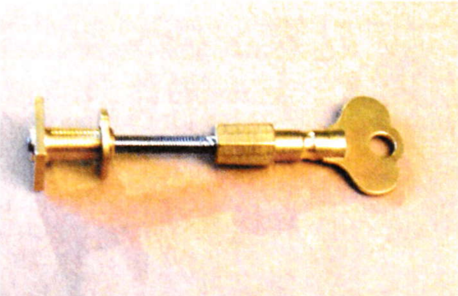
MISSION IMPOSSIBLE PART 1

In the first of a four-part series, **Shaun Newman** embarks on the making of a classical guitar with detachable neck, which is cleverly designed to fit into the overhead locker of an aircraft

SUPPLIERS OF MATERIALS, TOOLS & ACCESSORIES

- **www.stewmac.com** – for all materials, tools, plans, drawings and accessories
- **www.touchstonetowoods.co.uk** – for timber and tools, rosettes and bindings/purflings
- **www.tonetechluthierssupplies.co.uk** – for timber and a wide range of tools
- **www.luthierssupplies.co.uk** – for timber, tools, rosettes and tuners
- **www.madinter.com** – for exotic timber, tuners, rosettes and tools
- **www.tonewoods4luthiers.co.uk** – for beautiful, exotic timber
- **www.dictum.com** – for fine quality tools
- **www.londonguitarstudio.com** – for strings, sheet music and many accessories
- **www.magic-guitar-parts.com** – for good quality tuners
- **www.smallwonder-music.co.uk** – for inlay materials, purflings, etc.



2 The Staufer neck screw – 'Halsschraube'

Is it possible to make a full-sized concert classical guitar that will fit into a case capable of stowage in an overhead locker of an aircraft? Alternatively put: can you get a quart into a pint pot (**photo 1**)? Well, 'travel guitars' have been around for many years, notably instruments such as the Gibson and the Martin Backpacker, the Larrivee P-03, the Taylor BT2, the OF420 by Journey Instruments, and even the Yamaha 'Guitalele'. These guitars, however, would not always meet today's requirements laid down by most airlines for hand luggage that will fit into an overhead locker, the most common measurements for which are 55 × 40 × 20cm. Given that a full-sized concert classical guitar is normally around 1m long, and the smaller guitars mentioned above are not far off that, it does seem like an impossible task. Some manufactures claim their instruments, with a folding neck, will meet the measurement requirements, but on closer observation either the height of the case or the length will exceed most regulations, though some US internal airlines permit something a little larger than the average.

A further consideration is of course the quality of the sound. Other 'travel' guitars, apart from the ones with the folding neck, have simply reduced the size of the soundbox, and in most cases, shortened the string length considerably. This has a detrimental effect on the volume that the instrument can produce, as well as projection and breadth of the 'classical' timbre.

Some early thoughts

Before settling on a design, I was tempted to try out making a guitar with a folding neck, with the view to shortening both the string length by just a little and reducing the dimensions of the headstock where the tuners fit, while retaining as full a soundbox as possible. The folding neck is achieved through a clever internal hinge mechanism. I contacted the firm that made such guitars, but they refused to sell me a hinge, wanting to keep their 'trade secret' secret! Then, after much deliberation, I wondered if an instrument with a detachable neck could fit the bill, using a mechanism invented by the Austro-German luthier Johann Georg Staufer as far back as the late 1820s. The mechanism is simply a bolt, which passes through the heel block of the neck and into a threaded socket and nut in a second block inside the soundbox. Other makers at around the same time, notably Lacote, had also invented bolt-type mechanisms, but they were usually bulky and inelegant. Staufer's idea is simple and operated by a clock key with all of the mechanism hidden from view, bar a small entry point in the heel of the guitar.

Some time ago I had built a replica of a Staufer guitar, first made in 1830, and bought a mechanism, known as the 'Halsschraube' (neck screw) (**photo 2**). The customer, however, had decided against it during the build. His view was that the mechanism, which is essentially designed to enable the neck to be tilted to adjust the height of the strings over the frets (i.e. the action), might not be worth fiddling about with, and in any case, he never intended separating the neck from the soundbox at any stage, so the Halsschraube became temporarily redundant.

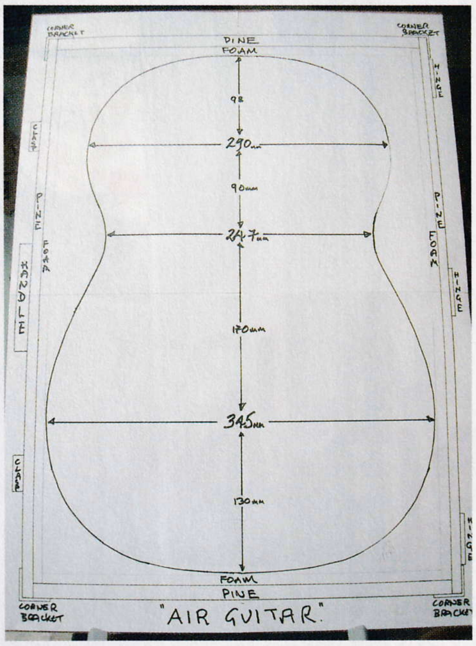
Inside-out thinking

Back to the construction of the 'air guitar'. From the outset, I felt that this instrument would stretch the ingenuity of any maker, and that I would need to work in ways to which I was thoroughly unaccustomed. I was dead right on both counts! The first task was to settle on body dimensions and string length. To get the fullest sound I decided to go for the standard Spanish classical string length of 650mm, and try to keep the upper and lower bouts (the width of the upper and lower parts of the body across the instrument) as near to standard as possible. I looked for my drawing of the 1963 Ramirez concert classical, which I have used time and again and began making up some plywood templates. It was only then that I realised I was on the wrong track. What I needed first was some sort of guide as to the external dimensions of the carrying case, so that I could work from the outside in, contrary to my customary way of working, which was the other away round. The breakthrough came when I realised that I should ditch my usual method of construction, which is to use an external mould and go with a workboard, a method not unique to this project and used by several makers.

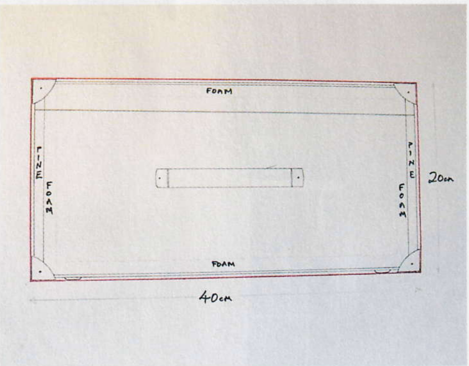
Outline drawings & the workboard

It seemed a good idea to first draw out the necessary dimensions so that I could see what I was dealing with. I began with a plan of the carrying case seen from above. I drew the outline of the maximum size of the case in red ink, which even had to account for the thickness of all external hardware, such as hinges, clasps, handles and the corner strengthening brackets. Some of these amounted to no more than 3mm each, but collectively had quite an impact on the internal space that would eventually be available. Then, working inwards, I drew in the thickness of the case sides, and the two ends, still remembering to allow for the external hardware. I thought the case sides could be around 1cm thick while the ends would be a bit stronger at 15mm. These lines were beginning to show me how much room I might have in the box. I decided to make the top and bottom of the box from 3.5mm ply, so also drew out a plan view of the case end. Next to come was allowance for padding. I had made several guitar cases before and found that

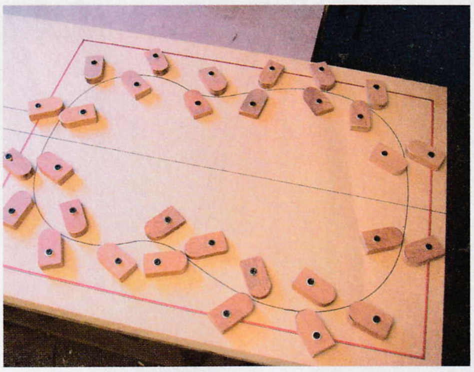
1 Will a quart fit into a pint pot?



3 Outline drawing of carrying case, seen from above



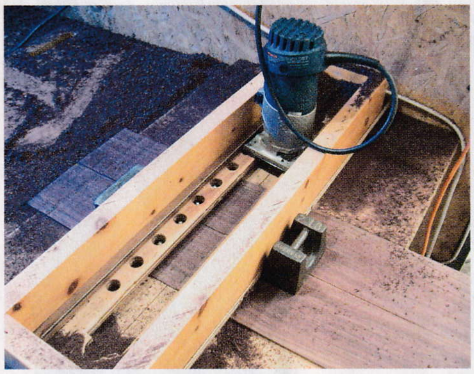
4 Drawing of the end of the carrying case



5 Cams screwed onto workboard to hold the ribs

1cm thick sheet foam rubber does a good job and is easy to cover with crushed velvet for a professional look. If 1cm thick foam is not easily available, I have in the past used a yoga mat, which worked well (**photos 3** & **4**). Next I bought a thick piece of MDF (25mm × 46cm × 85cm) and transferred the outline onto the board. This outline was drawn near the lower edge of the workboard.

So, I now knew what I was working with, and that was a space just 495 × 365 × 170mm. Finally, before the workboard could be put to use, I needed to find a way of holding the instrument in place during the construction process. In their excellent book *The Classical Guitar – Design and Construction*, first published in 1975 (see reading list), McLeod and Welford demonstrate a workboard in use and the key is to make a series of small hardwood cams, which are screwed to the board on either side of the outline of the soundbox on the guitar, working against each other. As the ribs are held flat to the workboard, alternate cams are pressed in towards the outline and screwed down tight. They grip the ribs (i.e. the sides of the guitar) firmly and prevent any movement during the various stages of the build. Each cam is around 40mm long, 25mm wide and 12mm thick with one end shaped on the disc sander to a semicircle (**photo 5**).



6 A homemade rib thicknessing jig

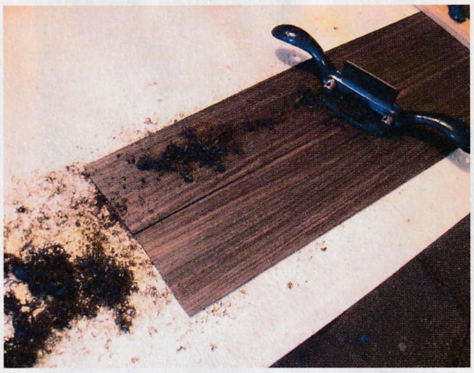
Preparing & fitting the ribs & tail block to the workboard

Once the outline has been drawn onto the workboard, the length of the ribs can be ascertained with a tailor's tape measure. I usually allow for around 25mm additional length at each end to permit a little leeway. The excess can be trimmed off after the ribs have been bent on the hot iron. In this case the ribs are each 580mm long, but initially cut to 620mm. On almost all classical guitars, the ribs taper slightly from the tail to the heel end. At the tail end, therefore, the depth is 94mm and at the heel, 89mm. The taper starts at the centre of the waist curve, i.e. around 290mm from the midpoint of the heel line.

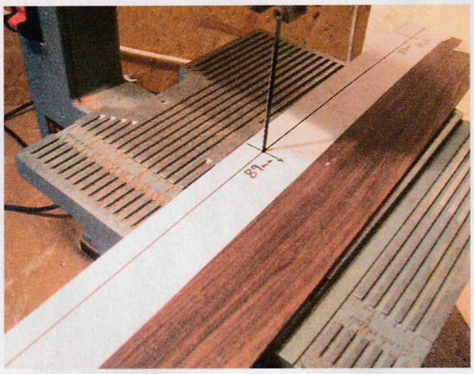
Before being cut, the ribs must be reduced in thickness from the 5mm or so, as supplied, down to 2mm. This can be achieved with a drum sander, with a jig made to support a router with a rebate cutter fitted (**photo 6**), or by hand with a power sander and scraper plane (**photo 7**). By hand the job takes a while, but the result is usually better than the other methods. The router jig is easy to make provided the base is dead flat and the sides are parallel. The ribs are pinned down with spherical rare-earth magnets from above and flat ones inset into the base. Weights also help to stabilise the ribs while the cutter is in operation. The device removes stock quickly but can be difficult to control. People often ask me how just 2mm of thickness can be strong enough, and of course the strength comes from the curvature of the wood. Also, anything thicker can be very difficult to bend. One or two makers insist on 4mm thick ribs – for example, the very famous Daniel Friedrich – but these are normally laminated with each layer bent separately.

The ribs are then cut to the correct taper (**photo 8**) before being bent into shape. To bend the ribs, a hot bending iron is required (**photo 9**). These are relatively expensive, so if the intention is to build just one instrument, it's probably not worth it. Homemade bending irons are easy to make, and instructions can be found in several YouTube clips. These often involve a gas-fired blowtorch attached to a piece of iron piping. In his book, *The Guitar Maker's Workshop*, Rik Middleton shows how to make one using a hot air paint stripper attached to a length of steel piping. If you make your own, be sure to not set fire to your workshop; they can easily overheat, especially the gas-fired ones.

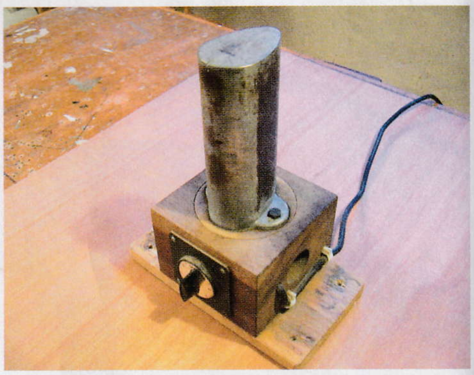
Bending the ribs can feel like a life shortening moment as there is always the sense that the 2mm thick rosewood could simply snap (**photo 10**). However, if the part being bent at any stage is kept wet, thus producing a steam cushion, and pressure is applied evenly and steadily with a rocking motion along the length of the rib, all should go well. It is important not to hold the rib against the hot iron without movement for more than a few seconds as it is very easy to scorch the timber, and some scorch marks can be very difficult to remove. If they are on the inside it is not too critical, but on the outside



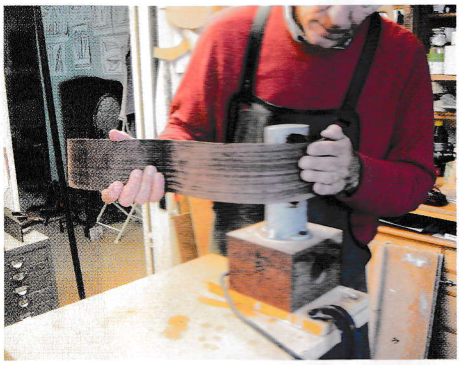
7 A scraper plane can be used to thin the ribs

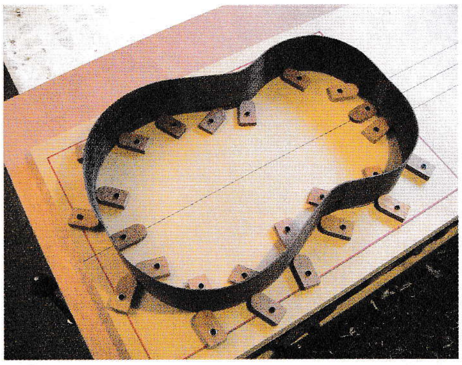


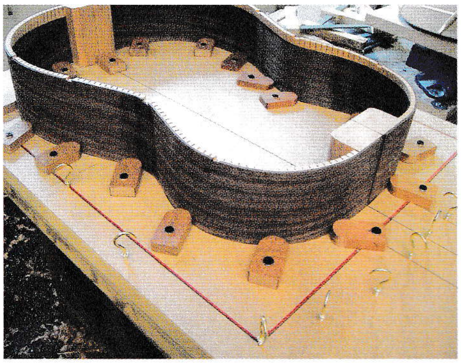
8 The correct taper is cut into ribs



9 A commercially available bending iron


10 Bending the ribs can feel life shortening


11 The ribs are cut to length and attached to the workboard


12 The heel and tail blocks dry fitted

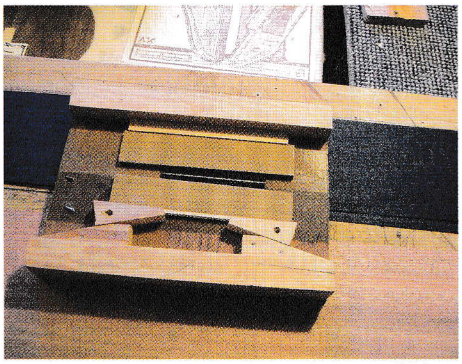
the appearance of the finished guitar can be seriously compromised. There is a good tutorial on bending ribs in Cumpiano and Natelson's book *Guitar Making – Tradition and Technology* (see reading list).

The heel & tail blocks

Once bent and held in place by the cams, the true length can be cut at the ends of each rib and preparations made to create a heel and tail block (**photo 11**). These blocks add strength to either end and, in the case of the heel, provides the point at which the Halsschraube socket and nut can be located. Both blocks are made from mahogany. The tail block measures around 106 × 70 × 16mm and has a gentle curve on one face to match the curve in the bottom of the guitar. The heel block is more robust and measures 91 × 75 × 35mm and can be kept flat, although Staufer used to curve the face that connected to the neck of the instrument. Each block should be exactly as long as the width of the rib where contact is made. A centreline should be drawn around the length of each block to ensure they sit accurately on the inside of the ribs, and exactly on the centreline of the workboard (**photo 12**).

Before the ribs and the blocks are put back onto the workboard and held by the cams, an inlay can be inserted onto the outside of the tail. This is to cover the join between the ends of the two ribs, and also offers the opportunity for some personalised decoration. Many makers choose to make very ornate inlays at this point; this one is a simple wedge shape made up from scraps of ebony and purflings that will match the eventual colour choices of the headstock veneer and bridge later in the build.

The inlay itself is made by first tapering a strip of 12 × 120 × 2mm ebony and gluing strips of white/black/white purflings (see suppliers list) along each edge. To keep the whole inlay flat and in place while the Titebond cures, a simple jig can be made from a flat piece of MDF and some lengths of pine 15 ×15 and 160mm long with wedges to push everything tightly together. It is really important to line the jig with parcel tape where the glue joins make contact with the base, otherwise everything gets glued together and you have to start again (**photo 13**). The housing for the inlay is first cut out with a fine dovetail saw (**photo 14**) and finished off with a sharp 6mm paring chisel (**photo 15**).

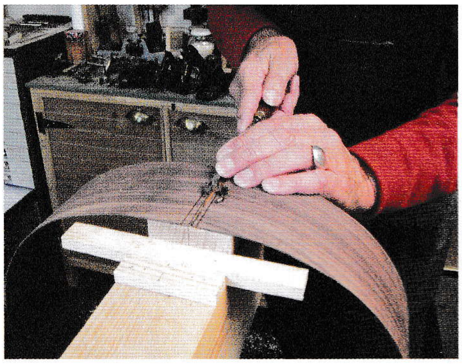

13 The tail block inlay jig

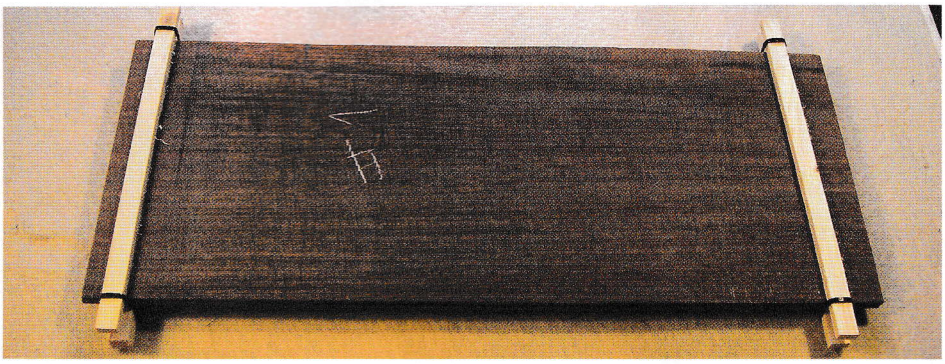
The back

At this point of the build I would normally make up the neck and head and proceed to fit it to the ribs. Because the Halsschraube mechanism needs a socket in the heel block, however, and the heel itself needs very accurate drilling, it is now time to fit the back to give the ribs some stability and to be in a position to line up the neck and heel correctly when it has been made.

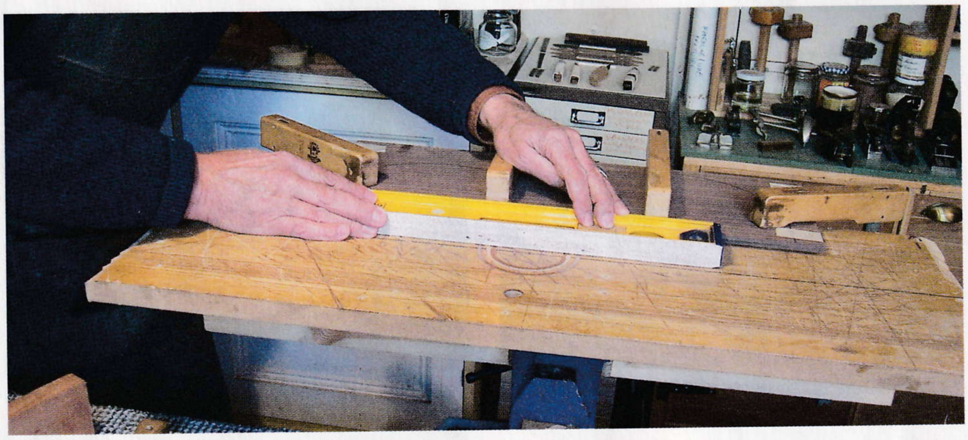
The rosewood for the back is supplied in two 'book-matched' sheets cut from the same log, measuring 560mm long × 240mm wide × 5mm thick (**photo 16**). The book-matching is to ensure a symmetrical pattern when the two boards are joined. To create a perfect join, the inner edges of the boards must be trued to exact right angles with absolutely straight edges. At this stage it is possible to put a decorative inlay along the centre join, but whether or not this option is chosen, the edges must still be dead right. I normally use my 50-year-old Record No.5½ plane to begin truing the edges (**photo 17**), but to ensure the edges are


14 Sawing the tail inlay housing


15 Chiselling the inlay housing


16 Book-matched back in rosewood as supplied


17 My old 5½ plane is used to true the back join



18 Spirit level sanding tool accurately neatens the back join

19 The wedge and lace jig for joining backs and soundboards

exactly at right angles to each other, I run a 90° sanding tool against them. This tool is a builder's spirit level fitted with 80 grit abrasive along each edge (**photo 18**).

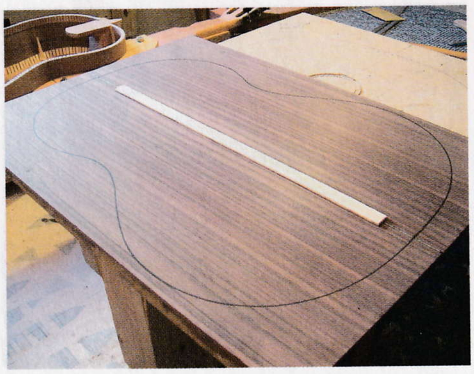
Once the join is determined to be perfect, which is established by holding the two edges together with a bright light behind to check for gaps, it is joined using a very old-fashioned device – the 'wedge and lace' jig. I have used this jig hundreds of times and it has never failed to give a perfect join. It is made from a length of floor joist and roofing 'scantling'. The joist is 600mm long, 134mm deep and 45mm thick, while the scantling is what traditionally has been termed 'two-be-one', with each strut being 510mm long. Lengths of thick nylon cord are attached to one end of each piece of scantling, which in turn has been housed at the halfway point into the joist. At the opposite end of the scantling a groove is cut to trap the end of the lace after it has been pulled tight. Each lace is around 3m long (**photo 19**). When the two halves of the back have been laced into the jig, long wedges are driven under the lacing and these push the two halves downwards while also pulling them tightly in towards each other. A clever bit of kit (**photo 20**).

The inlay that I chose was a simple strip of black/white/black purfling, which can be made by laminating veneer strips or are alternatively commercially available.

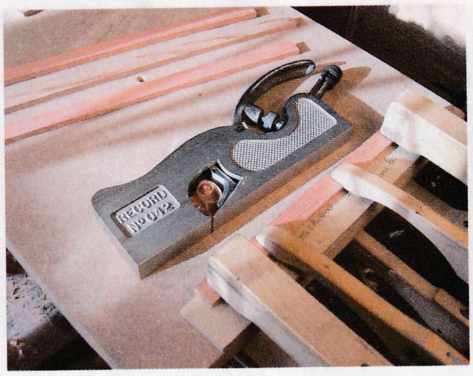
Once the adhesive has cured and the back is removed from the jig, it is time to bring it down to the correct thickness. Luthiers often dispute the correct thickness of the back, some saying a thicker one (i.e. around 3-4mm) will help to project the sound better, while others favour a thinner one to create a lighter and more responsive instrument. I normally settle on 2mm. This can be done by hand with an extremely sharp plane and finished with a scraper plane (**photo 21**). Some makers just use sanding machines,

20 The back in the wedge and lace jig with centre inlay

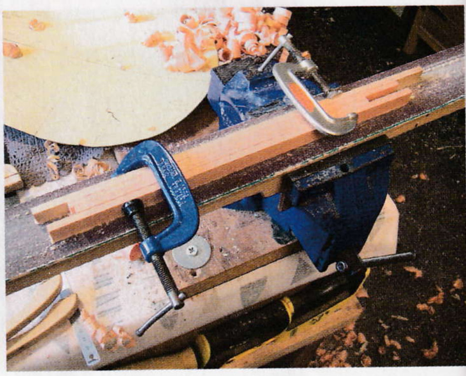
21 Thinning the back with a scraper plane



22 Back centre cross-banding strip in place

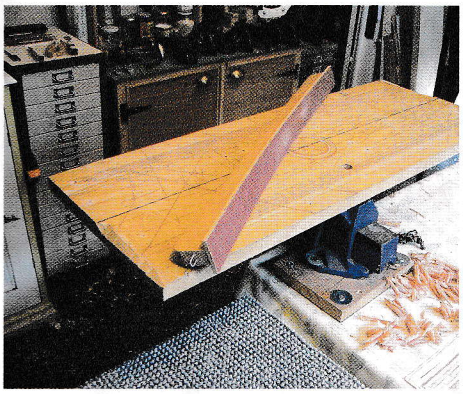


23 A shoulder plane cuts initial curve on the braces



24 A sanding stick completes the job but whichever method is used, the back will be extremely fragile when it is finished and requires a cross-banded centre strip on the inside to protect the join. This strip is made from spruce and is normally between 12-15mm wide and no more than 2mm thick. The edges are feathered down towards the inside surface of the back (**photo 22**).

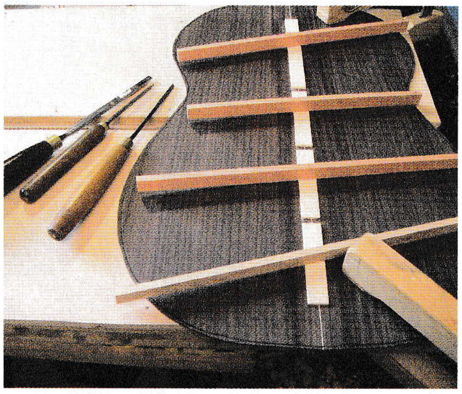
With the centre strip in place the back is more robust and can be prepared for bracing. Three or four braces may be used, each 12mm high, and 6mm wide. They are usually made from mahogany, but cedar or spruce are alternatives. Each brace is slightly curved to help produce a dish-like profile onto the back when it is put into place. This curve helps with the appearance, but most importantly acts as a sort of amplifier driving the sound out of the instrument. I usually begin the curve with a shoulder plane and finish all of the braces at the same time on a curved sanding stick (**photos 23 & 24**). This is made from a length of hardwood 145mm long, 40mm deep and 20mm thick and has a curve cut on the bandsaw. The amount of curve that I use is at a ratio of 3:145, which means that at the centre point of the back there will be a 3mm 'lift'. As the edges may be a little uneven when the hardwood



25 The curved sanding stick, which creates a 3mm 'lift'

strip is taken from the bandsaw, a length of thin plywood can be glued along the inside edge and this evens out any discrepancies. The plywood is cut to around 50mm in width (**photo 25**).

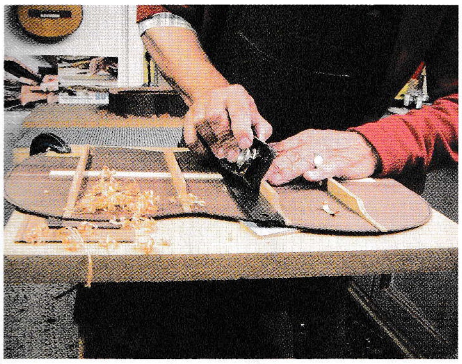
The brace bars must be fitted through housings in the centre strip and should be at right angles to the centre join (**photo 26**). If a right angle is not achieved, the bars look odd and out of line when seen through the sound hole. After they have been curved the bars are clamped into



26 Housing slots are cut in the centre strip for the back braces

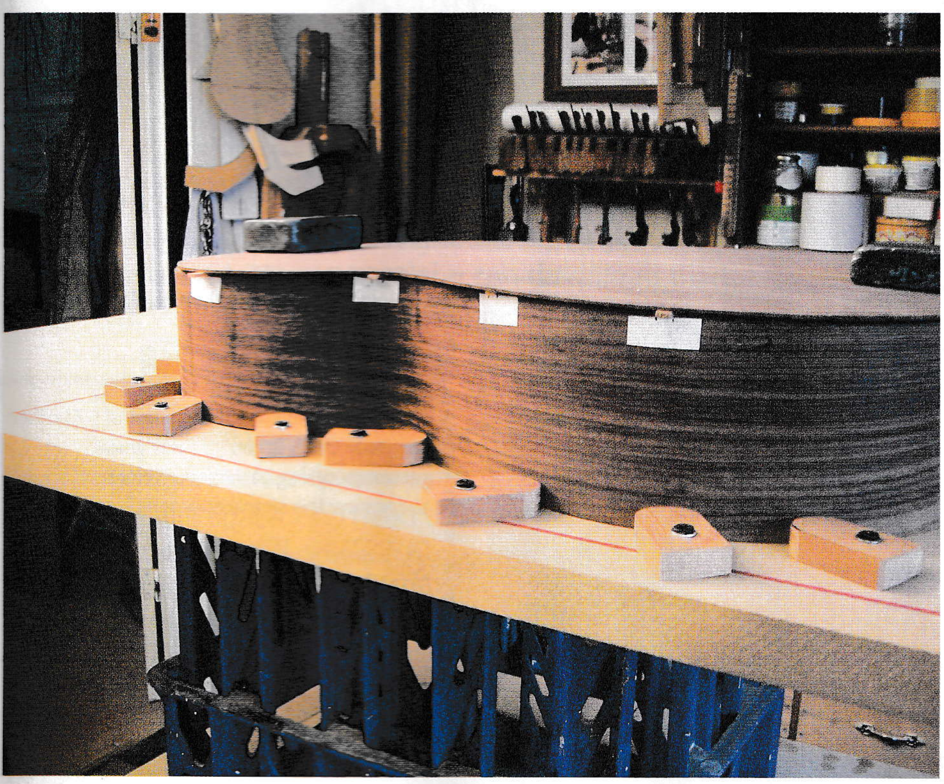
position (**photo 27**), eventually gabled (**photo 28**) and the ends scalloped (**photo 29**). This is to reduce weight and to allow for a smooth airflow inside the instrument. The ends of the scalloping are just 3mm deep and will be housed into the top edge of the ribs to ensure they do not pop off over time. The housing will at first be visible from the outside but will eventually be covered by the bindings, which run around the edges of the instrument for protection (**photo 30**).

27 Clamping the back braces into place



28 Gabling the back braces

29 Scalloping the ends of the braces



30 Small housings are cut into the ribs for the back braces

NEXT MONTH

In part 2 of this project, Shaun describes how the back of the guitar is fitted and bindings and purflings put into place

READING LIST

- ***The Guitar Maker's Workshop*** – Rik Middleton – ISBN 1-86126-040-7
- ***The Classical Guitar, Design and Construction*** – Donald McLeod and Robert Welford – ISBN 0852190778
- ***Guitar Making Tradition and Technology*** – William Cumpiano and Jonathan Natelson – ISBN 0811806405
- ***Making a Spanish Guitar*** – Jose Luis Romanillos – ISBN 13008619001
- ***Classical Guitar Making*** – John Bogdanovich – ISBN 9781402720604
- ***Making Master Guitars*** – Roy Courtnall – ISBN 0709048092
- ***Make Your Own Classical Guitar*** – Stanley Doubtfire – ISBN 0805238336
- ***Classical Guitar Construction*** – Irving Sloane – ISBN 0860012328