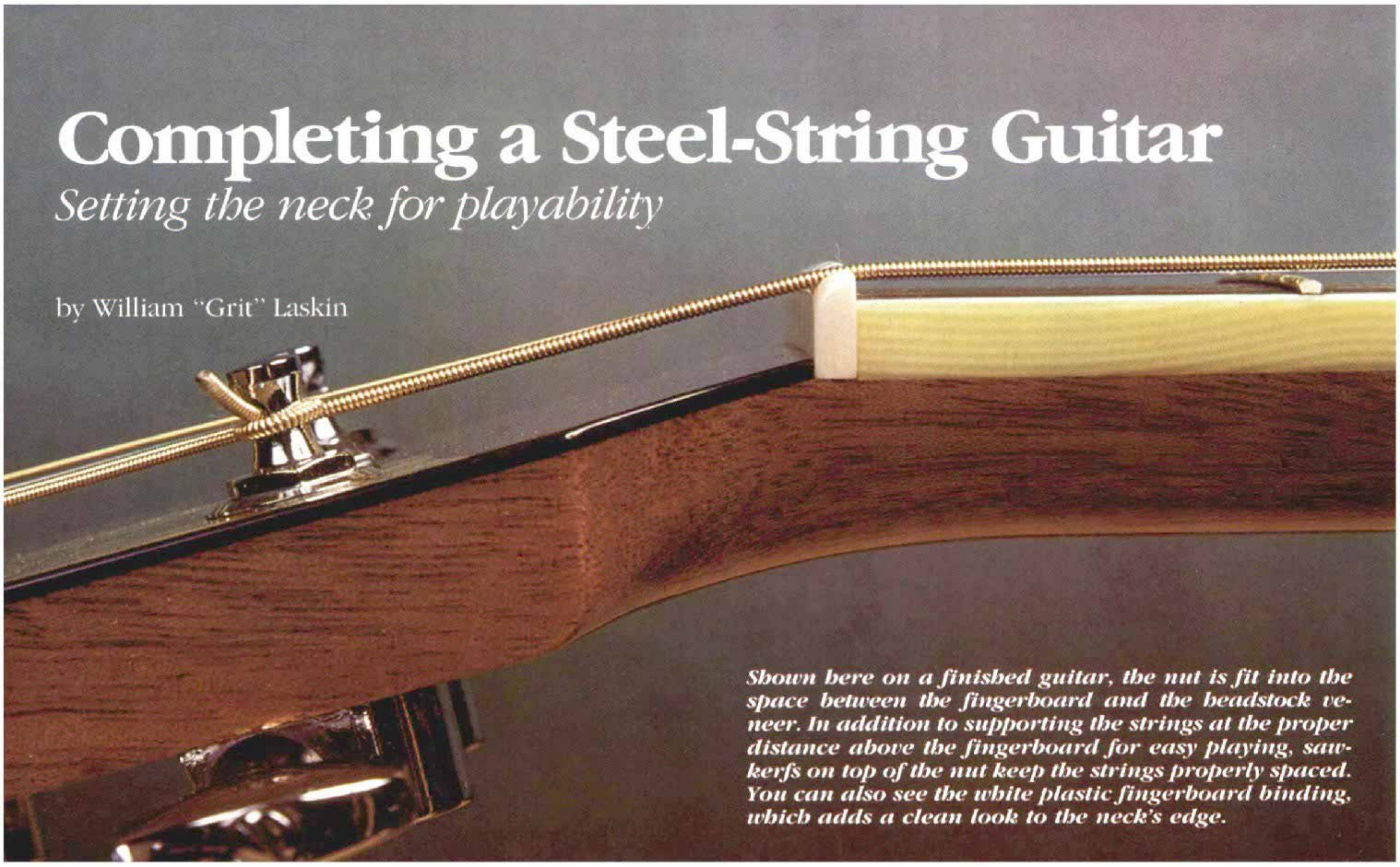
Completing a Steel-String Guitar

Setting the neck for playability

by William "Grit" Laskin



Shown here on a finished guitar, the nut is fit into the space between the fingerboard and the headstock veneer. In addition to supporting the strings at the proper distance above the fingerboard for easy playing, sawkerfs on top of the nut keep the strings properly spaced. You can also see the white plastic fingerboard binding, which adds a clean look to the neck's edge.

The differences between a mediocre guitar and a great one are pretty subtle, but these details are an essential part of producing an instrument that plays well. Once the basic guitar has been built, as outlined in *FWW* #67 and *FWW* #69, you're ready to delve into these final steps to complete the steel-string guitar, including dovetailing and setting the neck, fretting, and making the nut, bridge and saddle. I'll also cover some of the underlying aspects of guitar construction that determine setup, action and playability. Even if you're not building a guitar but are rather an admirer or player, you should still read on, because the processes discussed here relate directly to enjoying the instrument. This article isn't meant to tell you everything about the last stages of building and fine-tuning a guitar, but to provide the last part of the overview started in *FWW* #67 For more information on details and processes that I don't cover, refer to any of the guitarmaking texts either cited later in this article or in the bibliography in *FWW* #67, p. 49.

The first step toward finishing the guitar is setting the neck. Starting with a rough-shaped neck blank with the heel block and peg-head veneer already glued on, we'll proceed with the following steps: sanding the end of the neck so it will butt to the body at the correct angle, routing the male dovetail on the neck and hand-shaping it to fit the female dovetail in the body. Then the neck can be shaped and the fingerboard prepared, fretted and glued on. After fine-tuning the neck's back bow, which is the backward angle of the neck needed to balance the tension of the strings, the neck is glued to the body.

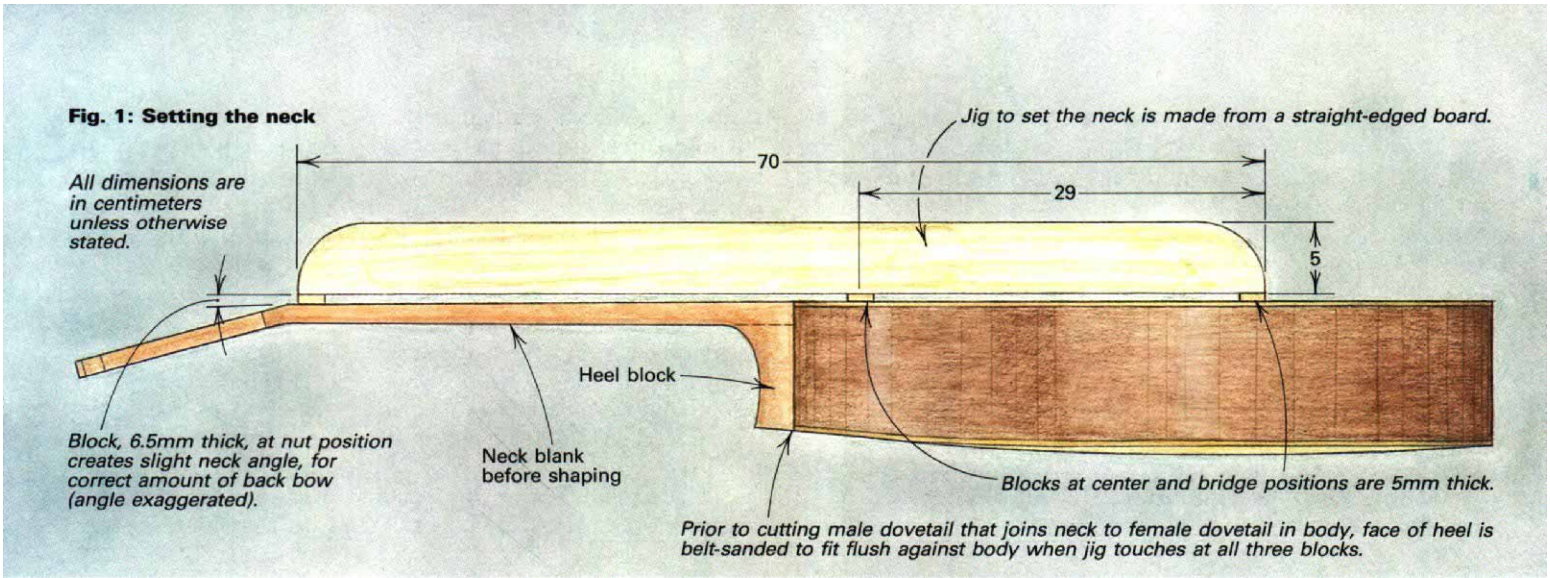
Neck-setting begins by machining the neck's heel on a stationary belt sander to flatten the surface and create the proper angle between it and the guitar body. This angle is determined with a simple gauge cobbled together from a strip of wood and three small blocks, as shown in figure 1 on the facing page. You'll also need to draw a pencil line down the center of the neck and the body, for laterally aligning the neck.

The heel face becomes the reference surface for routing the male dovetail, so sand carefully. Adjust the belt sander's fence to the desired angle (judge this by checking with the neck-angle gauge), and then sand a little and check again. The goal is to have all three gauge blocks touching the neck and top of the guitar with the neck butted up flat to the body. This positions the neck with the proper amount of back bow (more on this later). As you sand, lean the neck right or left as necessary, aligning the centerlines of bodi the neck and body. After sanding, use a square to mark a centerline down the face of the heel. This centerline is needed to align the template for routing the male dovetail.

In *FWW* #69, we routed the female dovetail into the guitar body using a standard ½-in. dovetail bit and a shopmade jig. We'll now use the same bit in the router table to cut the male dovetail to fit into the female dovetail. This time, a Plexiglas template rubbing against a ½-in.-OD bushing sticking up from the router table guides the cut, to ensure that the shape and taper of the male dovetail match the female exactly. Make the template by first laying a piece of Plexiglas over the female dovetail and tracing its oudine. Extend the tapered outline at the top and bottom, and cut out the template. After centering it on the heel, you'll need to slide the template up to compensate for the diameter of the guide bushing (see figure 2 on the facing page). Then, screw it in place, countersinking the screw heads. In the photo at the bottom of the facing page, you can see joint-cutting in progress, with the guide bushing against the template (seen projecting beyond the heel). To steady the neck while routing, clamp it to a board that extends slightly beyond the heel to be flush with the template. With the bit set to cut slightly shallower than the female slot in the body, take several light passes on both sides of the male dovetail, until the guide bushing rubs against the template. When completed, unscrew the template and chisel off the excess end of the dovetail until the neck can be gently tapped to slide most of the way into the female dovetail.

Because of the complexity of the neck dovetail joint and the

Photos: Brian Pickell; drawings: Vince Babak



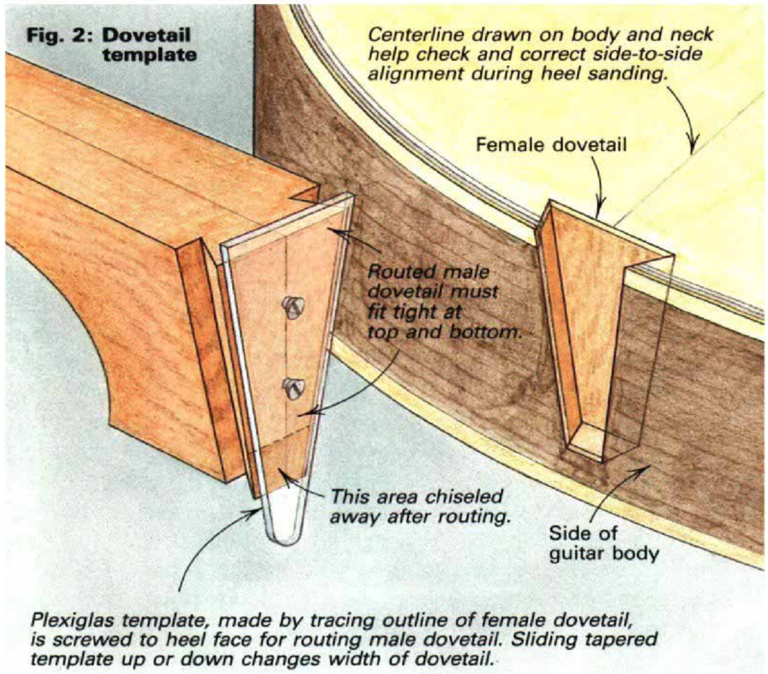
stress put upon it when the guitar is strung, don't expect to get a perfectly fitting joint right off the router table. Instead, aim to rout the neck's dovetail pin so that the neck will sit about 6mm proud of the body's soundboard. This extra 6mm allows you to final-trim the pin with a rasp and file. Trim carefully, and if you accidentally file off too much, glue a thin strip of veneer onto the dovetail and try again. When the neck fits tightly, yet is still 0.5mm proud of the soundboard, the joint is done.

Prior to routing a slot for the truss rod (the metal bar that reinforces the neck) and gluing on the fingerboard, handplane the top of the neck, starting at the approximate location of the fifth fret and working toward the joint. Remove a gradually deepening shaving until the neck is perfectly flush with the body. The result is a neck with a very slight kink in it. This kink, or back bow, is designed so that string tension will bring the neck into the proper line for good playing response without undue finger pressure or buzzing strings. The scraping done just prior to gluing the fingerboard will remove this kink.

The fingerboard—You're now ready to handplane the roughly bandsawn fingerboard blank to the proper taper: 44mm at the nut, 55mm at the 14th fret. Then, thickness-plane it to approximately 6.5mm. The slots for the frets are sawn next, a process described in any good guitarmaking text; my favorite is *Guitar Making: Tradition and Technology* by William Cumpiano and Jon Natelson (Rosewood Press, 31 Campus Plaza Road, Hadley, Mass. 01035). Although not all guitarmakers do, I like to add a binding to the edges of the fingerboard, using either wood, white plastic or imitation ivory. While mainly decorative, I find this binding enhances the look of the neck and hides the fret slots. Before setting the fingerboard aside, sand or scrape its bottom until it's either perfectly flat or very slightly concave. This is important for the fingerboard and neck to bond well when glued.

A steel-string guitar neck needs extra reinforcement to withstand the tension of six strings. There is a vast array of adjustable and non-adjustable truss-rod systems, but I've found that the simplest is one of the most reliable: a hollow ⅜-in.-square steel tube (available from the G.F. Martin Co., 510 Sycamore St., Nazareth, Pa. 18064). Whether you choose this style of reinforcement or venture to try an adjustable rod, there is one aspect worth noting: Routing the truss-rod slot releases tension in the neck, causing the top of the neck, which should be perfectly flat, to become slightly convex. The fingerboard may crack when glued to this surface, so use a stiff scraper to flatten the neck after slot routing.

Trimming and locating the fingerboard just prior to gluing are



The dovetail that joins the guitar's neck to the body is shaped on the router table. A standard dovetail bit cuts the male dovetail as the neck, screwed to a Plexiglas template that rides against a stationary guide bushing, is moved over the table.

well covered in the recommended texts, especially Cumpiano. In fact, other texts do such a good job of explaining how to carve the neck, final-sand and finish the guitar, and glue on the neck that I'll also not discuss these topics. Instead, I'll review some critical aspects of a guitar's proper setup. In my shop, I glue the neck, shape and attach the bridge, set the frets, and make the nut and saddle after finishing. So let's first look at adjusting the final set of the neck.

The relationship of the neck and body—Even though most of the neck's back bow is set when the neck is glued in place (after finishing), it must now be fine-tuned for best playability. When the guitar is first strung, the tension of the strings pulling the neck upward will bring the neck to its minimum playable position—dead flat. This is where you want the neck, as it allows for reasonably low action (height of strings above the frets) and comfortable playing. However, during the first 12 to 18 months it's strung, a neck usually continues to pull up slightly. Too little back bow may eventually cause string buzzing, and too much means the strings may be too high to play. Planing the fingerboard allows you to slightly adjust the degree of back bow and make sure it has a smooth, gentle curve. I also plane the radial curve of the fingerboard at this time. To do this, I first establish the back bow of the neck with the fingerboard flat, and then I shave a small amount off the fingerboard, taking care not to remove too much.

Confirming the correct degree of back bow is something I've been doing by eye and feel for more than 19 years. A neck that pulls up flat when first strung and bows up very slightly over time is the goal. I check the back bow by gripping the guitar in the heel area with one hand and pushing the neck upward, at the nut area, with my other hand. I then sight down the edge of the fingerboard to see that it lays perfectly flat under this simulation of string pull. It's not too difficult to judge when you have reached the limit of the neck's natural flexing: At that position, the fingerboard flattens out or is slightly concave. If it's not, you have some planing or sanding to do. To complicate matters, hammering the frets into the slots may increase back bow slightly. If your fret wire fits tightly, compensate by allowing a little less back bow. Also, the gauge of strings you use will effect back bow: The heavier the strings, the more they pull up the neck and require more back bow to compensate.

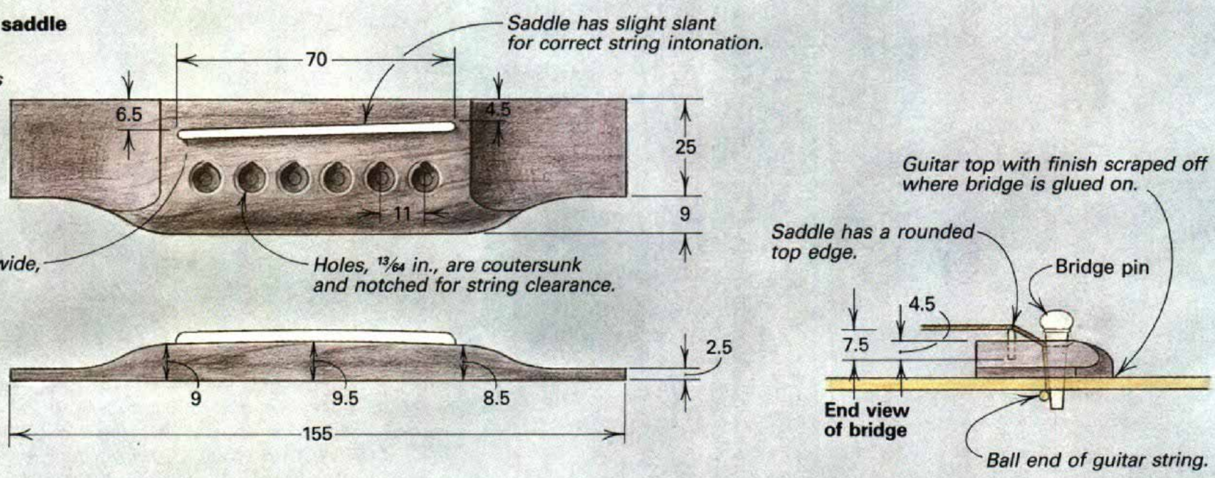
Fretting—An auto-body hammer, with its slightly convex head, is very good for fretting. I hammer in each fret by first seating one side securely, and then hammering my way across to the other side. Be sure the neck has some support directly beneath the fret you are hammering; once you reach the heel, neck support is not necessary. For the 12th through 16th frets, the heel and inner block themselves will be support enough. After that point, you must hand-hold a small metal block or some other dense object inside the guitar, beneath the fingerboard, as a support to hammer against. Check that the bottom edges of the crown of each fret sit evenly and flush against the fingerboard at all points—don't rely on final-dressing the frets (filing them flat) to smooth out irregularities in their heights. The edges of the frets are snipped off with wire cutters and filed to a shallow bevel. By filing very slightly into the edge of the fingerboard, you will recess the fret ends out of your hands' way as you play. To finish, scuff-sand the surface and edges of the frets with 400-grit paper or 0000 steel wool.

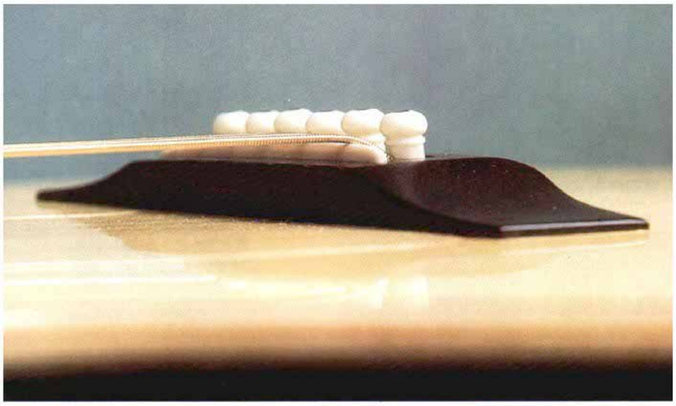
The bridge—The guitar's one-piece bridge, shown in the left photo on the top of the facing page, can be made from ebony or rosewood. Shape it to the dimensions illustrated in figure 3 below. I cut the saddle slot with a ⅛-in. two-flute straight bit fitted in the router table and guided by a template. A more simple approach would be to use a straight burr in a Dremel tool. Prior to gluing, I final-shape and sand the bridge to 240-grit and leave it unfinished. Accurate bridge location on the top is critical, so carefully check your measurements. The distance from the near edge of the saddle slot at the high E-string location is 32.7cm from the center of the 12th fret. The near edge of the slot at the low E-string location should be 32.85cm away from the same point. Once the bridge is located in relation to the scale length, mark the position of the edge with two layers of masking tape. The lateral position is located by stretching a taut thread to simulate the positions of the outer strings (both Es). Hold the thread approximately where the string would cross the nut and across its corresponding bridge pin hole. When the thread positions are equidistant from the edges of the fingerboard, mark the bridge edge with tape.

Now, cautiously scribe the outline of the bridge onto the top, gently cutting only through the finish with a surgeon's scalpel fitted with a new blade (both available from an art-supply store). If you use an X-Acto knife, hone the blade to razor sharpness to avoid chipping the finish. Remove the lacquer finish within the scribed area next by bubbling the lacquer with a hot chisel pulled backward across the area. This separates much of the lacquer from the surface and makes scraping off the remainder easy. Then, posi-

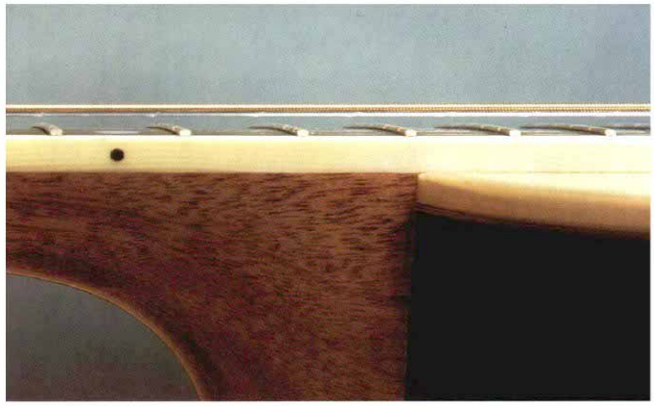
Fig. 3: Bridge and saddle

All dimensions are in millimeters unless otherwise stated.





The bridge and saddle on Laskin's guitar, shown here finished, anchor the strings, via pegs in holes, and transmit string vibration to the body, which then acoustically amplifies the sound.



The distance between the strings and the 12th fret, marked by a black inlay dot, is crucial to the guitar's playability. The distance is checked with a thread and any adjustments are made at the saddle.

tion the bridge and accurately tape around it. This will help hold it in place when gluing, a step well covered in the recommended texts. After gluing, the pin holes in the bridge are drilled through the top itself and then countersunk, and the guide slots for the strings are filed.

Nut and saddle—The nut is made first, shaped from a 7mm-thick piece of either imitation ivory or bone. Snugly fit the piece into the gap between the peg-head veneer and the edge of the fingerboard, as shown in the photo on p. 82, either by filing or sanding the nut. Then, trim the nut's ends flush with the neck. Now, draw a line parallel to the fingerboard's curve, but 1.5mm above it. File the nut down to this point, angling and rounding it on the peghead side of the nut For string slot positions, first mark the outer strings' locations 2.5mm from each edge and then divide the remaining distance by five, for equal string spacing. File each slot just wide enough to hold its respective string snugly, but not too tightly. To check slot depth, set a very thin straightedge into each slot and rest it on the second fret. You should be able to see a slight clearance (a few thousands of an inch) above the first fret.

The saddle, sawn and filed to the dimensions shown in figure 3 on the facing page, is fitted into the bridge next. It should fit snugly, but not so tightly that it won't seat properly or that it splits the bridge as it's pressed home. The top edge of the saddle should be shaped so its curve is equal to or slightly more exaggerated than the fingerboard's curve and so the top edge is 1mm lower on the treble side than on the bass side. Establish this height by stretching a thread from the nut to the saddle and measuring its height at the 12th fret. When the distance between the top of the fret and the thread is approximately 3mm on the bass side, mark the saddle where the thread passes it. Repeat this on the treble side when the height of its 12th fret is approximately 2.5mm. Should these measurements produce an action that is slightly high when you string the guitar, plane or scrape material from the bottom of the saddle. If the action is slightly low, place a thin ebony shim into the bottom of the saddle slot. Finally, I sand the nut and saddle down to 320-grit and then give them a quick polish on my buffing wheel using buffing compounds—the same fast-cut compounds I use to buff out the finish of a guitar.

Assuming that you have followed me and the suggested companion texts all the way through the construction of a steel-string guitar, let me now say "dig in!" String it up, play it and be proud as hell. For persevering with a uniquely difficult woodworking project, you deserve all the credit you can get. □

Grit Laskin is a guitarmaker, performer and author living in Toronto, Ont., Canada.

One of the joys after enduring the long process of building a guitar is finally being able to string and play it. Here, Laskin, tuning fork in mouth, tunes up his latest creation.