Turning Federal Reeded Legs

Featured Piece of the Month – November 2021

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Introduction

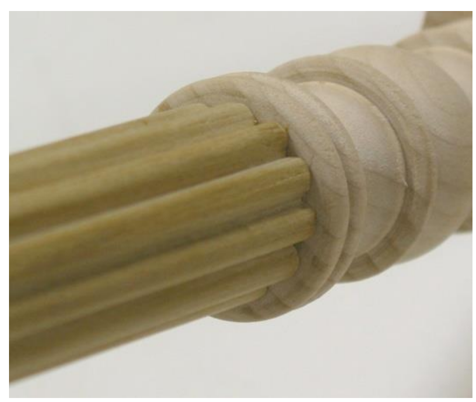
When the Guild of New Hampshire Woodworkers' Period Furniture Group was formed, the members agreed to build Federal style tables to learn the decorative skills of inlay and stringing. Having built a couple of simpler tables, I decided now was the time to tackle a Federal Work Table for my wife, who is an avid knitter and stitcher. Many of these 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 well described in *FWW*. One router method is covered in No. 138, pp 56-57, and the scratch stock method in No. 163, pp 62-65. I built this router jig and was not happy with the results. So I set about finding a better method. The May 2009 *Woodshop News* (p 39) had an article on a jig for reeding tapered legs, but little detail was included. However, it did advance the concept of separating the bottom of the taper from the foot with a dowel joint. This 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.

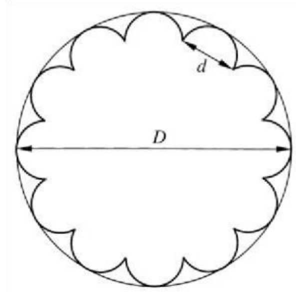
Fine Woodworking subsequently published an article on just this technique in September 2010, No. 214, pp 70-75. The reeding jig's design was well described, and so I set out to reproduce this method. The jig and my sample leg worked out well, but along the way I found the need to accurately explore the reed geometry and to make several gauges to accomplish the jig setup accuracy required for perfect reeds. This information was 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 ends 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.

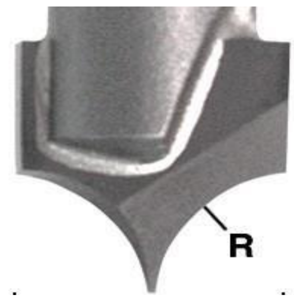
Tapered Reed Geometry



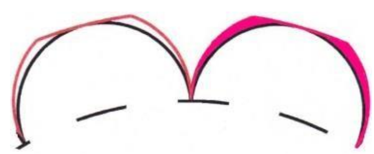
For a good result it is essential to understand the geometry of the reeded leg shown at the right. The detailed calculations are available by request at wedlock@alum.mit.edu. For our purposes, we will just use the results. For twelve semicircular reeds of diameter *d* close spaced around a circle, the 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 legs 1/8" or 3/16" are the most useful. The cutter radius *R* should be chosen as close to but greater than the largest reed radius, *d/*2, 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 will need to be 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.

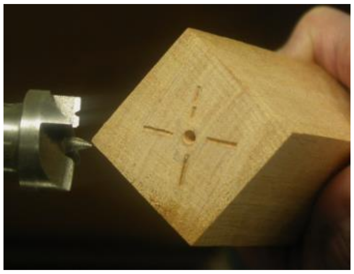


A sketch of the routed reed when the cutter radius and reed radius are equal is shown at the right. The black line shows the desired reed shape, and the red line shows the actual cut. The red shaded area is the material that needs to be removed by scraping and sanding. The reason the cutter and reed 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 whose diameter is 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" the 3/16" radius bit should be employed.

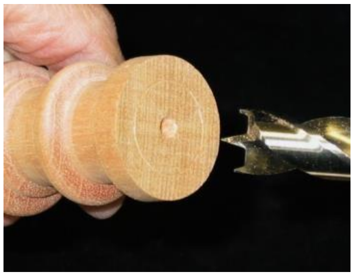
As the reeds taper, their outer diameter is correspondingly reduced. While the router bit will not change diameter, the reeding jig described below can control the depth of the cut to match the reduction in the outer diameter along the leg. This is easily accomplished using the gauge system described 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 a *Robert Sorby* 1/4" bead forming tool from *Woodcraft* 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.

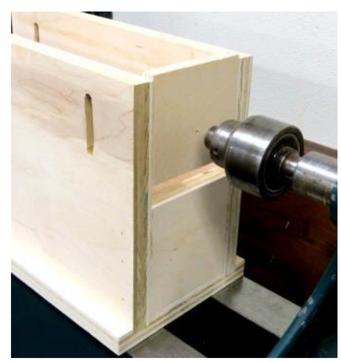
Turn smaller diameters at each end for router bit clearance. They should be about 5/16" less than the finished top diameter and 1/4" less than the finished bottom diameter. These are all shown in the photo above. Unlike the picture, continue this dowel to the tailstock center to permit the use of a gauge 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. In order that the reeds will be accurately cut, all construction steps must be very precise, more like a machinist than a woodworker.

A U-shaped, 3/4" Baltic birch plywood box about an inch or so longer than the rough leg blank 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, and fastened to the jig base after it has been centered on the lathe axis. The centering blocks are optional, but allow a quick setup when the jig is reinstalled. The two remaining blocks shown provide clamping to the ways.



Centering the position of the jig on the lathe by direct measurement is difficult to get accurate. There is no room for a rule inside the box. With the jig lightly clamped to the lathe ways and the guide strips removed, a wooden centering block is snugly fitted between the jig walls. Since router base is guided by the jig walls, the center of the router bit will be half way between the walls. Therefore, a vertical center line, carefully drawn on the centering block, will locate the center of the router bit. To position the bit's center over the axis between the lathe centers, the jig is moved to align the center of the lathe's tailstock with the vertical center line. The tailstock end of the jig is then clamped in this location. The centering block is then moved to the headstock end of the jig and that end of the jig is positioned and clamped. Double check the locations and with a light tapping adjust to perfectly center the jig.

If you are using centering blocks, fasten them 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 guide 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 sixteenth inch 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. We will need this location later. Insert the gauge as shown at the right with the narrow edge resting on the top accurately turned cylinder. Raise the guide rails to touch the notches in the gauge and tighten. Repeat the steps at the lower accurately turned cylinder and set the rails. The rails are now parallel to the desired taper of the leg. Double check these adjustments.

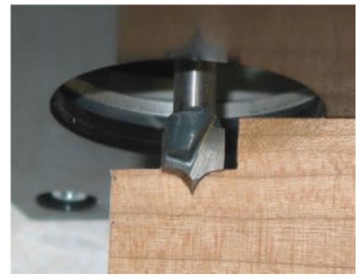
Router Setup

The point cutting round over bit must be centered over the lathe's axis. This can be done 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 aligned with an edge of the centering block used to center the jig on the lathe. Lower the router and note the point location relative to the center line. Adjust the router base so the bit point is located on the center line. 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 equal to the height of the notches cut in the guide rail gauge. The bit will now cut to the exact depth 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 least 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 route 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 gauge notch. Since the starting reed radius matches the cutter radius, no depth correction is necessary at the top of the leg.

However, the depth of the router cut into the leg needs to decrease to account for the taper. All the dimensions of the reeds decrease in direct proportion to the decrease in the outer leg diameter. So at the 7/8" diameter end, the proportional reduction from the 1-1/4" top diameter is given by the ratio of the diameters.

$$\frac{7/8}{1\text{-}1/4} = \frac{0.875}{1.25} = 0.70$$

The depth of the point of the 1/8" radius bit measures 0.108", and this will be the reed depth at the 1-1/4" top diameter. If no correction is made, this penetration will be constant along the whole taper with a poor result. Applying the reduction ratio we find the depth of the cut at the 7/8" diameter end should be

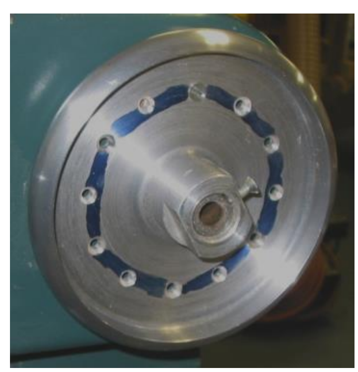
$$0.108'' \times 0.70 = 0.076''$$

If we raise the router's guide rails at the 7/8" diameter end by the difference in penetrations,

$$0.108 - 0.076 = 0.032''$$

the reduction in reed diameter called for by the taper will be achieved. To woodworkers this may seem an impossible task, but it is easily done with this jig.

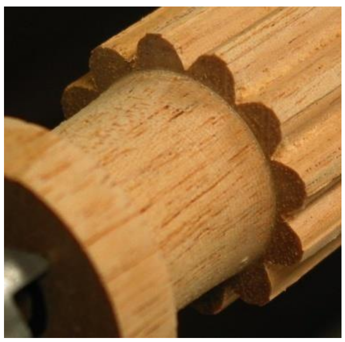
To raise the guide rails by 0.032" we will use the guide rail gauge and a feeler gauge set for 0.032". Insert the guide rail gauge at the location of the foot end of the leg (which was earlier marked on the jig) with the feeler gauge set for 0.032" thereby raising the gauge above the tapered leg. You 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.

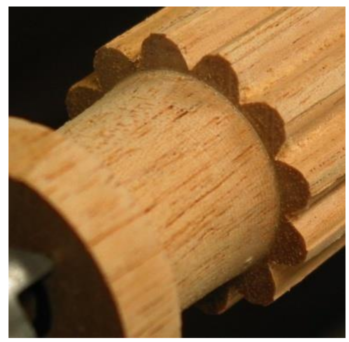


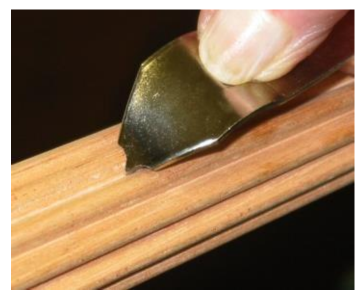
To route twelve reeds you will need to index your lathe in 30º increments. If your lathe is equipped with an index feature, great. Mine was not so I made an index wheel from an outboard faceplate installed in the reverse direction to permit me to fasten the plate to the headstock with a flat head screw. 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 set over the bit relief section at the foot, route 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. Now route the remaining legs. You can then remove the jig from the lathe.





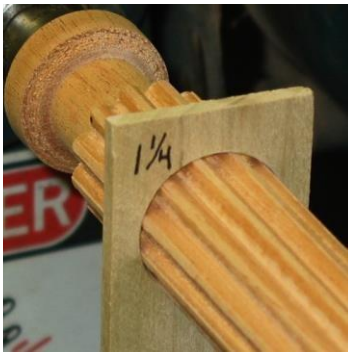


You will now need to scrape and sand the reeds to obtain a pleasing shape. An old fashioned "church key" with small circular shapes filed on either side of the point works very well. It is easy to hold to remove and round the flats. Finish with sandpaper folded sharply to insert into the grooves.

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 handshake 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.

Summary

The detailed use of a jig for turning tapered reeded legs in the Federal style has been presented. The success of this method depends on using a variety of shop-made gauges for accurate results. Once the jig and gauges are made, one can produce a reeded leg section from scratch in about a half hour.

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

The three part 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 on than full-length legs. In all, it results in an excellent leg in a short amount of time.

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