Turning Federal Reeded Legs

by Bruce D. Wedlock

Introduction

When the New Hampshire Guild's Period Furniture Group was formed a couple of years ago, the members agreed to build Federal style tables to learn the decorative skills of inlay and stringing. Having built a couple of simpler tables, I decided now was the time to tackle a work table in the Federal style for my wife, who is an avid knitter and stitcher. Many of the originals sported turned, tapered reeded legs, which would be a new challenge for me.

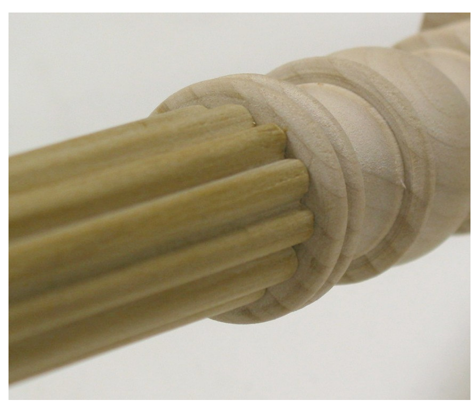
The method of forming the tapered reeds, popular with masters like Alan Breed and Phil Lowe, uses a simple scratch stock with the leg mounted in a lathe or jig. This method is described in *Fine Woodworking* No. 163, pp 62–65. Phil Lowe has a *Fine Woodworking* video showing a complete leg construction in detail at http://www.finewoodworking.com/subscription/sheraton-leg-video-series/. You will need to log in to your FWW account to view this.

There are two methods for cutting the reeds in a leg: using a router or a scratch stock in a jig. Both are described well in *FWW*. One router method is covered in No. 138, pp 56–57, and I showed it this jig the PFG meeting in September 2009. I was not happy with the results, so I set about finding a better method.

The May 2009 *Woodshop News* (p 39) also had an article on a jig for reeding tapered legs, but with little detail included. However, it did advance the concept of separating the bottom of the taper from the foot with a dowel joint, which greatly simplifies the transition from the longitudinal tapered reeds to the transverse bead on the foot. Why not do it at both ends of the tapered section, dividing the leg into three parts? An additional advantage is that if one part is not satisfactory, only that part needs to be redone; the whole leg doesn't have to be scrapped.

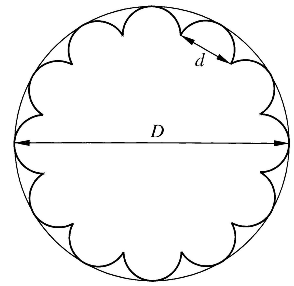
Fortuitously for my table project, *FWW* published an article on this technique in September 2010, No. 214, pp 70–75. The reeding jig's design was well described, so I set out to try this method. Along the way I found the need to explore the reed geometry and to make several gauges to accomplish the set-up accuracy required for perfect reeds – information missing in the *FWW* article. We will discuss these techniques here.

Leg Parts



The three parts of the leg are shown above. The top (pilaster end) and foot are conventional turnings with a bored mortise on the mating end of each. The centered tapered section has turned tenons to mate with the top and foot. Note how cleanly the tapered reeds dive into the surface of the bead. This is a major time saver over hand scraping the reeds and carving the interface.

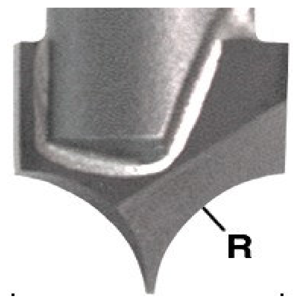
Tapered Reed Geometry



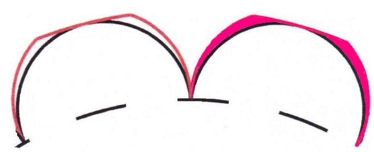
For a good result it is essential to understand the geometry of the reeded leg shown at the right. The detailed calculations are available by request at wedlock@alum.mit.edu , but for our purposes, we will just use the results. For twelve semicircular reeds of diameter *d* close spaced around a circle, the overall diameter *D* is given by $D = 4.74 \times d$. For example, if the reeds are 1/4" in diameter, then the outer diameter of the leg will be

$$D = 4.74 \times 0.25'' = 1.18''$$

so a 1-1/4" upper diameter will work quite well. The factor 4.74 is for twelve reeds; this factor will be 3.41 for eight reeds, 4.08 for ten reeds and 6.03 for sixteen reeds.



The reeds will be routed with a point cutting round over bit. These are available with a radius from 1/16" to 1/2", but for tapered reeds 1/8" or 3/16" are most useful. The cutter radius *R* should be chosen as close to but greater than the largest reed radius, *d/*2, that you plan to cut. When the reed radius is less than the cutter radius, there will be small flats on the top of each reed which are easily smoothed by scraping and sanding. If the reed radius is greater than the cutter radius, the resulting reed shape will be like a Gothic arch and less than the desired leg diameter when rounded over.



A sketch of the routed reed when the cutter radius and reed radius are equal is shown at the right. The black line shows the desired reed shape, and the red line shows the actual cut. The red shaded area is the material that needs to be removed by scraping and sanding. The reason the cutter and reed of equal radius do not match exactly is that the cutter geometry is designed to cut on a flat surface, while leg reeds are cut on a cylindrical surface. This causes the reeds to “tip” away from the cutter resulting in the red area.

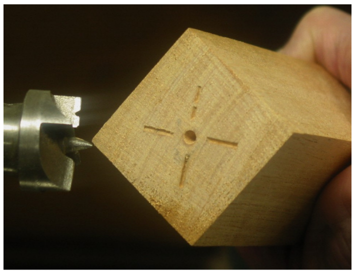
As a rule of thumb, use a bit with a diameter equal to or larger than the largest expected reed diameter. We have already seen that a 1/4" reed results in a leg diameter of about 1-1/4", so a 1/8" radius bit should be used for legs up to this size. For legs between 1-1/4" and 1-3/4", a 3/16" radius bit should be employed.

As the reeds taper, their diameter is correspondingly reduced. While the router bit will not change diameter, we can control the depth of the cut into the leg. As a rule of thumb, the depth of cut should match the reed’s radius, decreasing as the leg diameter decreases.. For example if the leg’s maximum diameter is 1-1/2", then the maximum reed radius *r* would be

$$r = 1.5''/(4.74 \times 2) = 1.5''/9.58 = 0.158''$$

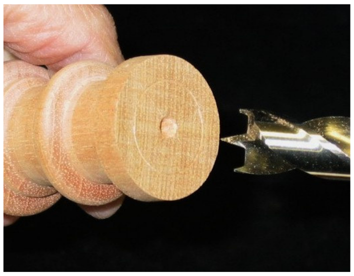
The number 9.58 relates the leg diameter to the reed radius. Since the 3/16" bit cuts a maximum depth of 3/16" or 0.187", the initial bit depth at the top is set by raising it by the difference in these depths, 0.187" – 0.158" = 0.029". To woodworkers this may seem an impossible task. However, this is easily accomplished using the gauge system we describe below.

Rough Turning the Leg



Four legs will be installed and removed from the lathe several times during the reeding process in order to employ various setups. To guarantee they will be returned on the lathe axis exactly, file a notch in one blade of the live center so that the leg will be returned to the same location.

The top and foot of the leg are turned in the conventional manner. As a novice turner, I've never mastered small beads with the skew, and these legs have lots of them. I purchased an Ashley Isles 1/4" bead forming tool from Craft Supplies USA which performed superbly. Forget the skew. Also, I obtained the Easy Wood Tools which also greatly improved my lathe skills. The beads and coves were now duck soup.



When turning the top and foot, be sure to have the mortise ends facing the tailstock. When the turning is finished, bore the mortises with a brad point bit mounted in the tailstock. The cutters on good bits can extend to near the tip of the center point, making it swim around in the center hole left by the tailstock dead center. If this is the case, then remove the turning from the lathe and trim the end back to leave just a small dimple to accurately center the drill bit. I used a 1/2" drill for the foot and a 5/8" drill for the top mortises.

For the reeded section you will need a rough leg blank at least 4" longer than the expected reeded length. This is to allow for the dowel tenons after the reeded portion is finished. The blank's square should be at least 3/8" larger than the final maximum diameter to allow for roughing to the starting diameter. Rough turn the leg to a straight cylinder.

Lay out the location of the top and bottom ends of the reeded section centered on the blank. You should have at least two inches extra for the dowel tenons on either end. Now use a parting tool to establish accurate cylinders equal to the finished leg diameter plus 1/32" at the top and bottom of the reeding. The extra 1/32" is to allow for stock removal during scratching and sanding. Now rough turn the taper to about 1/8" greater than the cylinder diameter using these cylinders as a guide. Putting a third diameter half-way down the reeded portion aids in turning the taper. This third diameter should be the average of the start and finish diameters. Continue the rough taper 1" past the starting and ending cylinder diameters.

Turn smaller diameters at each end for router bit clearance. They should be about 5/16" less than the finished top diameter and 1/4" less than the finished bottom diameter. These are all shown in the photo above. Unlike the picture, continue this dowel to the tailstock center to permit the use of a gauge to monitor the diameter of the routed leg later. Repeat for the remaining three legs.

The Reeding Jig

The reeding jig is shown at the right mounted on the lathe. A detailed sketch of the jig is found on p 80 of *FWW* 214. All construction steps must be very precise, more typical of a machinist than a woodworker, in order that the reeds will be accurately cut.

A U-shaped, 3/4" Baltic birch plywood box about 20" long is centered on the lathe bed. Two vertically adjustable guide strips of 1/2" MDF are mounted on the inner surfaces for the router to ride on. Their position controls the taper. The jig sides must gently grip the router base permitting no sideways motion.

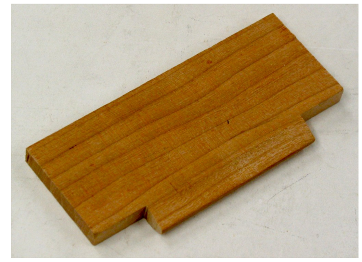
The bottom of the jig is shown at the right. The two centering blocks fastened to the jig's bottom position the jig precisely between the lathe ways. The two remaining blocks provide clamping to the ways. The centering blocks are fastened to the jig base after it has been centered on the lathe axis.

Centering the position of the jig on the lathe by direct measurement is difficult to get accurate. Because there is no room for a rule inside the box, we will accomplish the centering by using geometric symmetry. With the jig lightly clamped to the lathe ways and the guide strips removed (the router is centered on the jig walls), a wooden block is placed against the jig wall at one end and pressed into the lathe center to make a small dimple. The block's reference edge (black stripe) is now positioned on the opposite jig wall and another dimple formed.

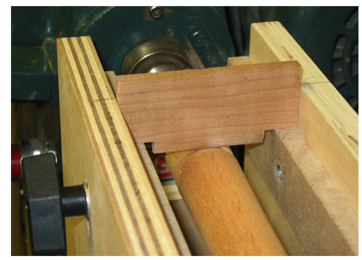
A resulting dimple pair is shown at the right. The reference edge is at the bottom. The dot pair at the right shows the difference in position of the jig walls from the lathe center. Move the jig's end with a light tapping until the dimple pair are the same distance from the jig walls as shown by the left dot. Repeat the centering at the other end of the jig. With the jig now perfectly centered on the lathe axis, fasten the centering blocks to the jig's bottom. Now when you reinstall the jig, it will be perfectly centered.

Replace the guide strips in preparation for routing the leg.

Reeding Jig Setup



Install the reeding jig on the lathe with a rough turned leg between centers. The next step is to set the guide rails for the router to match the taper of the leg. This is accomplished with the guide rail gauge shown at the right. It is roughly a 2" x 4" piece of quarter inch hardwood. The critical dimension is the width, which should provide a firm, friction fit between the walls of the router jig. The notches are 3/4" wide by about 5/16" high. The edge between the notches is planed to about a 1/16" width to rest on the cylinder turning.



To set the guide rails, first mark the jig's top edges at the location of the top and bottom cylinders cut for the rough turning. Insert the gauge as shown at the right with the narrow edge resting on the top turned cylinder. Raise the guide rails to touch the notches in the gauge and tighten. Repeat the steps at the lower turned cylinder and set the rails. They are now parallel to the desired taper of the leg. Double check these adjustments.

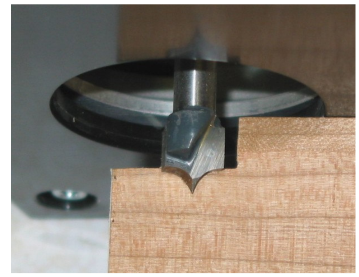
Router Setup

The point cutting round over bit must be centered over the lathe's axis using the same method employed in centering the jig on the lathe. Insert the point cutting bit in the router and place one edge that will ride against the jig touching a fixed strip of wood. Lower the router to make the first dot. Then repeat for the opposite edge. Adjust the router base so the dots coincide. The bit will now be centered over the lathe's axis.

Routing the Final Taper

Install a 3/4" flat bottom dado bit in the router. Set the depth of the bit below the router base to equal the height of the notches cut in the guide rail gauge. The bit will now cut to the exact surface of the turned cylinders. Place the router with the bit over the bottom dowel clearance area. Start both the lathe and the router. You will need to run the lathe at a minimum of 2000 rpm to eliminate "screw threads" on your work. Run the router at top speed. Slowly and firmly push the router to the top of the leg's dowel relief area keeping downward pressure on the guide rails. Replace the leg with another rough turned one, and rout the remaining three legs to their final taper.

Routing the Reeds

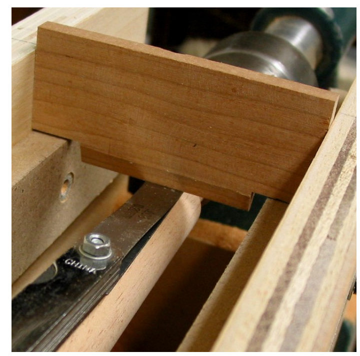


For our 1-1/4" legs we will use a 1/8" radius bit. Install it in the router and adjust the bit depth so that the top of the cutter radius just matches the guide rail notch. Since the starting reed radius matches the cutter radius, no depth correction is necessary at the top of the leg.

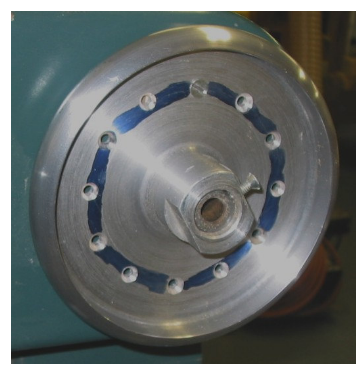
However, we do have to make a guide rail adjustment at the foot end, which is 7/8" in diameter, to compensate for the fact that the reed radius there is

$$r = 0.875/9.58 = 0.092"$$

or about 3/32". The depth of the bit penetration for a perfect reed is the reed radius. We have set the penetration at the top of the leg to be 0.125". If no correction is made, this penetration will be constant along the whole taper. But for a reed radius of 0.092" at the bottom, the penetration should be reduced to the reed radius at that end or 0.092". If we raise the guide rails at the foot end by the difference in penetrations, 0.125 – 0.092 = 0.033", we will achieve the reduction in reed diameter resulting from the taper.



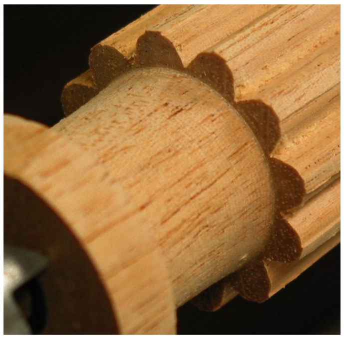
To raise the guide rails by 0.033" we will use the guide rail gauge and a feeler gauge set for 0.033". Insert the guide rail gauge at the location of the foot end of the leg (marked on the jig) with the feeler gauge set for 0.033" between the leg and guide rail gauge, thereby raising it above the tapered leg. You can see the small amount the guide rail gauge is raised by the dark space between the gauge and the guide rail. Carefully move the guide rails up to touch the gauge, and the adjustment is complete.

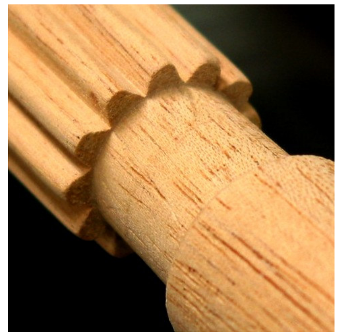


To rout twelve reeds you will need to index your lathe in 30º increments. If your lathe is equipped with an index feature, great. Mine was not so I made an index wheel from an outboard faceplate installed in the reverse direction to permit me to fasten the plate to the headstock with a flat head screw. The faceplate already had six holes, so I carefully laid out and drilled six more. I also needed a set screw to keep the faceplate fixed on the shaft. There is an alternate indexing jig shown in *FWW* 138, and the construction of a third shown in Lowe's video referenced above.

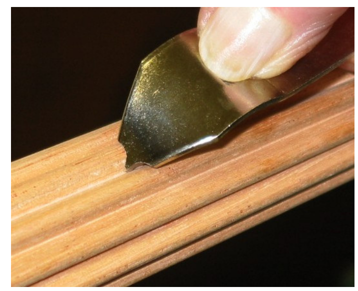
Unplug your lathe for safety and set the index wheel for the first reed. With the router placed over the bit relief section at the foot, rout the first reed with a slow, firm motion of the router. Do not stop moving the router, or you will end up with burn marks on the reed. Reset the index and repeat until twelve reeds have been cut.

If all went well, you should have reeds ending at the top and bottom as shown below. These are straight off the router. After you rout the remaining legs, you can then remove the jig from the lathe.



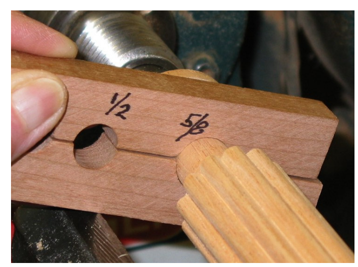


You will now need to scrape and sand the reeds to obtain a pleasing shape. An old fashioned “church key” with a small circular shapes filed on either side of the point works very well. It is easy to hold to remove and round the flats. Finish with sandpaper folded sharply to insert into the grooves.



Turning the Tenons

The mortises were bored into the top and foot with brad point drill bits. We now need to turn the tenons to their final diameter to fit the mortises. Using a caliper is not sufficiently accurate to insure a well-mating fit between the mortise and tenon. Instead, make a tenon gauge to monitor the turned diameters by clamping two pieces of 1/2" hardwood together, and using the same drills to bore holes centered on the clamped joint. These can then be used to check the final diameters of the tenons. Turn to obtain a snug fit with the gauge closed tight. With the tenons turned, use the scraper to scratch some longitudinal glue relief grooves.



We now need to determine the location of the ends of the top reeds. Make a diameter gauge by drilling a hole of the final top outer diameters in a piece of 1/8" plywood. Slip this over the tailstock end of the leg and slide it to the point where it just fits the reeds. Mark this as the location of the start of the top tenon. Carefully turn the top tenon, checking the diameter with your tenon gauge. You will find it helpful to undercut the area inside the reed ends for a tight fit against the mating bead.

Next measure the length of the reeded section and mark the location of the start of the bottom tenon. If you turn your tops and feet first, you can hold the pairs together and measure their total overall length. It is not uncommon for these lengths to vary by a sixteenth or a bit more. You can now correct for these variations in length by adjusting the precise length of the reeded section, resulting in four legs with the exact same overall length. This is another advantage of the three part leg system. Complete the turning of the bottom tenon. As before, repeat for the remaining legs.

Your legs are now ready for finishing and assembly.

Summary

The success of this method for turning tapered reeded legs accurately in the Federal style depends on using a variety of shop-made gauges for results. Once the jig and gauges are made, one can produce a reeded leg section from a rough turning in less than a half hour.

The leg taper need not be straight. By shaping the guide rails into a bow, you can make reeded legs that have a bow. And by reducing the router bit depth, reeds with oval or flat surfaces can also be made.

The three-part-leg system provides a number of advantages. First, the need for a scraping jig with several cutters is eliminated, along with hand carving at the start and end of the reeded section. Second, the routed reeds are so close to the final shape that only a small amount of scraping and sanding is required. The three section construction provides more flexibility in turning the leg, with less waste in case of a spoiled section. For making the carcass and adding inlays, the short, top-leg sections are far easier to work with than full-length legs. In all, it results in an excellent leg in a short amount of time.

Bruce D. Wedlock
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