. 2. for the enlarged cross section of the finished neck.

4. Using a block plane, finish the sides of the neck root up to the scribed lines. Be careful not to dent the fingerboard edges extending beyond the root.

1



Shaping the neck

1. First, take a look at Fig. 3. , namely the neck "A" . Scribe two marks "a" and "b" on each side of the neck, at the distance of 25 mm from the nut and 50 mm from the neck root.

2. On both sides, mark the thicknesses "c" 19 mm and "d" 21 mm /18.5 and 20.5 being the final thicknesses on the finished neck/ in these areas, measured including the fingerboard.

3. Connect these with a straight line "f" on both sides.

4. Measure 110 mm from the heel towards the neck root and make a mark "e" , which will serve to position the template.

5. If you haven't already, create a neck template as you have your other templates before. Again, you can print out the template in Fig. 3. , glue it to the templating material and transfer the outline this way.

6. Using this template, transfer the contour marked "root" so that it is aligned with the mark on the neck root. Use the "chin" end of the template to transfer the contour of the heel on the unfinished heel. Repeat on the other side.

7. Take look at neck "B" in Fig. 3. . Make incisions 1 cm apart ending 1 mm clear of the two dashed lines you just created.

8. Chop off the wood blocks in the same manner as you did on the sides of the neck.

9. Along the length of the underside of the neck, scribe a parallel line at about 1/3 distance from the fingerboard, see Fig. 4. The same on the other side.

10. Between these two lines the wood can be safely removed using a rasp. It may be difficult to clamp the neck in the vice for this, so try opening the vice just enough to lay one side and part of the top of the fingerboard on the vice. Hold with your hand and file away.

11. Level the underside of the neck and get to the final numbers, check with the template often. With a rasp make the coarse outline of the neck.

12. Using a file, start getting closer to the final curvature of the neck, check often with the template "g" and "h" at the points "c" and "d" . Keep checking the thicknesses in these points too. When the template almost fits, you should be close to the numbers "c" 19 mm and "d" 21 mm .

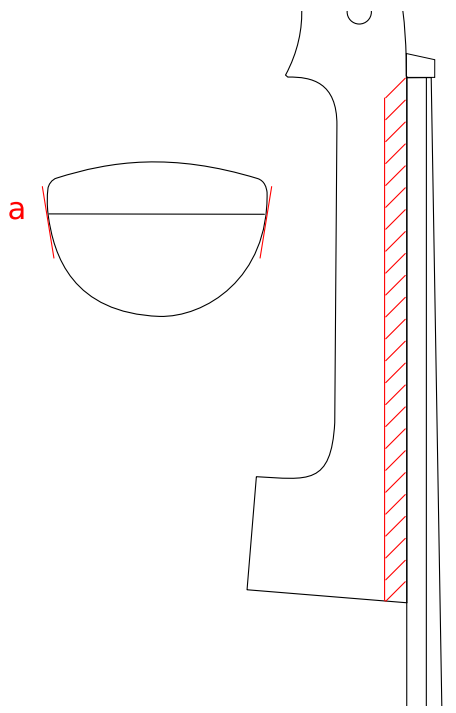
13. Using your knife, create the shape of the nape, make sure its contour flows smoothly into the pegbox sidewalls.

14. Using your knife, roughly form the round shape of the heel. The final shaping is done later with the neck glued on.

    The final shaping of the neck is done later with the neck glued on.

15. Trim the ends of the nut so that they are flush with the finished surfaces. They should form a smooth transition from the sides of the fingerboard, usually widening a little to accommodate the peg box walls. Finish with fine file.

2



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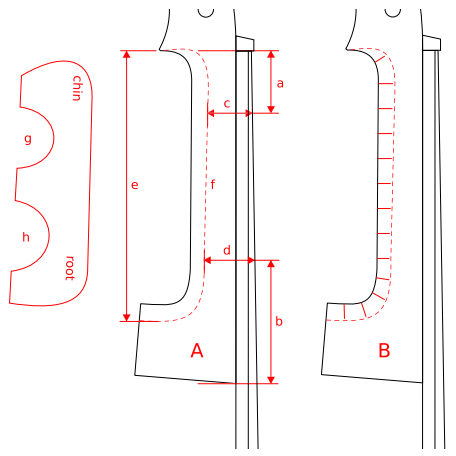

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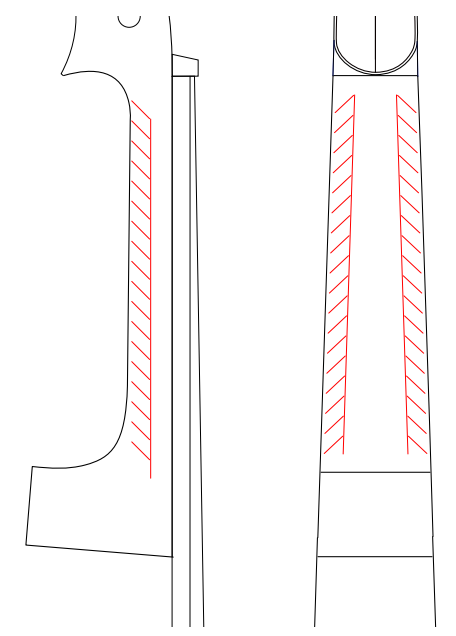

Category: Neck and scroll

Finishing the nut

1. Take a look at Fig. 1. Using a file, finalize the arching contour of the nut to 1 mm at h1 on the G side and 0.75 mm at h2 on the E side.

2. Take a look at Fig. 2. which depicts the sloping of the top arch. The slope goes towards the pegbox and ends a little under the projected top of the fingerboard (see the red dashed line). The slope can be created by using a file moving in short strokes in the direction of the scroll, slightly angled. The angle of the file can be set by putting your finger underneath the handle, the finger serving as a wedge, sliding on the fingerboard.

3. Finish the arching with fine sandpaper.

4. Set your compass to 16.5 mm , w1 in Fig. 3. and at the top of the nut, mark the outter positions for the G and E strings, leaning a little to the G side so that the E string will have a little more space on the fingerboard.

5. Set your compass to 5.5 mm (w2) and repeat to mark the inner positions for the D and A strings.

6. Use a knife to cut through these marks, creating guides for a keyhole file. The guides for D and A strings are straight, those for G and E are cut at a slight angle, see Fig. 3.

   Using a four-sided keyhole file, create the final grooves for the strings. Do not make them too deep as the string should only be fixed in position by these grooves, not buried in them. The width of each groove should also reflect the thickness of the string it is to accommodate.

7. The last step here is to create a smooth shaped bevel, so that the sloping front wall of the nut assumes the shape of letter D. See the red lines in Fig. 4. which depict the extent of the bevelling. Use your fine file to create the bevel. Finish with fine sandpaper.

8. Using fine sandpaper go over the whole nut and soften the edges just a little.

Finishing the fingerboard

The top edges of the fingerboard are now softened. For that use a flat file, going in long strokes all the way. The nut is treated as part of the fingerboard in this, so it gets rounded off at the sides and the top as well. Use a scraper to finish the bevels and remove any remaining marks. See Fig. 5.

You should now be left with an almost finished neck - the final shaping of the nape, the underside of the neck and the heel are done with the neck glued to the violin body. Go over the volute again making sure the surfaces are are smooth, the fluting and the bevels are perfect, the pegbox is cleanly cut.

Category: Neck and scroll

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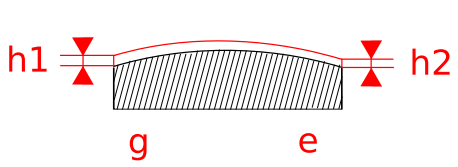

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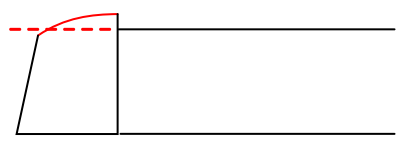

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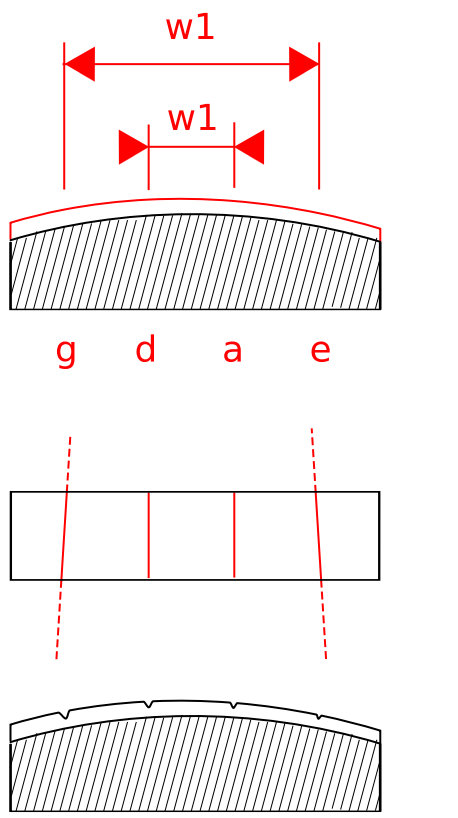

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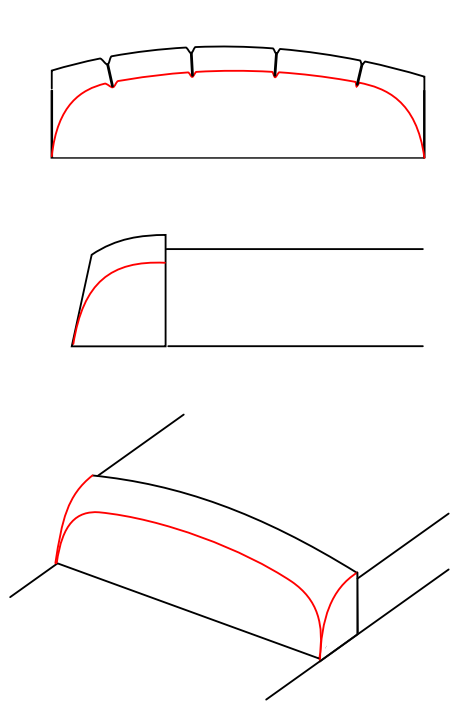

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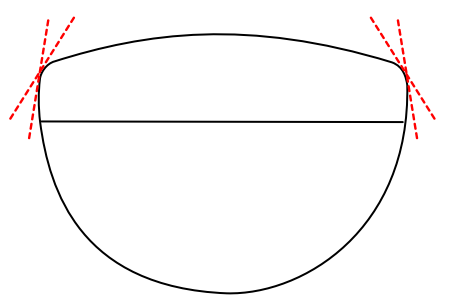

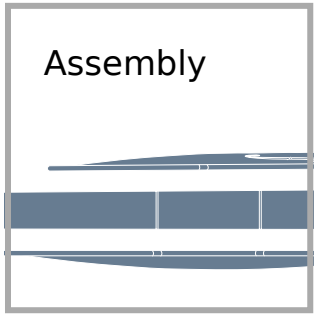

1. Fitting the back
2. Fitting the front
3. Edgework
4. Fitting the neck
5. Saddle

Now is a good time to remove the ribs from the mould. For that, refer to the Finishing the rib structure chapter.

Chamfering the underside

Before gluing the back plate to the ribs, you should create a chamfer on the bottom side (the first of a series, which will make the edges of the plate round). It goes all the way around the plate, except for the button. The same chamfer will later be done on the front. See Fig. 1. for illustration.

1. Using a suitable file, create the chamfer at about half the distance from the edge to the ribs' outline.

Clamping the back to the ribs

The back is clamped to the ribs prior to gluing. Self made spool clamps can be used, see the Tools section.

1. Fasten the back plate to the ribs using locating pins.
2. While carefully aligning the ribs to the outline marked on the plate, start adding clamps, making sure you are not over-tightening them. See Fig. 2. for placement. The top and bottom blocks are clamped with the use of C-clamps. Put some soft-wood padding between the clamp and the back plate to avoid damaging the plate.
3. Remove the locating pins.

Gluing

1. Prepare medium thickness glue and have a pitcher of hot water, a parting knife and a brush at hand. Put the knife and the brush in the hot water.
2. At one corner, remove a few clamps which will allow you to pull the ribs away and insert the knife with the glue.
3. Take the knife out of the water and dip it in the glue.
4. Insert the knife in the joint, spread the joint if necessary with your fingers and make sure enough glue gets applied.
5. Put the knife back in the hot water and remove excess glue with your damp brush.
6. Check that the alignment is right and re-clamp quickly.
7. Repeat with the other corners.
8. Go over the bouts, including the top and bottom block.
9. Let dry thoroughly.

The endpin hole

1. Mark the position of the endpin hole, on the centerline, just 1 mm bellow the horizontal center of the ribs, see Fig. 3 .
2. Mount the back on the plate holder you used to carve the inside of the plates.
3. Drill the hole using a 6 mm drill bit making sure you are drilling at right angles to both the horizontal and vertical plane of the body of the instrument. Be careful not to split the wood especially at the end of the drilling.

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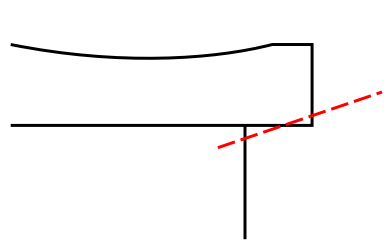

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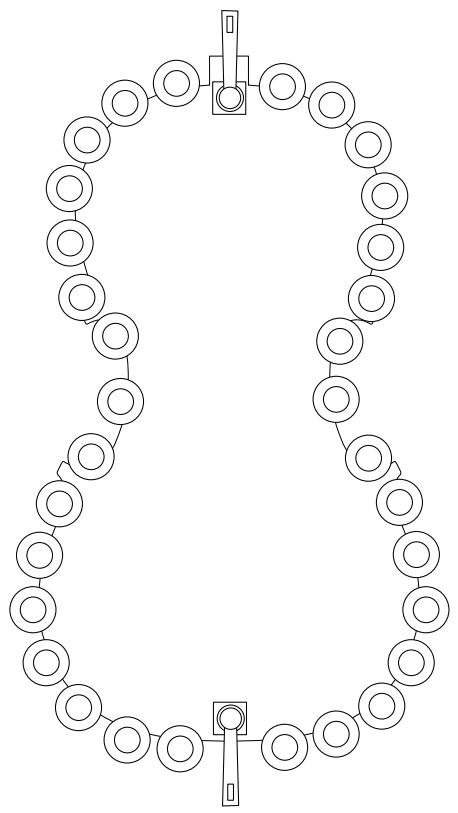

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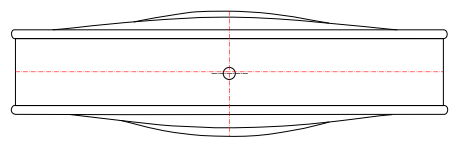


Category: Assembly

Finishing

Before closing, go over all the surfaces that will be after gluing on the inside of the instrument and make sure there are no loose splinters and other parts that might cause buzzes later on. Remove remnants of glue, if necessary.

Your label

Before closing, it is customary for many makers to put their personal label inside the instrument. The labels come in many different shapes and types. Hide glue is used to attach the paper label to the maple back. The information on the label can be the name of the author, date and place of creation, the number of the instrument. The position of the label is usually somewhere in the center part of the back plate so as to be readily seen through the f-holes, but many makers put their marks also in other parts inside the instrument, ie. on the ribs (Stradivari).

Clamping and gluing the front

1. Before fitting, the chamfer on the underside of the overhang needs to be done, as it was on the back plate. For this, refer to the page Fitting the back.

2. The front is glued to the back and the ribs in the same manner as was the back with the only exception of the glue being of thin consistency to ensure easy removal of the plate later on. Again, see Fitting the back for the instructions.

Location holes filling

To close the for location holes that are no longer needed, make tiny wooden dowels, spruce for the top and maple for the back. The easiest way is to use your electric drill to "turn" the dowels to required diameters. These plugs must go into the holes with ease and should have a point.

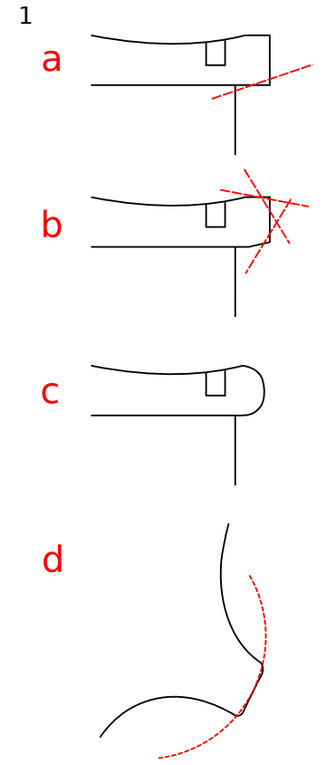
1. Cut four pieces of required wood and create the dowels from them.

2. Put a drop of glue on the tip of the dowel and insert. Repeat with the other holes. Let dry.

3. Using your sharp knife, cut off each dowel as close to the plate`s surface as possible.

Category: Assembly

Profiling the edge



Before you proceed with the shaping of the edges, check again that the archings and the flutings on both plates are perfect.

The overhang for the violin we are building here is approximately 2.5 mm so correct it if its too much. The chamfer in "a", see Fig. 1 , should have been done before the gluing of the plates to the ribs.

1. Using your file, start with the sequence of chamfers in "b".

   On the back plate, skip the button as it will be adjusted later when the neck has been glued on.

   Leave the tips of the corners untouched for the time being.

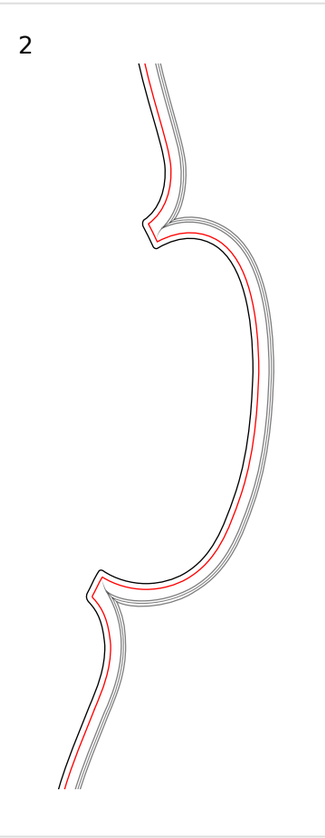
2. Use abrasive paper to connect the chamfers into a round edge as in "c". Towards the tips of the corners the overhang gets less round, more edgy.

3. Round off the corners a bit, as in "d".

The corners

The final shape of the corners is created now. It should "go" with the shape and direction of the bee sting. The overhang at the tips can be a little less, say 2 mm.

The ridge you have created on the outline, continues all the way to the corners, see Fig. 2 . The fluting naturaly rises to the ridge, from a valley with the bee sting at the bottom.



The points of the corners are usually not as round as the rest of the overhang so do not use a lot of sandpaper there. Also, the outer tip on each corner is often a little smoother, to emphasize the visual flow. If needed, make the corners a little sculpted and edgy, using just your scraper or fine file.

Finishing

On almost all surfaces the last tool that touches them should be the scraper. It gives the wood a unique texture, expecially in spruce (corduroy). The scraper also allows for greater control over the subtle features of the corners and the scroll. When removing little scratches and depressions caused by tools, try applying a little amount of water to them and let dry. Water causes the wood fibres to swell, filling the nicks.

1. Go over the arching again and make sure there are no irregularities.

2. Go over the fluting and make sure the area where the fluting connects to the rounded edge is well defined and sharp. You can soften the sharp ridge later on if you like, but now it should be sharp and flow perfectly.

3. Go over the ribs removing any residues of hide glue and generally cleaning up the surface.

4. Go over the f-holes and correct any irregularities using your extra sharp knife.

Category: Assembly

Fitting the neck

To successfully fit a neck the following set of criteria must be met:

a) 2:3 ratio between neck stop length and body stop length.
b) Overstand of 6 mm . See a in Fig. 1 .
c) The center of the neck must coincide with the center of the violin body.
d) The elevation of the fingerboard projected to the bridge position must be 27 mm .

Marking the neck root

First we need to transfer the real widths and thicknesses on the back of the root. See Fig. 1 .

1. Mark out the "a" overstand of 6 mm .
2. Measure the thickness of the top plate at the overhang, where it will meet the neck root. In our case its 4 mm . Mark this on the neck root "b" .
3. 2 mm downwards from the top plate is the place to measure the first width for the mortice "c" .
4. Measure the height of the ribs, 30 mm in our case, and make the mark "d" /29 mm in our case/.
5. Measure the thickness of the bottom plate, and make the mark "e" .
6. Finally, 2 mm from the "e" mark is the place to measure the second width, "f" /18 mm in our case/.

Transferring the widths

With the widths "c" and "f" measured, you can proceed to the violin body to make the neck mortice.

1. Set your compass to half of the width "c" . Using the compass, mark this width at the top of the plate, from the plate centerline. See the red vertical dashed lines in Fig. 2.
2. With your sharp knife make two incisions on these marks, cutting through the thickness of the top plate, through the purfling, to the depth of about 4.5-5 mm . The knife should be a little tilted, copying the directions of the neck root walls, see the two red dashed lines in Fig. 3. to get an idea.
3. Connect these two cuts with a straightedge and again use your sharp knife to cut through the top plate down to the neck block. See the red horizontal dashed line in Fig. 2.
4. Remove the vaste material between these three cuts. Making a series of incisions along the grain helps.
5. Using your compass again, transfer the width "f" to the top side of the button, close to the ribs. See Fig. 3.

Cutting the mortice

1. Put your straightedge inside the cut-out in the top plate and make two incisions, through the ribs, see the two red dashed lines in Fig. 3.
2. Make sure the incisions are deep enough to remove the rib material between them safely.
3. Using a suitable chisel, remove the rib material between the lines down to the button.

Fitting

Bear in mind that small changes in the mortice may cause great changes in the position of the neck. Always make sure that when removing material, the walls of the mortice are perfectly straight for a good fit.

1. Make a small mark at the top of the top plate at the centerline right where the mortice starts so that you can check the centering of the neck root to the centerline of the plate.
2. Offer the neck root in place. If the bottom of the root touches the button, cut it a little shorter so that a gap, lets say, half a millimeter is present.
3. Measure the basics: Neck stop {130 mm } Fig. 4 , elevation {27 mm } Fig. 5 , overstand /neck step/ {6 mm } Fig. 6 and the centering Fig. 7 , so that you have some idea from whence to start. The numbers in the curly brackets are your goal towards which you should carefully proceed.

   The elevation is connected to the arching. Thicker tops can have slightly {tens of a mm} more elevation because it causes the sound to be more powerful.

   The overstand is connected to elevation. It should be around 6 mm . On less arched tops it can be slightly less. Always make sure the fingerboard gets a clearing of at least 2.5 mm from where the top's arch is nearer to it.

   As for centering, it is good to make the mark mentioned above, at the top of the mortice. Make yet another at the end of the fingerboard so that you can compare it to the centerline running beneath it in the top plate. These should be perfectly aligned. This is by no means a substitution for bridge checks, which are the final check of centering.
4. Bridge check for correct centering: With the help of two rubber bands, put the bridge in place and sight along the fingerboard. See Fig. 7 . The fingerboard should be in alignment with the bridge.
5. Work carefully and slowly towards the aforementioned numbers at the same time making sure the neck root is in good contact with the mortice walls. When being a mm away from the designed numbers, chalk fit the neck so that when at the final numbers everything sits perfectly. Bear in mind that the pull of all the four strings tuned to standard pitches is about 22 kg so a good joint is required.
6. When everything is all right, put on the neck, take a spare bridge, put it on the top plate right at the end of the fingerboard and scribe on its face the fingerboard radius. This helps you compare the elevation now with the one after you have glued to neck on. It should be identical which means that nothing went wrong during the clamping and gluing.
7. Clamp the neck down to the violin body and check whether the measurements change. The elevation should be checked with the spare bridge. If the elevation changes it means that the fit is not perfect and that it changes under pressure so it needs some more work.

Gluing the neck

1. Prepare medium hide glue.
2. In the meanwhile, try to dry fit and clamp the neck, as in Fig 8. so that you are comfortable with the procedure and can carry it out as fast as possible.
3. When dry clamped, check the elevation, centering, overstand. If anything changes, you need to go over the mortice and make corrections.
4. With everything perfect, apply to both the mortice, the button and the neck root itself ample amounts of hot hide glue.
5. Insert the neck root swiftly in place, squeezing out all surplus glue.
6. Clamp down as in Fig 8. again and let dry overnight.

Marking and shaping the button

See Fig. 9 . The actual dimensions will depend on the violin you are copying. With the Messiah, the "a" is 17 mm and "b" is 15 mm .

1. Make a mark at the top of measurement "b" , see the upper "x" mark.
2. Set your compass to half of "a" , put the needle on the centerline (see the lower "x"), the compass marker on the previously marked point (the upper "x") and draw a half-circle. Check for correctness with your model violin.
3. Start removing material with your knife, checking the curvature of the heel with the neck template.
4. Using a round file, finish the shape.

Shaping the neck

1. Put the neck template in the middle of the neck underside and move it towards the heel and chin again to see whether the neck is in good shape. Remove any irregularities.
2. The final thickness of the neck is 20.5 mm towards the neck root and 18.5 mm towards the heel so make sure it is close to these numbers. Of course these are general numbers which may need to be changed based on the size of the player's hand.
3. When the side profile of the neck is perfect, turn the violin around its axis to see the other surfaces of the oval underside and remove anything odd with a flat file.
4. Finish the whole neck with abrasive paper to remove file marks.

Category: Assembly

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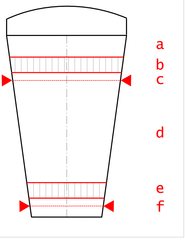

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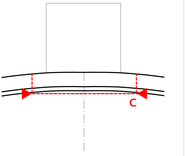

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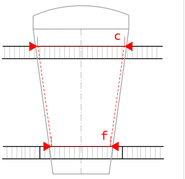

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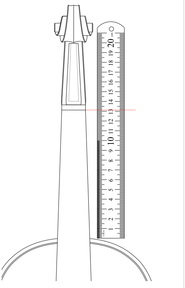

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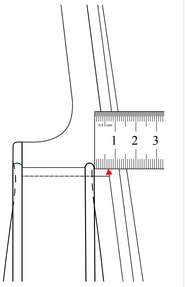

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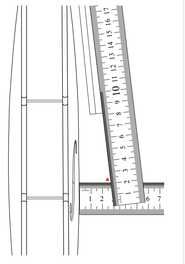

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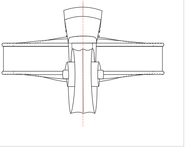

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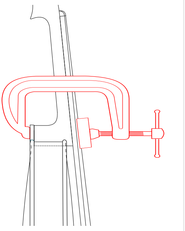

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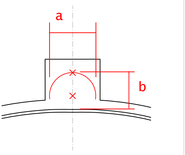
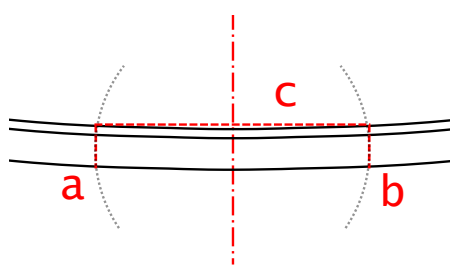


Cutting the mortice

1. Depending on your judgement and the violin you are copying decide what the actual width of the saddle will be. Usually, its width is between 32-35 mm .
2. Take a compass, measure a half of that width and make marks on both sides of the centerline as in Fig. 1 .
3. Make two incisions a and b, see Fig. 1 . Using a straightedge make a line c at right angle to the centerline connecting them. The same as with the neck mortice.
4. Remove the material in the same way as in the neck mortice, down to the ribstock.

1

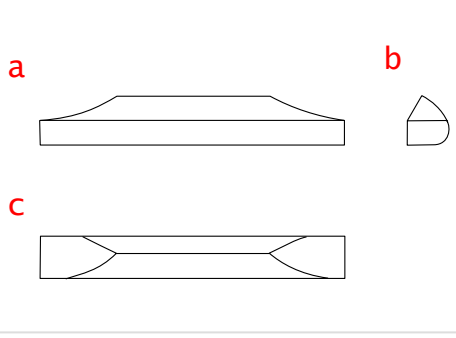


The saddle

For illustration, in Fig. 2 , you can see the diagram of a finished saddle. View a / front, b / side, c / top.

1. Prepare a block of ebony, about 8 x 7 x 35 mm .
2. Choose what will become the back of the saddle in contact with the mortice in the plate and make those two sides at right angles to each other, the 8 mm side going up.
3. Cut the ebony block to the correct length so that it fits the mortice easily. Remember that later on, as the top plate shrinks in dry weather, this block of ebony shrinks much less in extreme cases causing the top plate to split. So the fit must not be too tight.
4. Put the block in the mortice, make sure everything fits perfectly. If it does, run a marker around its front and sides to mark the level of the top plate, see the dashed line in Fig. 3 .
5. Plane the front side of the saddle down to the marked level at the angle of about 60 degrees . See the side view of the saddle in Fig. 3.
6. On the top of the saddle, mark the center c and from it, using a compass, mark two lines a and b, 9 mm from the center on both sides. See Fig. 4 .
7. From those two marks, down to the lines scribed in 4, create on both sides shallow slopes as in Fig. 5 using a knife.
8. Put the saddle back in the mortice and make sure the front and sides run down smoothly to the plate`s level. Also, make sure the sadle is put in its position without any force. There should be a slight gap where each of the ends meet the top and the saddle should fall out if you flip the violin belly down. This rather loose fit hels prevent cracking in the top if the spruce dries out too much.
9. Glue in this position using medium hide glue.

2



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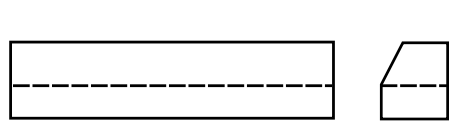

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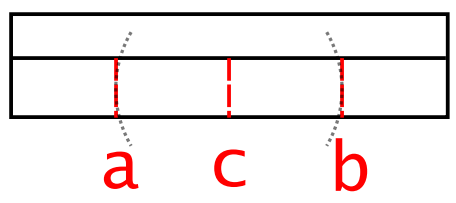

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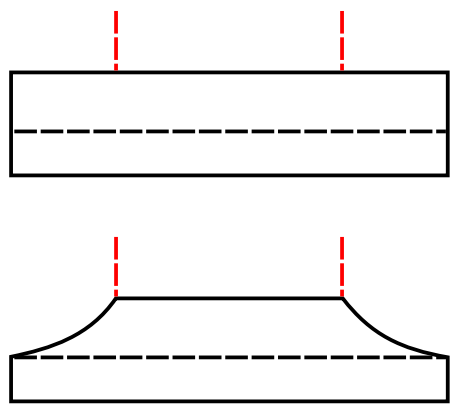
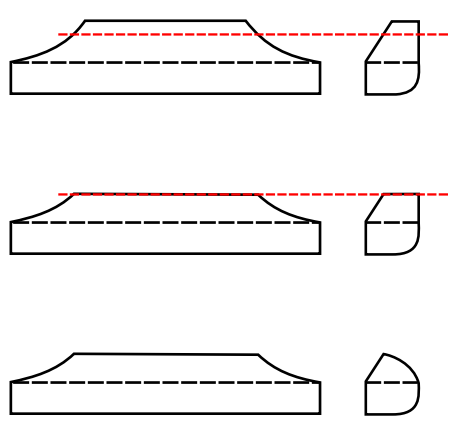


Finishing steps

1. When dry, using a file, on the back of the saddle, recreate the outline of the plate. On the bottom of the back, make it round so that it naturally continues the overhang.
2. Decide on the height of the saddle. Normally its about 3 mm but with higher arches it can be slightly more.
3. File the top down to the chosen height.
4. Connect the newly defined top with the back with a rounded slope, see Fig. 6.
5. Finish the surfaces using fine abrasive paper. Do not at the same time loose much of the the crispness.

6



Category: Assembly

Prior to varnishing, you should set up the violin in the white and make sure it is playable, and it doesn't have any buzzes, which could require reopening of the instrument. Only if you are satisfied with the sound, should you proceed to prepare the surfaces for varnishing.

Preparing the wood surface

1. Go over the whole surface of the violin and correct areas which you have overlooked before, or defects arising from manipulation. Be especially careful in the areas where grain sticks out, ie. overhang and make sure you make these places smooth without loosing the crispness of the ridge.

2. Using a damp wash sponge or cloth, wet the whole violin with water to rise the grain. Let dry.

3. Remove the grain everywhere using a fine scraper, knife and sandpaper. Be careful on the top plate where you shouldn't use any sandpaper, just scrapers to not loose the texture of spruce. For more see the previous chapter on finishing.

4. Redefine the edges and chamfers if necessary.

5. You may now selectively smooth out some of the features, ridges and chamfers if you feel the violin should look less edgy. Keep in mind though that the varnish itself will make the edges smoother.

Tanning overview

Now that your violin is ready we need to make the wood darker which will save us some coats of varnish and make the varnish look more attractive. At our disposal, we have a number of methods A-D, which we will discuss here in some detail.

Any of these procedures are best first tried out on scrapes of wood, so that you get the idea about the amounts and times involved.

A] Sodium nitrite + UV sun ra ys

You need:

1. 4% Sodium nitrite, 50 ml . To prepare, weigh 50 gr of water and add 2 gr of Sodium nitrite.

2. A sunny day or an UVB mercury lamp or an UV cabinet.

The process:

1. Put a coat of 4% sodium nitrite on the violin. Make sure the coat is even and there are no drops left as these would make the wood darker. Don't forget to apply some under the fingerboard as well.

   Sodium nitrite accelerates what normally happens when you put the violin out in the sun. It helps oxidize the outer layers of the wood making it look darker.

2. With the fresh /wet/ coat of sodium nitrite expose the violin to UV radiation. For wood tanning again exposure to direct sunlight or a strong UVB light is required.

   You have basically three options:

   a) Put the violin out in the sun. Get a length of firm string, tie the volute to one end and the other somewhere where the sun shines most of the day, ie a tree branch. The violin will rotate this way ensuring the proper distribution of UV. The only weak spot may be the underside where the button is, so put a sheet of aluminium foil right under with the distance of about 5 cm. The times depend on the strength of the sun. In summer a couple of hours should be sufficient.

   b) Use a UV mercury sun lamp, which emits strong UVB. With these precautions must be taken to avoid direct exposure of any part of your body, eyes especially.

   If you have the one bulb mercury lamp you will have to make sure, all parts of the violin get the same exposure. You can coat the whole violin with sodium nitrite at once though. Then expose different parts. The violin can be dry during exposure but higher humidity levels either in the violin /freshly coated/ or in the air help speed up the oxidative process of tanning.

   For a 250 W att mercury UV lamp about 20-30 minutes from 40 cm distance are enough, assuming the violin is still damp from the solution.

   You will need to rotate the violin every 30 minutes to cover all angles. Don't forget to turn off the lamp before you do this, or wear UV protective glasses. It takes a whole day to tan a violin this way.

   c) UV cabinet. The black light UVA-B tubes used in varnish curing are usually much slower in tanning so you will need the white ones which don't block out most of the UVB.

   Tanning times for the whole instrument may vary from hours to days depending on the kind of tubes you are using. Watch for humidity, see the varnishing section.

Sodium nitrite precautions

Though commonly used as food additive (E250), in higher amounts it can be toxic and lethal to animals and humans. Human lethal dosage is 71 mg/kg, meaning a 65 kg person would likely have to consume at least 4.615 g to result in death.

UV exposure precautions

Wood tanning by exposure to UV radiation is inherently a destructive process so it should be practiced with caution. The desirable darkening of the wood is caused by the uppermost layer of the wood getting oxidized and degraded. The UV light produces ozone, which reacts with the nitrogen gas present in the air and forms nitrous oxygen. The nitrous oxygen then "burns" /oxidizes/ the wood leaving it slightly acid.

Precautions!
UVA can cause irritation of the eyes, prolonged overexposure may lead to some damage.
UVB can cause irreparable damage to the retina (welders eye) overexposure may cause sunburn and skin cancer.
UVC carries seriously increased risk of all of the above and it really should not be used in UV cabinets.

Also any type of UV light will produce some ozone and nitrous oxygen, the UVB/C lamps produce the greatest amount of these. They both are classified as poisons {depending on concentration} so precautions should be taken so that the room is sufficiently ventilated.

B] UV sun ra ys

If you want to avoid using sodium nitrite or are unable to obtain it, you can still expose the violin in the white to sunlight to darken naturally. But there is a catch. Without any accelerator, the violin takes a considerable time to darken. Exposed to direct sunlight, the stresses in the wood would be immense, humidity levels dropping which would probably result in numerous cracks. So instead of baking the violin in the sun, hang the violin somewhere with only indirect sunlight and wait... a couple of months. This is still possibly the least structurally invasive method, if done properly and if you have the time.

C] Ammonia fuming

In case you can't or don't want to use sodium nitrite as tanning accelerator, you can use ammonia fuming instead. This method offers uniform colors, color stability, brings out the annual rings in spruce. The tan can turn a bit greenish. If it is a problem, higher temperatures supposedly get rid of that. Maple can get less affected by ammonia, applying tea prior to ammonia on those parts can help. The long-term effects of ammonia on resonant wood are unknown, some makers say it even improves the wood while others fear it may adversely affect the instrument's structure.

You need:

1. An airtight box large enough to accommodate a violin + a cup of ammonia. The violin should preferably be hanged.
2. 26% ammonia /laundry grade/

The process:

1. Put the violin in the box together with a cup o ammonia.
2. Let it stand for a couple of days, up to five, or until you are satisfied with the color.

D] Staining

Staining can be used as an add on method to complement the tanning methods mentioned above. You can stain the bare wood with commercially available stains or use home made stains such as the black tea stain.

Category: Varnishing

Plaster of P aris ground

Plaster of Paris is produced by the grinding of gypsum and subsequent heating to 150C to get rid of water. For this recipe, any plaster without additives {resins} can be used.

The recipe:

1. Put a measure of plaster in a pot. Keep adding water, while vigorously stirring, until you get a milky solution. The large amount of water will prevent the gypsum from setting.
2. Keep stirring for about an hour.
3. Stir /or shake/ every other hour for a whole day.
4. Stir /or shake/ once a day for a whole week.
5. If necessary, add more water so that it stays withing the consistency of, somewhat creamy, milk.

You have now prepared the ground solution. The remaining plaster can be left in the jar or allowed to dry to be used on the next instrument. If left dry, just add some water before using it again.

Application:

1. Put the milk first on the back of the violin, using a brush.
2. Before it sets, wipe off with a towel trying to remove as much as possible rubbing it at the same time into the pores. Great care should be taken especially with the edges of the plates and the areas of the scroll where most of the end grain is.
3. Let it dry. Don`t be alarmed at the plaster-like looks of the instrument at this point.
4. Take your colorless oil varnish. It should be of the viscosity of honey. Apply a patch of this varnish, the size of a quarter of the plate, with your brush, on the back plate. Right away, wipe off all the excessive varnish with a cloth so that a silky smooth surface of the color of honey remains. Move onto the next section.
5. When you are finished with the back plate, you can expose the new ground to UV for about ten minutes to harden it. Or if you have a varnishing cradle, just continue on the front plate.
6. Continue to the front panel, then ribs, then the pegbox and scroll. Work in small sections so that you can wipe off the varnish before it sets.
7. If necessary, apply to difficult end grain parts more gypsum and wipe off again, repeating the whole process {including varnishing} where needed. The whole surface of the instrument must be sealed having that silky sheen.
8. Put in your UV box or out in the sun and let dry thoroughly.

Special thanks to the Roger Hargrave for the recipe and application.

Category: Varnishing

Varnishing

Your violin should now be the yellow/brown/honey color, the ground properly dry and cured. Generally, when varnishing, you should watch out for the following qualities: color, darkness, thinness, transparency.

Color la yer

The next layer is the Madder tincture. Refer to the Madder tincture section on how to prepare the tincture. Make sure the tincture is the right viscosity and that it doesn't streak. Test on scrap wood.

1. Put one coat of Madder tincture on the back of the violin. Work quickly, wiping off any excess tincture with a paper towel. Let dry for at least an hour.

2. If the color looks good to you, apply to the remaining parts of the violin.

3. Let dry for at least an hour or two otherwise you risk dissolving the last layer when putting on a fresh one.

4. Repeat until you think its red enough.

5. Now you can accentuate some parts of the violin with more color. Study other violins which you consider good looking. The areas with more color are often the C bouts and the scroll. Use a small brush and/or your fingers.

6. Let dry overnight.

Color oil varnish la yers

Before you continue, make sure there are no fibers sticking out anywhere. Use a 1200 grade sand paper to make the surface even. Don't overdo it, you still want to retain the character.

Refer to the section Varnish recipes for how to prepare an oil varnish. The varnish can be colorized and darkened:

a) During the cooking / see the recipes.
b) By adding tar / darkening
c) By adding Madder lake / reddening

We will use options a and b, namely the Wood ash oil varnish, which has during its cooking been already colorized/oxidized by the Wood ash oil varnish which gave it a dark brown-yellow tint and add some tar the make its color even darker. We may use the option c if the violin seems to want more red.

1. Pour some of the varnish in a new jar.

2. To make the varnish darker, add a couple of drops of tar and check the result.

3. If the varnish is too viscous, add a little turpentine, stir and check again.

4. Put a drop on the back of the violin to see how it will look like.

5. If you feel its too light, add more tar but be careful not to add too much as that would render the varnish impossible to dry. A drop for a milliliter is ok.

6. If you feel it needs more red, get a glass table and mix a couple of grams of Madder lake into the varnish. A glass muller is great for that.

   Bear in mind though that adding this pigment will decrease transparency of the varnish. It depends on the size of the particles, so only finely ground pigment should be used. It is also a good idea to let the bigger particles of the pigment settle in the varnish for 15 minutes before varnishing.

   Put some of the varnish on the glass, add a bit of Madder lake pigment and using the glass muller, keep making circular movements with it to incorporate the pigment into the varnish. You shouldn't need to press down on the muller, just keep moving it about.

7. When you are satisfied with the color, try some of it on scrap wood and let dry to see how it behaves.

   The varnish before application should have the consistency of fresh paint. Too thick gives you streaks and is difficult to spread, too thin forces you to do too many layers.

Varnishing

1. Using a flat 25 mm wide brush put on the first coat of varnish on the back. Make sure there the distribution of varnish is equal without streaks and smudges. Work fast as the varnish starts to thicken in tenths of seconds. Try to work in areas, quarters which you should make perfect fast to move to the next area.

   If there are smudges or other defects, don't worry, you can wipe off the varnish with a cloth, which you should have handy at all times.

   If you cannot avoid smudges, it can be you are using a brush which is too coarse or the varnish is too thick or colored.

   If the varnish runs, you are probably using too much of it or it is the wrong type. There is a great amount of calcium in the Wood ash oil varnish to prevent the running.

2. If you are satisfied with the coat, using your fingers, go over the edge areas, corners and make sure there is no buildup of varnish there.

3. Move over to the top side. Again, work quickly. Make sure there is no buildup at the edges, corners and especially in the area of f-holes.

4. On the ribs, use the least amount of varnish here because it tends to collect underneath the overhangs and then flow towards the center creating an ugly patch.

5. On the pegbox and scroll again make sure you are using only the amount of varnish necessary. Go over the pegbox holes and collect any varnish buildup there.

6. Take a look a the whole instrument again and correct errors. A different viewing angle helps so does taking the violin outside and inspecting it under the sun.

7. Put the violin in the box or outside to dry. Allow at least a day or two per layer.

8. Use your finger to check how the varnish is curing. When it ceases to be sticky to the touch, you can go over the surfaces removing any zits and dirt with your nail. The varnish is considered sufficiently dry when your finger leaves no fingerprint in it after mild pressure for a couple of seconds at room temperature.

The number of color varnish layers depends on the thickness of the layers, their colorizing effect and common sense which says that less varnish, if possible, affects less the sound of the instrument. With medium thickness varnish layers, three should be enough, supposing the violin has been properly tanned and received some layers of Madder tincture before.

Drying

Oil varnishes need UV light to speed up the oxidization of oil. It is best and often fastest to put the violin out in the sun. For this, get a length of firm string {a fishing synthetic line is great} and attach it somewhere, where the sun shines most of the day. A tree branch is great. At the other end create a noose to hang the scroll of the violin on. The violin should freely rotate in preferably a light breeze.

It is important to keep checking the state of the varnish and the violin as a whole. A strong sun, especially without wind can make the violin very hot which can result in dehydration, cracking or blistering of the varnish.

Whenever there is insufficient sunlight, the usage of an UV box is preferred. Check the UV cabinet building section for more info. The cabinet should be spacious enough to allow plenty of fresh air around the hanging violin. Ventilation must be installed /in and out fans/ to supply that fresh oxygen needed for the catalysis process taking place in the varnish and also to prevent the violin from overheating and overdrying and cracks from forming. The key is to keep the temperature inside as low as possible. Putting a bowl of water at the bottom is a good idea, but it will not do much good if the temperature of the instrument itself is too high.

It is a good idea to measure the humidity inside the cabinet. In my cabinet it can get as low as 30 percent so I keep to limit the time the violin stays inside the box as much as possible with breaks /ie. outside during the day and in the cabinet at night/.

Either way, the varnish drying is, along with tanning, the most stressful time for the new violin so bear that in mind and check often.

The drying times are obviously based on many factors. For this reason to make sure every layer is dry enough, press your finger on in for a couple of seconds to see whether it leaves a print. By leaving a print I mean that the varnish will get visibly grooved not that you just leave a fingerprint as on a glass window. If the varnish is still plastic, it is not sufficiently dry. Repeat the test in different areas on the violin, especially if you have a reason to think that certain areas received less UV than others, ie. in the upper curves of the C bouts.

Oil varnish finishing la yers

Put on a coat or two of your colorless Wood ash oil varnish to form a protective layer. Following the lean to fat principle, this varnish should have somewhat more oil in it, making it slightly softer.

Category: Varnishing

Testing the varnish

1. Go over the whole surface and remove zits.

The varnish must now pass the print test in all areas.

1. Hold you finger on the varnish using moderate pressure for a few seconds and see if it imprints, and you can see the fingerprint imprinted plastically into the varnish.
2. Check in the areas of C bouts again, especially the upper C bouts sometimes have a hard time drying because of limited UV access. The areas where the varnish still imprints can be exposed to UV selectively, using a mercury lamp. 20 minutes is usually enough.
3. When the varnish doesn't imprint it is ready to be polished. With the varnishes used in this manual, this may be in about a day or two after the last coat.

Polishing

The goal of polishing is to remove: a] the errors in the varnish, small zits etc., b] that cheap sheen which comes with new varnish. At the same time you want to retain some of the surface's character and that of the wood underneath.

You need a cloth, mineral oil and tripoli.

Start on the back of the violin. Again, you want to remove most of the zits, and some of the "orange peel" texture. You don't want to make the surface look like a piano.

1. Take the cloth dip it in the oil and tripoli.
2. Using circular movements start polishing the whole surface. Make sure you cover the area evenly. Feel for any coarser particles under you fingers and remove them if found, as they might scratch the surface. Be careful in the areas of corners and the purfling edge as here you can easily cut thru the varnish.
3. When done, clean up the surface with a paper towel and see what it looks like. The oil residues will make the surface look somewhat unnatural, satin like, but you should get an idea about how the surface looks like. Again, don't overpolish.
4. If you want to remove the oil to see how the finished surface will look like, use a wet paper towel or a towel with flour as medium.

The same applies to the ribs.

On the front you may want to use a movement which goes along the growth lines which may have created a "corduroy" effect in the varnish which you don't want to remove. Again, be careful not to overpolish, just get rid of the zits but not the texture.

The same goes for the scroll.

1. When finished carefully remove the remnants of tripoli from all nooks.
2. Wash down with a wet towel or flour again to see the final sheen.
3. Let dry for a few hours to get the final look.

F-holes and pegbox staining

You can now decide, whether you want to make the inside of the pegbox and the f-holes any color or not. Some makers leave these parts just varnished, others stain or paint them. If you want to paint them, here you go:

You need a tube of artist's oil Burnt umber color, turps and a fine brush.

1. Squeeze out some of the color and make if of the desired consistency adding a little turpentine.
2. Paint the inside of the f-holes and remove any excess color on the top surface with a towel.
3. Paint the inside of the pegbox.
4. Let dry for a couple of days. The painter's oil colors have a comparatively long drying times. UV light doesn't help here. You could use some dryer additives to speed up the process, if you really need to.

The color, especially in the pegbox, can really be very thin, it doesn't have to necessarily cover a hundred percent. Think more about smearing the surface than putting a coat of paint on it.

When you are finished here, you can continue to the Peg fitting.

Category: Varnishing

1. Wood ash oil varnish
2. Madder tincture
3. Madder lake

Other recipes you may want to try out:

4. 1704 spirit varnish

Category: Varnishing

In this varnish, you have the option to use nitric acid to color the resin. If you decide not to use the acid, skip step 2 in the Preparation. The varnish will be less colored and great for the finishing coats.

Equipment

1. Hot plate preferably thermostatically controlled, with diffuser screen.
2. Thermometer. (maximum of 350° C will suffice). A candy thermometer or a cheap Radio Shack multimeter with a thermometric probe.
3. An enameled or stainless steel pot.
4. Lab spoon or glass rod for stirring.
5. Scales.
6. Coffee filters.
7. Fire extinguisher. (ready at all times)
8. A pipette or a dropper.

Ingredients preparation

Liquid wood ash

1. Burn preferably hard woods, a mixture of spruce and maple shavings is acceptable.
2. Put an amount of ash that is equal of that of resin {200gr} in a coffee filter.
3. Pour an equal amount of distilled water {200gr} in the filter and wait until all the water gets filtered.

Linseed oil thick ening

Cook 170gr of linseed oil for 1.5 hours - until it gets thicker and considerably darker.

Ingredients

1. 120gr Damar, 80 gr Calophony.
2. 65% nitric acid.
3. Linseed oil or Walnut oil Cold pressed.
4. 200gr Liquid wood ash.
5. 1/2 teaspoon - Slaked Lime.
6. Spirits of Gum Turpentine.

Preparation

1. Put 120gr of Damar and 80 gr of Calophony in your pot. Bring to 100C.
2. Bring to cca 170C and start adding 65% nitric acid. A pipette or an eye dropper are great for this. 50gr should be enough. Add a little, let bubble, stir, and when the reaction subsides, add more. {you can skip this step to obtain clear varnish}
4. Add 200gr of Ash water + 1/2 spoon of slaked lime, keep stirring.
5. Boil off all water.
6. Bring to 280C and boil for 10 minutes.
7. Thicken 170gr of linseed oil.
8. Warm up resin to 270C, add thickened oil.
9. Cook at 300C for approximately 30mins or more, until a successful string test, see bellow.
10. Remove from heat, warm up 100gr of turps to 100C.
11. Add stirring to 140C varnish.

Advantages

Gives a deep yelow/red/brown transparent color. Stable colors.

Disadvantages

Some people say the nitric part may negatively affect the varnish in time. If that matters to you, just don't add any.

String test

The string test gives you an idea about how well the resin gets bonded with the oil. A failing string test means insufficient bonding.

1. Place a drop of hot varnish into a glass of water, let cool for 5-10 seconds, pick up and pinch between your thumb and index fingers. As you pull your fingers apart a string should form.

2. Failing that, continue cooking until varnish strings. The longer strings it gives you, the better. 5 cm would be great.

Category: Varnish recipes

Madder tincture

Preparation

1. Steep Madder, Pernambuco and Tea {tannic acid serves as mordant} in warm alcohol for two days, in separate jars.
2. Concentrate the Madder tincture to one half by letting some of the alcohol evaporate.
3. Solve some ruby shellac in alcohol. Can be any alcohol soluble resin, such as shellac, mastic, sandarac, Venice turps. etc.

Putting it together

Madder tincture thickened to 1/2	30 gr
Pernambucco tincture	10 gr
Tea tincture	5 gr
Shellac ruby	10 gr
Ammonia / reddening	10 drops

The resulting tincture should have such viscosity which will allow you to brush the coat on without streaks but on the other hand not so thin that you would have to put on many coats.

The ground you use needs to be either neutral or slightly acidic and the varnish you use over the tincture should also be either neutral or acidic or an isolating layer of varnish can be applied.

Category: Varnish recipes

Madder lake preparation

This recipe is for those who want to prepare their own oil color from raw chopped madder root. You can as well skip this process and buy Alizarin Crimson oil color for painters.

Equipment

1. Enameled pot of at least 3 L capacity, {the solution must not get in contact with iron, similarly various glass cookery is not recommended, they may crack and spill the potassium carbonate}
2. A plastic bucket, preferably of white color to easily identify the sediment, cca 10 L capacity.
3. A precise thermometer, connected to an electronic relay which will turn the hotplate on and off to maintain a steady temperature.
4. A suction hose.
5. A funnel with coffee filters.
6. An empty bottle.

Ingredients

1. 180 gr chopped Madder root.
2. 60 gr Potassium carbonate.
3. 60 gr Potassium alum {Aluminium potassium sulfate}.

Preparation

1. Add 2400 ml of tap water into the pot
2. Add 60 gr od potassium carbonate and let dissolve.
3. Add 180 gr chopped Madder root, stir thoroughly.
4. Bring to 40°C for 36 hours . The temperature must not exceed 45°C for longer periods of time, otherwise the temperature sensitive Alizarin will turn brown. You may try to set 40°C on the thermometer and make its tip touch the bottom of the pot. Also, set the hotplate to its lowest setting. Stir occasionally.
5. Put a filtering cloth into a plastic bucket, put a sieve onto the bucket and pour the Madder root solution in it. Wring all the liquid out of the chopped root, remove the sieve.
6. Carefully lift the filtering cloth, tie it with a length of wire and hang it on a wooden stick across the top of the bucket.
7. Let it drain for a while and then squeeze out the rest of the lake.
8. Put 1200 ml of water into your empty pot and warm it up a bit {40°C}.
9. Add 60 gr of alum, stir until dissolved.
10. Add the resulting warm solution into the bucket with the drained Madder pigment and stir. The solution should froth profusely.
11. Stir occasionally for 3 days.
12. Add fresh water to the solution so that you fill the bucket to its brim.
13. Let it stay for 36 hours .
14. Drain the semi-clear water with a suction hose, stay well of the line of the sedimented pigment. If you are uncertain about the line, remove just one half of the bucket. Refill with fresh water and let the pigment settle for 24 hours .
15. Decant again and refill with water. Let it stay for 8 hours .
16. Repeat until you start draining clear water.
17. Put a funnel into an empty bottle. Put a coffee filter in the funnel. Pour the sedimented pigment from the bucket into the filter.
18. Let it filter for a couple of hours, or until the water no longer drips from the funnel.
19. Collect the sediment into a jar and start drying out, stirring occassionally.
20. When the paste gets too thick add a bit of thickened linseed oil and mix it in thoroughly.
21. Continue stirring and letting the mixture stand until it thickens, and adding more oil to keep it pasty. After maybe a week you should be left with just oil paint.

Consider warming up the paste if you want to speed up the process {40°C max}. To test that there is no water present in the paste, put a little bit on your finger and spread it on a smooth surface. If there is water, the paste will coagulate in a typical "watery" manner, if the water has been sufficiently removed, you will easily create a consistent "oily" layer on such a surface.

This smooth paint can then be directly added to your oil varnish.

Category: Varnish recipes

This varnish is great touch-ups. Should you need to correct anything after your oil varnish has dried, use this spirit varnish.

Equipment

1. Hot plate preferably thermostatically controlled. {for hot preparation}
2. A pot with something at the bottom to put the jar on. {for hot preparation}
3. Scales.
4. Cloth or pantyhose filter.
5. Glass jar.
6. Small jar.

Ingredients

1. 180gr ground Seedlac.
2. 30gr ground Sandarac.
3. 30gr Elemi.
4. 15ml Spike lavender oil.
5. Spirit

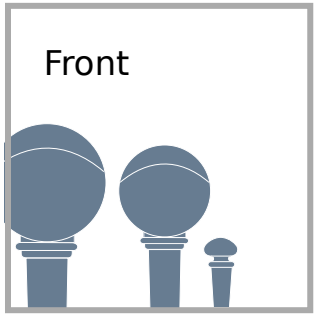
Preparation cold

1. Put all the ingredients in a jar and let dissolve for 2-3 days.
2. Shake occasionally.
3. Decant through a cloth or pantyhose.

Preparation hot

1. Put the Seedlac and Sandarac into the jar.
2. Fill the jar with spirit, just enough to cover the resins. Put on a lid, but don't screw it.
3. Put the jar into the pot.
4. Put the pot on the hot plate.
5. Fill the pot with water as high as the contents of the jar.
6. Turn on the hot plate.
7. Keep the water about 80 degrees for about 1-2 hours. Shake the jar occasionally.
8. When almost all the resins dissolved, turn off the hot plate.
9. Put the Elemi and Spike oil in the small jar and put it on the hot plate.
10. Stir occasionally until the Elemi dissolves.
11. Pour the warm Elemi/Oil solution into the warm Seedlac/Sandrac solution.
12. Decant through a cloth or pantyhose.

Category: Varnish recipes



1. Pegs and endpin
2. Bridge
3. Soundpost
4. Tailpiece
5. Strings
6. Setup tips

The pegs

To turn the pegs to a proper diameter you need a well adjusted peg shaper. I recommend the four hole shaper by Herdim. See the Tools section for more information.

Shaper setup

1. Make sure the shaper blades are very sharp {if sharpening, make sure the blades are resharpenable, HSS, not just surface hardened} and also that they project over the holes by 0.25 to 0.75 mm . They should also project over the fron side of the mouth opening by approximately 0.5 to 1 mm . This will allow for a close shave with no tearing.

2. Also, you need to make sure that the shaper blades are set to an angle that is perfectly in line with the holes the reamer does. For this, lightly insert the reamer with the round smooth part up and try to set up the blade in the shaper so that it both protrudes minimally, and is in line with the reamer.

3. You need to test the alignment on some scrap wood. Drill the 6 mm hole, preferably in maple, drive the reamer through it and shape a piece of hard wood, preferably ebony to match it. Put the shaped peg in the hole, turn quickly, pull out to see whether there is contact along the whole length. If there is, you have your reamer and shaper matched.

Shaping the pegs

1. Using a knife, make an incision around the circumference of the peg, right next to the collar. See the red line in Fig. 1 .

2. Insert the peg blank into the first hole where the shaper bites and start turning slowly.

3. Proceed to the smallest hole (8 mm width at the top here), again turning slowly and watching for any tear out, until you get to the collar. If for some reason the turning is not as smooth as you would wish, use a bit of dry soap for lubrication.

4. Repeat with the other pegs.

Reaming the pegbox holes

1. Insert the reamer into the smallest hole of the shaper and make a mark using a permanent marker about 1 cm in on the reamer. The initial reaming will be done up to this mark.

2. Insert the reamer in the first hole. See Fig. 2 for the order in which the pegs are positioned in the pegbox. Start turning the reamer while maintaining perfect vertical and horizontal alignment. When you have reached the previously made mark on the reamer, stop.

3. Insert one of the pegs, turn a few times. At this point the distance from the pegbox wall to the collar should be about 15 mm . Remove the peg to see whether the pegbox walls have left the shiny rings on the peg meaning there is a full contact with the holes.

4. Repeat with the rest of the holes.

5. Again, insert the pegs in their respective holes turning each quickly a few rounds. Then take look at each of them to see whether they are in perfect contact with both pegbox walls. A perfect contact is necessary for the pegs to be able to securely hold the pull of the string.

6. If all is fine, continue carefully reaming each hole so that the inserted pegs` heads are just a little bit over 10 mm from the pegbox walls.

7. Turn again each of the pegs a couple of times to drive them home. This will be their final position.

Finishing the pegs

1. Using your scribe, make a mark about 4 mm in from the inner pegbox wall at the side of the peg's head. Repeat with the remaining pegs. Make sure the marks are well centered.

2. At each mark, drill a 1,5 mm hole for the G, D, A strings and 1 mm hole for the E string.

3. Using your small round (needle) file, with a few strokes, create an in-set bevel at each of the openings. See the red elipse around the hole in Fig. 1 .

4. Now you need to trim the pegs to their correct lengths, almost flush with the pegbox walls. Take a scribe, put it on the peg shaft, right next to the pegbox wall on the side where the peg needs trimming. Turn the peg a few times, making a mark on it. Repeat with the other three.

5. Cut the pegs to their new lengths. To smooth out the ends and create the bevel, put a sheet to fine (600 grit) abrasive paper on your workbench and start making (drawing) circles from small to wide (a kind of a spiral) until you end up with a regular bevel. Finish in the same way on a yet finer paper (1200 grit). Burnish on a piece of linen (your pants).

Installing the endpin

To shape the endpin, the general rules described in the peg section apply.

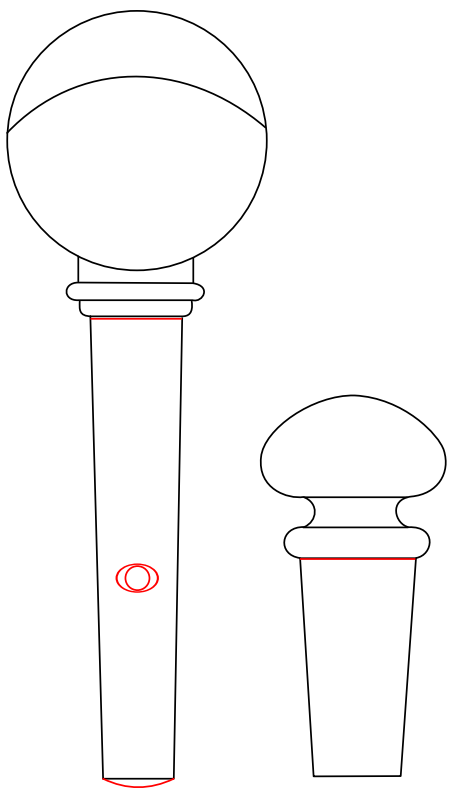
1. Assuming your equipment is set up properly, take the endpin blank and shape it in the largest hole available, which will produce an even shave.

2. Ream the end pin hole again with regard to maintaining horizontal and vertical alignment. Check the diameter constantly reinserting the endpin.

3. When the endpin is about 1 mm from being fully inserted stop. Put a bit of dry soap on it and carefully try to insert it fully. The endpin must sit in its position securely yet must be easy to remove so avoid using excessive force to drive it in. If necessary, ream the hole A LITTLE and try again.

Category: Setup

1



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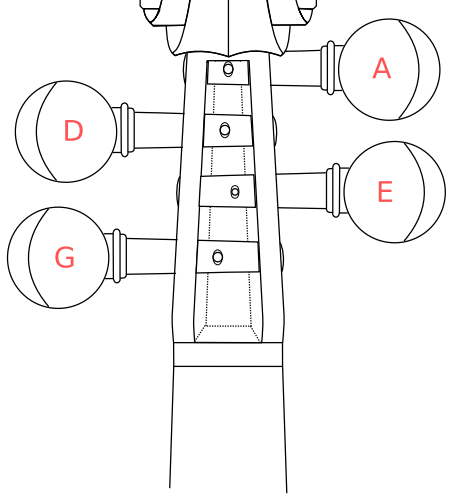


The bridge

The bridge, made of maple, serves the purpose of upholding the strings and transmitting the vibrations from the strings to the body of the violin. As such it must be both robust enough to withstand the pressure of the strings and light enough to transmit the vibrations freely.

Normally, you buy a bridge blank 41,5 mm width for the 4/4 violin and carve it to get the best sound. See Fig. 1 for a typical bridge blank.

The position of the bridge is marked by the inner nicks in the f-holes. The back of the bridge should be at right angles to the top plate, the feet of the bridge should be in perfect contact with the arching. See Fig. 2 . for the correct bridge position.

You also need to decide which side of the bridge is the front and which is the back. The medullary rays on the back side should have more dots than slashes.

The bridge feet

1. Make sure the back of the bridge is flat. Use fine abrasive paper on a flat surface and rub the back of the blank on it.

2. Turn the bridge over and in the same manner rub its front to get the thickness of 4.7 mm at the feet. To get to the 4.7 mm at the feet faster, you can use a sharp block plane (maybe holding it in your left hand upside down, while holding the bridge with the other) but be extremely careful not to chip away any of the fine tips and of course not to cut yourself. Keep checking the thickness often as it is easy to over-thin the feet this way.

3. Now to transfer the arching of the plate onto the bridge feet, put the bridge in its position and put a thin strip of paper or plastic (no more than 0.7 mm) on the arching, behind the feet. Take a fine pencil and with moderate pressure, transfer the outline onto the back of the feet.

4. Now use a sharp knife and start removing the wood along the lines (always cut towards the bridge center to avoid chipping). Keep putting the bridge on the violin and work towards the back of the bridge being at right angles to the violin top. At the same time try to eliminate the gaps so that the bridge "sits" in full contact with the arching. Keep fitting until the bridge has no gaps.

5. Get a strip of thin paper 2 x 6 cm . Take a soft graphite pencil and rub off as much graphite as possible on the paper where the bridge feet touch it. Blow off the excess graphite.

6. Put the paper strip on the violin top where the bridge should be, put the bridge on top of it, in its proper position and move half a millimeter from side to side to rub off some of the graphite on the bridge feet. Use only moderate force to avoid bending and inaccurate readings.

7. Remove wood where the graphite got rubbed on. Take your time. To remove just a tiny sliver, moisten the wood there a little. For the tiniest amounts use the knife to scrape the wood, rather than cutting it. Don't stop until the feet are in perfect contact with the top. At the inner tips of the feet, aim for about 1.5 mm in thickness.

Again, the perfectly sitting bridge has its back at right angle to the violin's top, is in full contact with it so that it doesn't rock when you lightly tap the violin body (the bridge freely resting on its feet, in its proper position).

The bridge arch

1. Put the bridge in position with the help of two rubber bands, each band fastened to the foot at one end and to the upper corner of the back plate at the other.

2. Sight along the fingerboard and mark its projected ends on the E and G side on the bridge. See Fig. 3 for illustration.

3. Remove the bridge and offset the previously made marks 4.5 mm higher on the E side and 5.5 mm higher on the G side. Again see Fig. 3 .

4. Create the bridge template in Fig. 4 . The template is best made of a sheet of plastic or aluminium. Print Fig. 4 out and transfer the outline onto the sheet. Cut out and refine the edges.

5. Using the template, connect the offset points "a" and "b" , as in Fig. 5 . The blue dotted shape is the template here.

6. Remove the wood from the top of the bridge down to the template line with your knife. Always cut "downhill". Retain an angle that is equal to both the front and back. Recheck with the template and use a fine file to finish the arch for now.

7. Pare away the wood on the first 5 mm creating a taper of 1.2 mm in thickness at the top using a knife. Again, "downhill" cuts only. See Fig. 6 . Finish with a file.

8. With your Vernier caliper transfer the width of 33-34 mm onto the top of the bridge. Put it slightly to the G side as you did on the nut.

9. Use a needle file to create shallow grooves.

10. Fit the G and E strings to adjust their heights. They should be 4.75 mm /G/ and 3.75 mm /E/, measuring their elevation at the end of the fingerboard. Make the strings somewhat tight for the true elevation to show, but not too tight to avoid bending the top, especially if you don't have the sound post in place. File away the wood under these strings, keep renewing the grooves until you get to the numbers. Make sure you don't drift from the position.

11. Restore the bridge arching by retracing the template and removing the wood and reshape the top to 1.2 mm again.

12. Mark the remaining two D and A string grooves equidistantly (cca 11.5 mm width) in between the G and E grooves.

Finishing the nut

With the strings on, take a look at their distance from the fingerboard at the nut. It should be 0.8 mm for the G string and slightly less 0.6 mm form the E string. Lowering the action here will lower the string distance overall, so check again the end of the fingerboard.

The grooves should be quite shallow, only one third of the string covered, so refinish the arch of the nut accordingly.

The front of the bridge

See Fig. 7. for the final thicknesses of the average bridge. To remove wood, you can use the bridge holder and a chisel or you can just hold it in your hands paring away the wood with your knife. For thicknessing, Vernier caliper can be used or the thicknessing gauge you used in the thicknessing of the plates.

Finalizing the contour

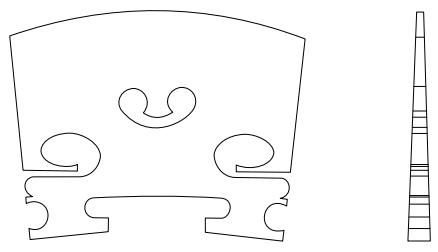
Fig. 8. shows you where to remove wood when finalizing the contours. Be especially careful when cutting the central part of the heart as chipping easily occurs. The left and right chamfers are always cut from bottom up to avoid chipping.

Burnish the bridge using a piece of paper with a bit of dry soap.

The weight of the finalized bridge ranges usually slightly above 2 grams. See the Soundpost section for the possible relationship between the bridge and the soundpost.

Category: Setup

1



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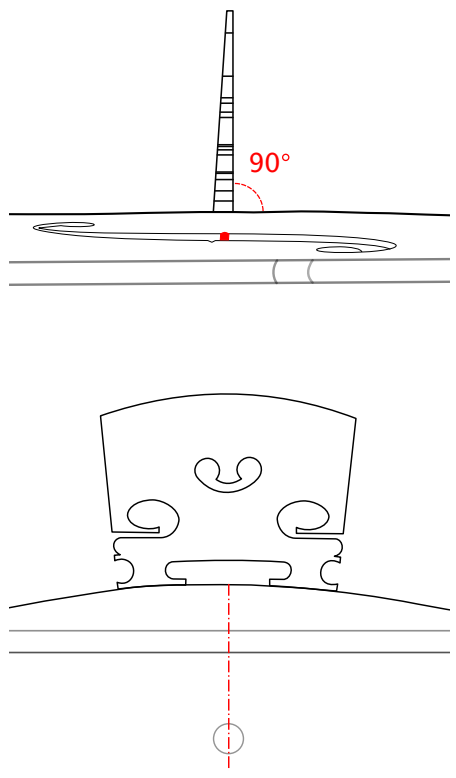

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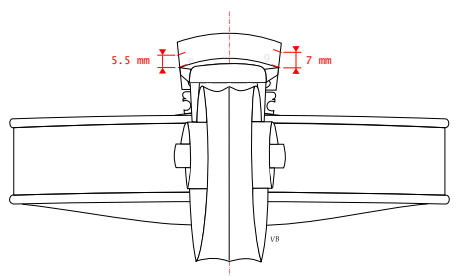

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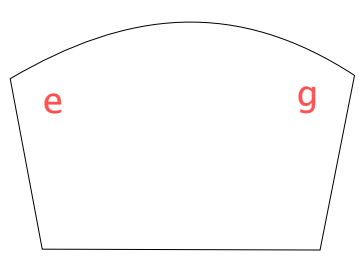

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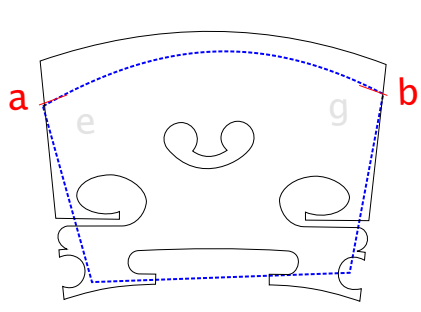

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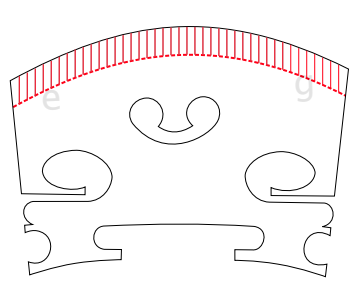

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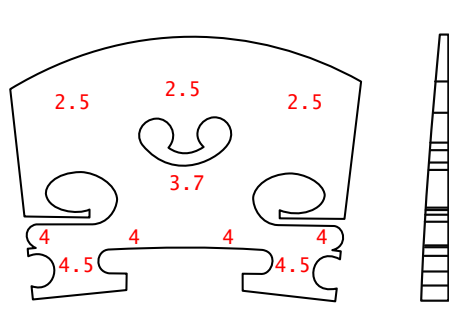

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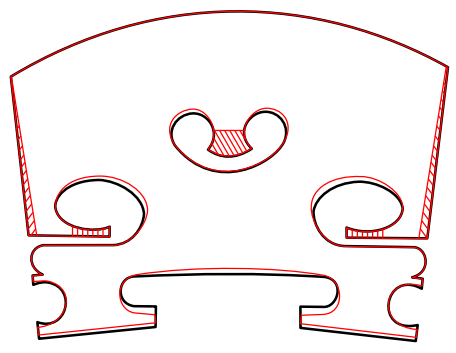

Measurements

The diameter of the finished soundpost is about 6 mm . The length depends on the arching, but may be a little above 50 mm in most cases.

To measure the required length of the soundpost, insert a pencil (or the soundpost blank) in the right upper f-hole eye at the right angle to the plane of the violin, until its tip touches the back plate. The point on the pencil level with the top of the arch at the center of the violin denotes the approximate length needed.

Choosing the wood

You need good quality spruce. It should be straight, and to ensure it has no runoff, it should be split. It should also be dense enough - ideally have around 5-6 annual rings in its final diameter (6 mm). The wood for the top plate is usually good for soundposts, but it varies in density, so split off a piece that has the required number of rings and is approximately 8 x 8 mm wide. The length of about 70 mm should be enough.

Now you need to round the stick, either by turning on a small lathe, or using your hand drill clamped in a vice, the stick fastened in stead of your regular drill bit. Use coarse {80} sandpaper and wrap it around the turning stick to remove material. Keep moving the sandpaper up and down the stick to achieve consistent thickness. When you have reached 6 mm everywhere, you are finished.

Or you can, of course, buy the soundpost blanks pre-made.

Cutting the soundpost

Use a razor sharp knife. Avoid files even though they may seem easier to work with in the beginning. The knife gives you the precision and flexibility needed. You know how much wood and where you have removed.

To cut the soundpost to its length, roll it on the table while making a cut around its circumference. When the cut is deep enough, you can break the soundpost off.

Now, to start fitting the post, you can try to insert it starting somewhere on point A. It will still be too long, so you will not be able to insert it farther to the side, to its final place, see Fig 1 .

Using a knife, the soundpost resting on your workbench, cut a sliver of wood from both ends and reinsert again. Try to get a feeling for this, do as many cuts as possible, trying to get thin slivers, to get the hang of it. You should be able to remove just part or the diameter or a whole consistently thick wafer if needed.

Fitting the soundpost

The default position for the soundpost is about 2.5 mm behind the treble foot of the bridge, see Fig 1 . You should aim to reach this position before adjusting the soundpost to change the sound.

The soundpost is held in position with the help of the soundpost setter, as in Fig 2 While the soundpost is inserted, you may keep the setter attached to the soundpost for easier manipulation.

This requires patience. Keep cutting and reinserting, inspecting the fit, also using the inspection mirror for parts where you cannot look. Perceive how both the top and the bottom plates are angled as you proceed more to the right side. The goal is to get the soundpost approximately in the position in Fig 1 standing at right angle to the plane of the plates, in full contact with the plates. Again, make sure the soundpost is perfectly perpendicular to the violin plane, both when you see it through the f-holes and the end-pin hole.

You can measure the position of the soundpost relative to the bridge foot using a simple strip of thicker paper, cut in the middle, as in Fig 3 .

Finalizing the position

Once you have reached the default position. Check everything sits perfectly, both through the f-hole and the end-pin hole, using the mirror. It is important that the soundpost be put in its default position with just light force.

You can now put on a set of strings together with the bridge and try the sound of the violin.

The soundpost serves as a kind of fulcrum for the top plate so its position influences the action of the plates, the bridge and the strings. With this in mind, you can change to a certain degree the timbre of the violin (and playability). With the soundposts position you not only change the spatial relationship between it and the moving parts but also the tension. The more east you go, the more tension you get.

Category: Setup

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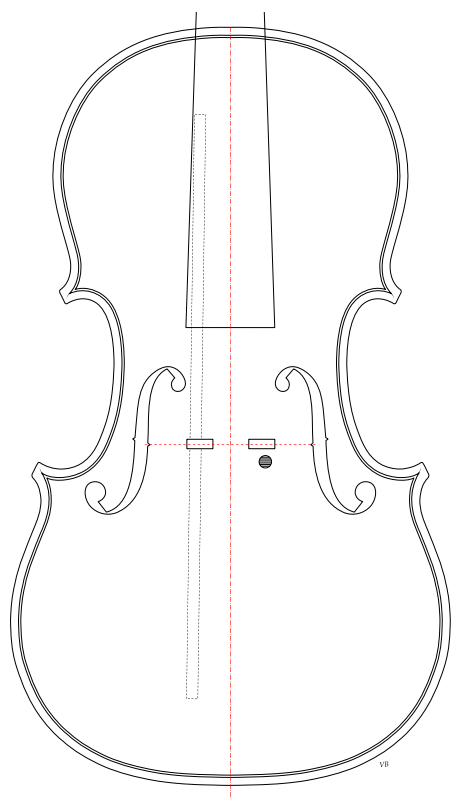

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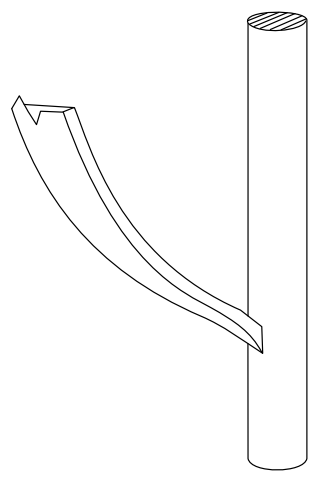

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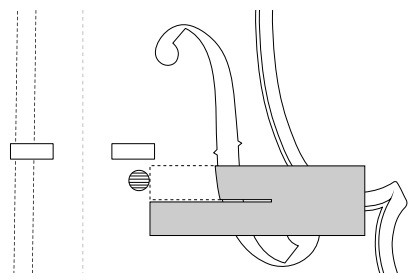


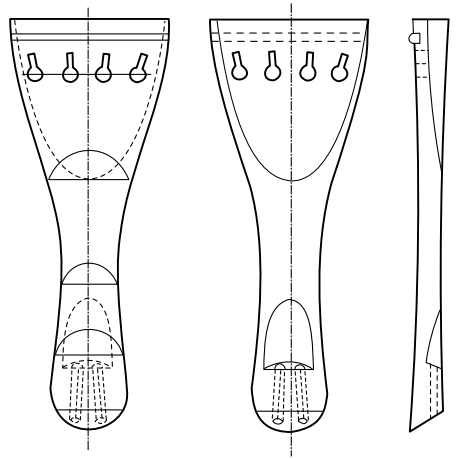
The tailpiece

The tailpiece can be made of many materials ranging from cheap plastic, aluminium to rosewood and ebony. With good instruments, quality ebony tailpieces matching ebony pegs should be used. See Fig. 1 for an example of a tailpiece.

The size of the tailpiece can vary, but properly positioned, the distance from its fret to the top of the bridge should be around one sixth of the string length from the bridge to the nut.

Most players prefer the fine tuner on the E string only.

1



Category: Setup

Stringing up

Stringing up the instrument, start with the G string, followed by the D, A and finally E string.

1. Make sure that at every turn of the string on the peg is laid down right next to the previous one. You are progressing towards the pegbox wall.
2. The last turn should end well off the pegbox wall.
3. The E string is the last to put on, and the first to unwind as it is the most likely to snap.
4. Make sure the bridge stays in its upright position, keep checking and readjusting as you are winding up the strings. Otherwise it might fall.
5. If you are using tuners, put some cloth underneath them to avoid scratching the varnish on the top plate.
6. After you have tuned all the strings to correct pitches, let the violin rest for a while and check back to re-tune. Especially with a new violin, as everything is settling down, the strings will have to be re-tuned a couple of times before they hold the pitch.

Category: Setup

Setup tips

A] The violin is not responsive enough. When played lightly, it does not sound good. It does not "want" to be played lightly.

First lower the pitch. If that helps, consider these:

1. Decrease the string length by moving the bridge forward by say 2mm. This should make the violin more responsive, but may decrease the overall strength of the tone.

2. Increased responsiveness can also be got by the decease of tension in the soundpost, either by moving it a little west, or by shortening it.

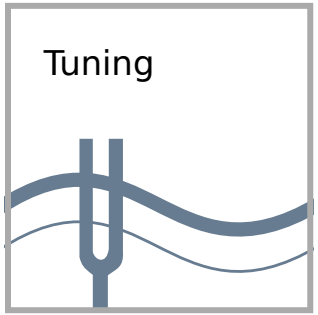
3. Increased responsiveness can also be achieved by using thinner strings. As previously mentioned, all this increased responsiveness costs you the strength in the tone.

B] The violin sounds bland, the sound is too soft, lacking strength.

Tighten the strings a semitone higher. If it helps, do the opposite of any of the 1,2,3 suggested above, or a combination of them.

If the tone of the violin is lacking carrying power, 1. Increase the distance between the bridge and the soundpost by moving the soundpost back a little.

Category: Setup



1. Free plate frequencies
2. Graduations - top plate
3. Graduations - back plate

Free plate frequencies

It is difficult to asses the relationship between the resonant frequencies of the free plates and the plates in an assembled violin. Some makers claim that free plate tuning is for that reason a waste of time. I think that using the following methods to measure the frequencies of the free plates as you are working on them can add to your understanding of how the sound system of the violin works. These methods are not a complete solution in themselves, but may help you produce, in time, better sounding instruments. With all these, you should keep a log for every violin you build so that you can refer back to it in case your instrument turns out to have an exceptionally good tone.

Chladni patterns

The free plates, when excited at certain frequencies, give exceptional responses. These responses can be visualized with the help of small particles. The vibrational response of the free plate can spatially be divided in areas with strong response {anti-nodes} and areas with with little response {nodes}. To get the strongest response possible, the plates should be fixed at points of as little vibration as possible {nodes} and should get excited in the area of anti-nodes.

Three frequency responses, or modes M1, M2 and M5 are considered important in violin plates although a number of other minor modes could be found.

See Fig. 1-3 for M1, M2 and M5 modes Chladni patterns. The red circle is where the driver {speaker} should be placed. The red rectangles denote the positions of foam patches which support the plate at the anti-nodes.

The speaker is connected to a power amplifier, which is in turn driven by a sinus signal generator, ie a PC with tone generator software.

1. Set up the plate upside down supported by the foam patches, see red rectangles in Figs.
2. Place the speaker at the position of the red circle.
3. As the detecting particles use black tea powder extracted from a couple of tea bags.
4. Spread the tea powder evenly on the inner side of the plate.
5. Controlling the tone generator, start a frequency sweep from 400 Hz down. The speed of the sweep should be maybe 1 Hz per second so that you notice when the plate starts to resonate.
6. First you should reach the M5 frequency. See Fig. 2 for the M5 pattern.
7. When you see the M5 pattern form, that's the plate's mode 5 frequency.

The same applies for M2 and M1 modes. The M2 should be somewhere about half of M5 and M1 could be above half of M2. For best results make sure the speaker is at the sweet spot and so are the foam pads. The anti-nodes should really have almost no vibrations at all while the rest should be vibrating strongly.

The patterns presented in Fig. 1-3 are for the back plate and top plate before f-holes are cut and bassbar added. The top plate with f-holes and bassbar installed generates slightly different patterns.

Application

So how is this helpful. First, the patterns should be in one word nice. Every plate is different and the wood varies in density but you should not have patterns that have gaps in them or are otherwise obviously a result of poor arching or wildly inconsistent wood.

Again, it is a visualization of the frequency response of the whole plate so if you happen to make a great violin it would be good to know how the patterns looked like.

Second, the patterns can help you locate mode frequencies you may otherwise have a hard time recognizing, either by ear or in software plots /more on both later/.

Measuring free plate modes by ear

The basic principle is the same here. The speaker is substituted by your knocking finger and the foam pads by your fingers. So you hold the plate at an anti-node, knock and listen for the dominant frequency response.

See Fig. 4 to learn where to hold the plates and where to knock. The top positioned "x" is the spot where you hold the plates, the lower positioned "x" marks the place where to knock.

Application

This serves as a quick method during plate graduation, when you need to keep track of how the modes keep changing based on where you remove wood.

For most people it is impossible, without any reference, to know what pitch in scale tones or Herz they are hearing. Here are some methods to reference what you are hearing:

1. Use a monochord. Knock and then tune the monochord to the pitch you are hearing to get the frequency.
2. Use a chromatic electronic tuner and whistle the pitch you are hearing.

Measuring free plate modes by microphone

The method is identical with the previously mentioned knocking so refer to Fig. 4 if you need to. Your ear is supplanted by a microphone and a computer software for analysis. This option will not only give you the the pitch of the mode but also a whole frequency "image" or plot of the plate. As this method seems to be the most commonly used today, we will describe it in some detail.

1. Download and install Audacity recording software.
2. Connect a microphone.
3. Hold the plate in front of the microphone and record a series of knockings.
4. In Audacity, highlight the sound wave or just the part of it you think is the most representative.
5. From top menu choose Analyze> Plot spectrum.
6. A windows shows up where you choose Size > 16384, Axis > Log frequency.

That's it. The plot you see, Fig. 5 is an example, is the graphical interpretation of the plate's frequency response. The mode you are holding and knocking the plate for should be the strongest spike in the spectrum. Again M5 should be somewhere between 300-400 Hz, M2 half of M5 and M1 above half of M2.

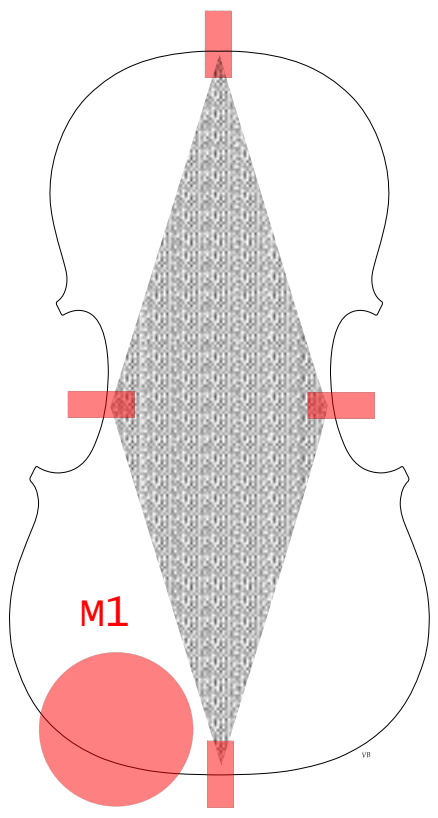
This works most of the time but sometimes, especially with M1 and M2 it can be quite difficult to locate. Chladni patterns can help you here.

Humidity

The plate frequencies are bound the the amount of water in the wood. Therefore, you should take your measurements in a stable environment. Humidity of about 47 percent can be considered ideal.

Category: Tuning

1



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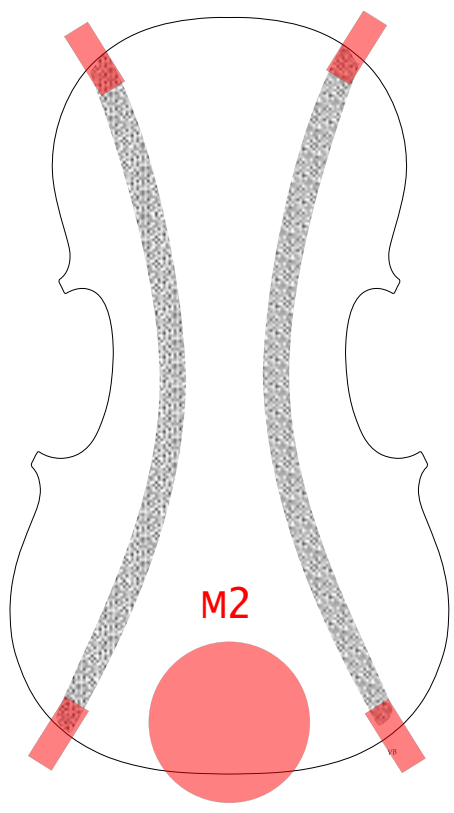

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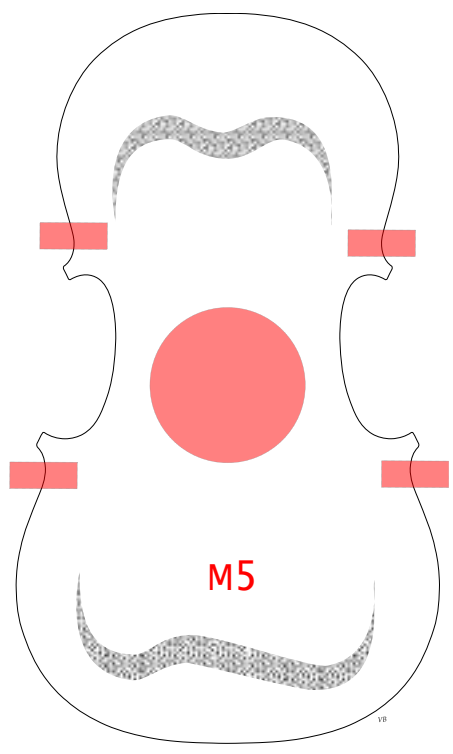

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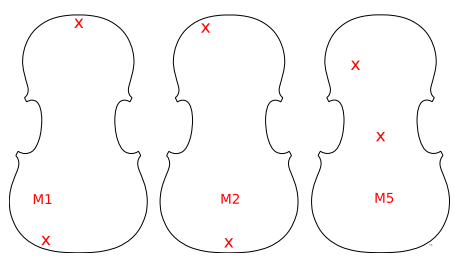

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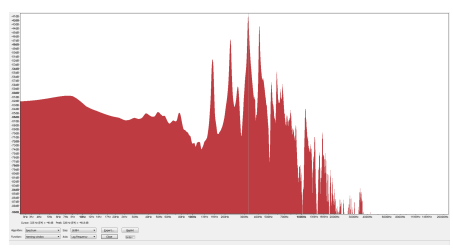


Top plate graduations

Graduations together with arching have a great influence on the resulting tone of the violin.

Graduation patterns

Before you start removing material, you should have an idea what graduation pattern you will choose.

a) membrane - uniform in thickness all over the plate
b) common - the most used system with the central part thicker
c) reverse - thinner in the center
d) spine - thicker along the center line

Each of these patterns has its acoustical qualities, which ideally are matched to the correct arching. It all depends on what sound you want from the violin.

In our violin we will use the common pattern which is also the pattern Stradivari used in many of his violins. This pattern is also best if you need to get the M5 frequency as high as possible.

Measuring variables

During graduation you will have to measure the following criteria:

a) Area thickness You will use the thicknessing caliper to measure the thickness in the area you are working on. See the Tools section for a description of the thicknessing caliper.

b) Mode frequencies These depend on the stiffness of the plate. The M5 frequency is the most important. Refer to the section on plate tuning to learn how to measure these frequencies.

330-360 Hz here is the accepted range for the common pattern. It shouldn't be more than the M5 in the back plate.

Look at Fig. 1 which describes how areas on a plate affect the mode frequencies. Therefore, for example, removing material in the central section number 1 lowers both the M5 and M2 frequency.

c) Weight Plate weight influences the ease with which the plate gets excited by the bow. 60-70 grams range for a finished plate with bassbar often considered is ideal. Too heavy a plate doesn't resonate freely enough.

d) Flexing Apart from measuring using instruments, you should also get a feel for how the plate feels in your hands. Flex the upper and lower bouts, twist the plate along its axis, flex the small areas in the bouts.

e) The stiffness index One of the numbers which describe the stiffness, weight and arching is the stiffness index. It really combines the a) and b) into a formula. The formula is (M5 frequency squared) * weight = stiffness index .

The ideal number for the common pattern is 8 000 000 for the front and 14 000 000 for the back {bulls eye}.

For our finished plate it is (333 squared) * 68 = 7 540 452.

Generally, the goal is to create a plate that is as lightweight as possible, while retaining as much stiffness as possible.

Thicknesses

In Fig. 2 you see the averages for 48 Stradivari top plates. The thickness maps are here for reference only so that you have some idea of the real thicknesses. Bear in mind that Stradivari used first rate wood which allowed him to graduate the plates thinner than you probably will be able to.

Graduating

Now you know what to check for, so you can start removing material.

1. Put the plate on something soft so that you don't dent the outside surface.
2. Use a small thumb plane. Make sure you don't remove too much wood in one place. Make the transitions between areas of different thickness as smooth as possible. Avoid overthining spots.
3. Keep checking the variables mentioned at the top of the page. First thickness, then frequencies, flexing, weight.
4. Create a table for your measurements, like the one below, to mark your progress.

Plate 4 mm uniform thickness:

mode 1	mode 2	mode 5	Plate weight
117 Hz	208 Hz	401 Hz	85 gr

Finishing

1. When you start getting close to finished, switch to your scraper and finish the surface smooth.
2. Measure again all variables and make a record.

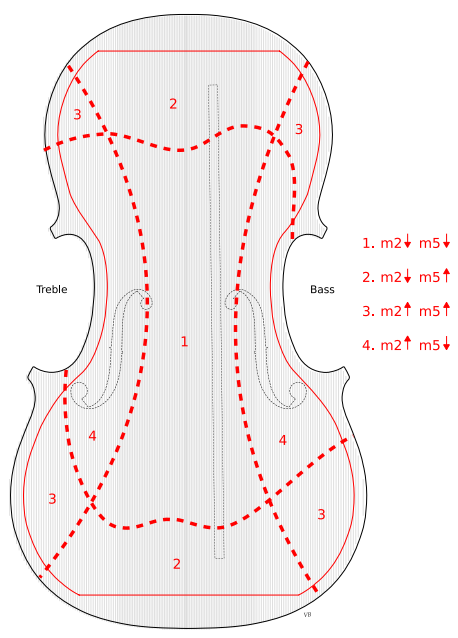
Finished plate:

mode 1	mode 2	mode 5	Plate weight
94 Hz	175 Hz	353 Hz	72 gr

The plate is finished for now. The numbers will still change after you have cut out the f-holes and after the bass bar has been added but not by too much. You can now proceed to the Cutting the F-holes.

Category: Tuning

1



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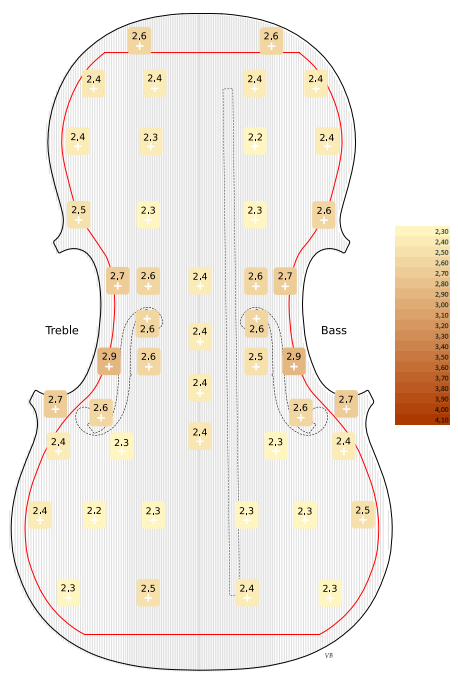


Back plate graduations

Refer to the section Graduations - top plate for all the information necessary to asses and graduate the plates.

Graduation patterns

a) bulls eye - thicker in the center in the for of a circle
b) spine - thicker along the centerline

For our violin, we will choose the most common bulls eye pattern. This is also the pattern Stradivari used, which is obvious from the average thicknesses in his back plates.

Thicknesses

In Fig. 1 you see the averages for 48 Stradivari back plates. You can distinctly see the bulls eye pattern used here with the thickest part right in the center of the plate. Again, these figures could be a little thicker. A good rule here is that the thickest part should be twice the thickness in the bouts.

Graduating

1. Rest the back on soft material to prevent dents.

2. Use a small thumb plane and start removing wood.

3. Keep checking the M5 frequency and the weight of the plate.

4. Create a table for your measurements, like the one below, to mark your progress.

Starting plate:

mode 1	mode 2	mode 5	Plate weight
* Hz	* Hz	430 Hz	143 gr

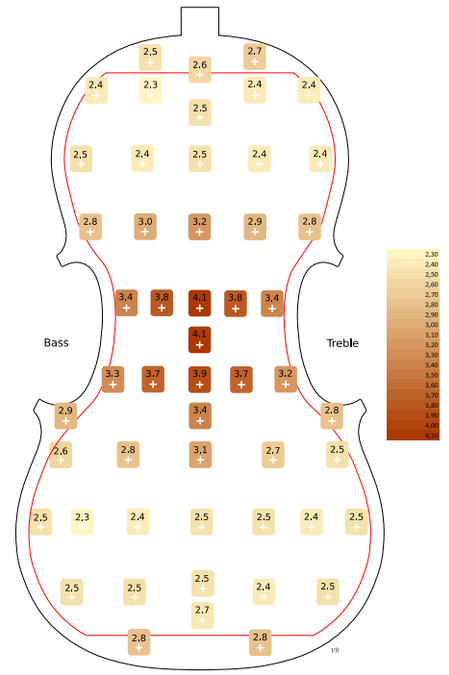
Finished plate:

mode 1	mode 2	mode 5	Plate weight
* Hz	* Hz	364 Hz	107 gr

Stiffness index: 14 177 072
(364 squared) * 107 = 14 177 072

Category: Tuning

1



Measurements of the Antonio Stradivari 'Messiah' 1716 violin, in millimeters

	Back	Belly	Misc
LENGTH taken from the side of the button	356	356	
Upper bouts	167.5	167	
Middle bouts, taken at the narrowest point	108.3	108.9	
Lower bouts	208	207.5	
Arching height, across arch, includes averaged edge thickness	15.4	13.8	
Stop length	bass 196.5	treble 195	
Corner width	upper 6.7-6.9	lower 7.0-7.2	
Purfling distance from edge	3.75		
Purfling width	white 0.6	black 0.4	total 1.4
Purfling depth back only	bouts 1.1-1.2	corners 0.8-1	
Overhang	bouts 2.4-6	corners 1.8-2.3	
Button	height 14.5	width 17.1	thickness 3.8
String length	328.5		
Neck length	129		

Average Measurements of the V iolin in millimeters

		1/4	1/2	3/4	7/8	4/4
CORPUS	length	285	320	335	345	355
	width					
	upper bout ca.	133	145	156	162	168
	middle bout ca.	91	97	105	109	112
	lower bout ca.	163	182	195	200	206
SCROLL	length ca.	85	94	101	104	108
RIBS	height - uniform	26	28	29	29.5	30
	thickness ca.	1.0	1.0	1.1	1.1	1.1
MOLD	thickness					12
LININGS	thickness	1.5	1.5	1.5	1.7	1.8
	width	4	5	5	6	6
BLOCKS size	upper	41/13	44/13	47/14	48/14	50/15
	lower	36/12	39/12	42/13	43/13	45/14
	upper corners	14/7	15/8	15/8	16/9	22/10
	lower corners	16/8	17/9	17/9	18/10	21/11
ARCHING HEIGHT	back ca.	13.2	13.7	14.1	14.3	14.5
	belly ca.	13.7	14.3	14.9	15.2	15.5
BACK average thickness at:	sound post	3.2	3.5	3.9	4.1	4.3
	upper and lower bouts 2	2	2.2	2.3	2.5	
	sinking (in general)	1.8	1.8	2	2.1	2.3
	sinking at center bout	2	2	2.2	2.3	2.5
	edges	3.1	3.2	3.4	3.7	3.8
BELLY average thickness at:	sound post	2.5	2.5	2.8	2.9	3
	upper and lower bouts	2.2	2.2	2.4	2.5	2.7
	sinking (in general)	2	2	2.1	2.3	2.4
	sinking at center bout	2.3	2.4	2.4	2.6	2.7
	edges	3.2	3.3	3.5	3.9	4
EDGES	overhang from ribs					2.2
CORNERS	width					7 - 7.5
	thickness, back ca.					4
	thickness, belly ca.					4.2
PURFLING	distance from edge ca.	3	3.1	3.2	3.3	3.5-3.8
	width ca.	1.1	1.1	1.1	1.1	1.2
FF-HOLES length	between ends of wings	62	68	71	73	75
	between upper eyes	35	36	38	41	42
	lower eye to edge	10	10	11	11.5	12
MENSUR: 2:3 proportion	belly	159	171	183	189	195
	neck to edge	106	114	122	126	130
	addition for mortise	6				
BASSBAR after fitting	length ca.	215	240	255	267	276
	thickness ca.	4	4	4.5	5	5.5
	height at center ca.	8	9	10	11	12
FINGERBOARD	length	215	238	255	262	270
	underside hollowing	60	70	78	90	100
	width at nut	20	21	22	23.5	24
	width at bridge end	35	38	40	42	43
	radius of curve	32	35	38	39.5	41.5
	thickness: end of neck	7	7	8	8.5	9
	thickness:edges	4	4.5	5	5	5.5
	projection (at bridge)	27				
	ht over belly at bridge end	16.5	17	19.5	20	21
	string angle at bridge	156°	156°	157°	157°	158°
NUT	thickness	4	4.5	5	5	5.5
SCROLL	width at eyes	42				
PEGBOX	width at nut	see fingerboard width				
	width at throat	14	15	16.5	18	19.5
	length ca.	60	65	68	72	72-76
	thickness of walls	5.5				
PEGS distance	a - g	40	46	50	53	55
	e - d	12	13	14	15	16
	protrusion, pegbox to collar	9	10	10	11	12
NECK, foot	overstand*	5.5	6	6	6.5	6.5
	angle	87°	87°	87°	87°	87°
	thickness including fingerboard	15/17	16/18	17/19	18/20	19/21
BUTTON	width	17	19	20	21	21
	height	10	11	11.5	12	12
SADDLE	length	32	33	34	35	36
STRINGS	spacing at nut	13	13.5	15	16	16.5
	spacing at bridge	26	28	31	33	34
	vibrating length: nut to bridge	267	287	307	317	328
	height over end of fingerboard					steel/gut
	e					2.5/3.0
	g					4/4.5
SOUNDPOST	thickness ca.	4	4.5	5	5.5	6
BRIDGE	width at feet	32	37	38	41	42
	thickness					4.5
	height ca.	30	30	32	32	33