Drop Spindles

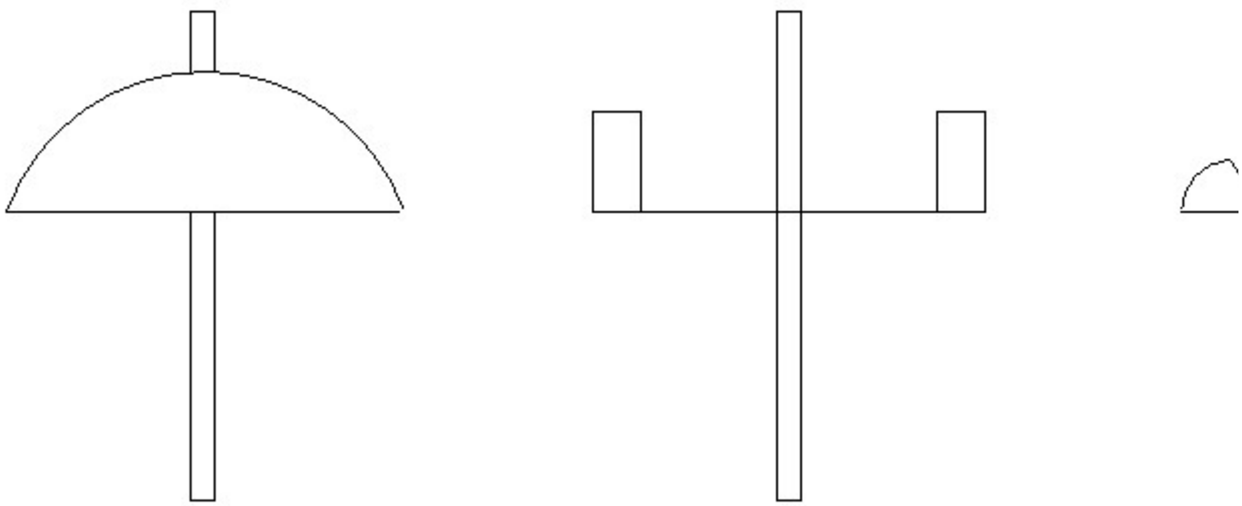
Introduction

You may be wondering what an article on making a drop spindle is doing in a spinning magazine, as the as the procedures described are more elaborate than those usually used by most casual do-it-yourselfers. My reasons are first that I think that spinners and others who make things are interested in how other things are made and why they are made that way. The second reason is that you may have a dream spindle in mind and this article might help you talk a wood turner you know (or can find) into making it for you. I won't cover all the technical information that turner might need, but at the end of the article I'll include my email address. I'll be more than happy to try to answer any further questions.

Theory

One could, I imagine, use a rock as a drop spindle. A rock would certainly drop, and will hold a spin nicely. Obviously, rocks are not ideal for spinning. There's no place to wind on the yarn, it's hard to start them spinning, and rocks are not very stable when spinning Adding a shaft and using something symmetrical for the weight would improve the theoretical rock spindle. A shaft would make the spindle easier to spin and would provide a place to store the spun yarn. Making the weight symmetrical would help it spin longer. Add a notch or hook to make attaching the yarn quicker and you've got a serviceable tool that might meet your needs if you're spinning wool into medium to heavy yarn. And, as one of my online acquaintances has mentioned, boat anchors like that are easy to find (and I've made a few myself).

But that's not all there is (for that matter it's never all there is, but that's a different story) to spindle design. After I had been making drop spindles for a while, it dawned on me that what I considered the most natural and easy whorl design, fat in the middle and tapering towards the edge, was contrary to dimly remembered concepts from High School Physics. One of the things that contributes most to difficulty in learning to use a drop spindle is that they tend to do just that, namely drop. The lighter a drop spindle, the less likely it is to break the yarn when it drops. Of course, the lighter the spindle, the shorter the time it will spin. Thankfully, it's not quite that simple. All the mass of a whorl contributes equally to the weight of a spindle, but weight close to the shaft contributes very little to its rotational inertia (which is what keeps it spinning). Mass far from the shaft, out on the rim of the whorl contributes much more rotational inertia for a given weight.



This whorl looks shapely but has the weight distribution backwards.

This whorl has all the weight on rim but has neither rigidity nor strength at the shaft.

This whorl isn't as radical in design but is practical when made in wood.

On the other hand, the idealization of weight distribution can't be carried too far. Too wide a whorl would be awkward to use and carry. In wood at least, enough mass must be left at the center of the whorl to make a strong join with the shaft, and enough thickness must be left in the wood between the center and rim of the whorl to ensure that it will be rigid.

Another factor in spindle construction that affects spin time is the concentricity of the axes of the shaft and whorl. Lack of concentricity leads to wobble, and wobble saps energy from the spin. Absolute accuracy in gluing wood to wood is made more difficult by the fact that a gap of approximately .005 inches (.13 mm) must be left for the glue. For example, a whorl 1/2 inch (12 mm) thick which ends up canted so that the top of its center hole touches the shaft at one side (eliminating the gluing gap), and the bottom of the center hole on the opposite side, results in an expected deviation of almost 1/4 inch (6 mm) at the tip of the shaft. (This expected deviation is derived from applying the rule of similar triangles to the tilt of the theoretical whorl with respect to a 10-inch- (25 cm-) long shaft.) And that's for a perfect gap, not a real one. One way to get around this is to glue the shaft to the whorl before it's turned. By turning the whorl and shaft as one piece, held in a chuck by the rim of the whorl, I attempt to minimize concentricity error.

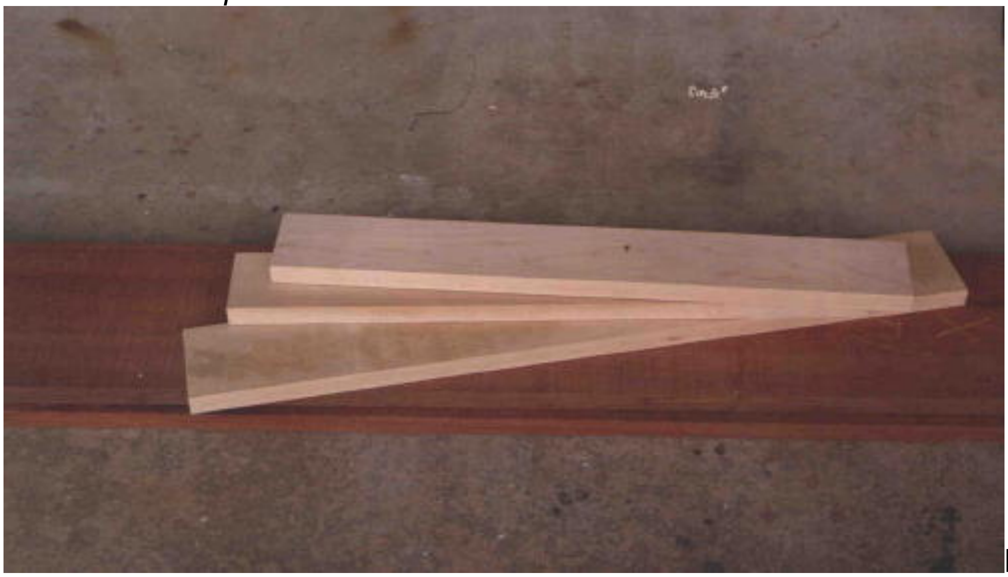
Another area that can affect spinning time and balance in drop spindles is the way the yarn is attached to the shaft of the spindle. If the yarn doesn't attach at the exact center of the spindle's axis during spinning every time, wobble will be introduced. The first thing you'll find at a hardware store if you go looking for hooks are cup hooks. But cup hooks aren't very suitable. They're threaded, and threads don't hold well when screwed into the end grain at the end of a shaft. What's worse is that the broad round top of the hook will lead to inconsistent yarn attachment points. Cup hooks are also too heavy and stiff to adjust.

I wanted to make my own hooks. I found some 0.043" (about 1mm) stainless steel wire at Small Parts. The wire is labeled as fishing leader, so it would probably be available at a large fishing tackle supply store. At first I tried imitating cup hooks, but found it hard to bend a uniform curve. Then I tried making sharp bends of about 90 degrees with needle nose pliers. I found that this was easier to do and even better, that it produced a single, consistent attachment point for the developing yarn. It was also fairly easy, after inserting the hook into the spindle, to adjust the centering of the peak of the hook by bending it in the desired direction.

Preparation of the Wood

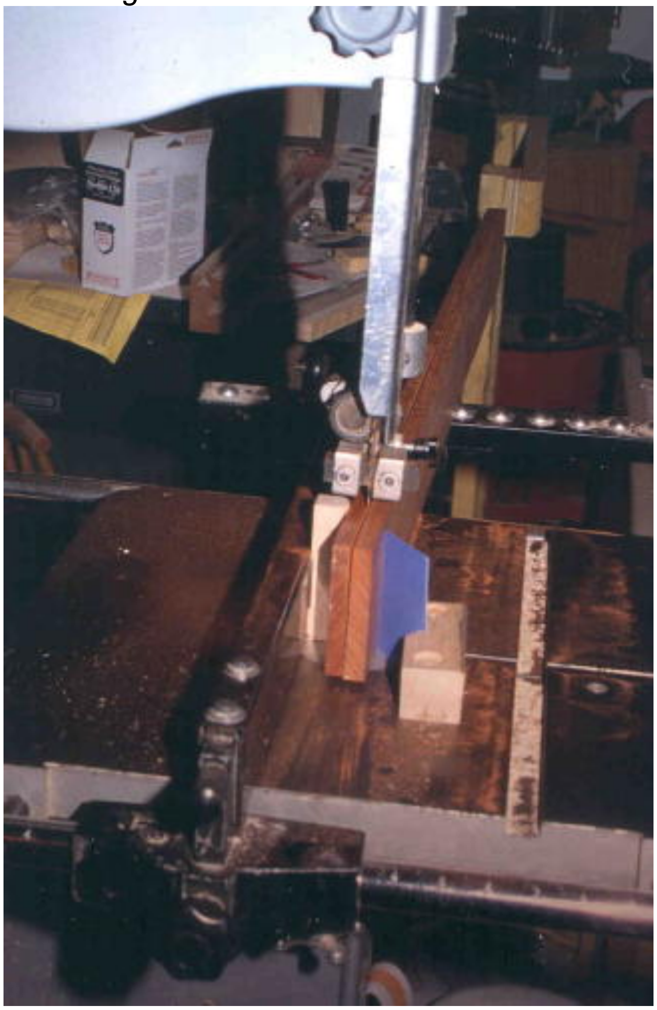
Unless you want to make a drop spindle from plywood and dowel rod, a good bit of stock preparation is needed before turning.

Padouk and Maple boards



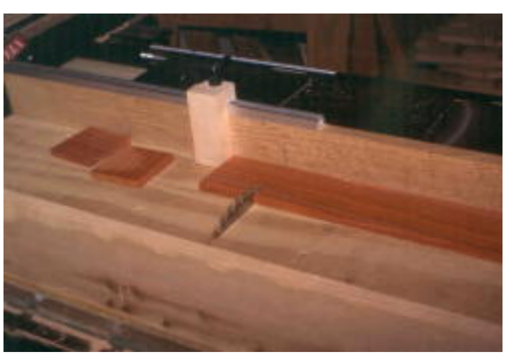
My Judi drop spindle has a whorl that is about 3-1/4 inches (8.2cm) in diameter and 1/2 inch (12mm) thick. I try to find a padouk board that is a little more than one inch (25mm) thick so I won't have to waste much of it. First I rip (cut lengthwise) the padouk with my table saw into boards about 3-1/2 inches (9cm)wide (a table saw is just that, a saw mounted in a table. The saw blade is a 10 inch (25cm)disk of steel with teeth. A motor turns the blade and various attachments control the wood while it passes through the blade). Then I resaw (cut into thinner boards) the boards into two boards about 1/2 inch (12mm) thick using my band saw (A band saw is a saw where a band, or loop of steel ribbon with teeth on the front edge, does the cutting. The band is tensioned between two wheels, one of which is turned by a motor.)

Resawing the Padouk to two half-inch boards



I've tried doing the next series of steps in several different ways. I've tried drilling holes first then using a circle cutting jig on the bandsaw, drawing circles, then cutting freehand then drilling, etc.

Cross Cutting Padouk into squares:

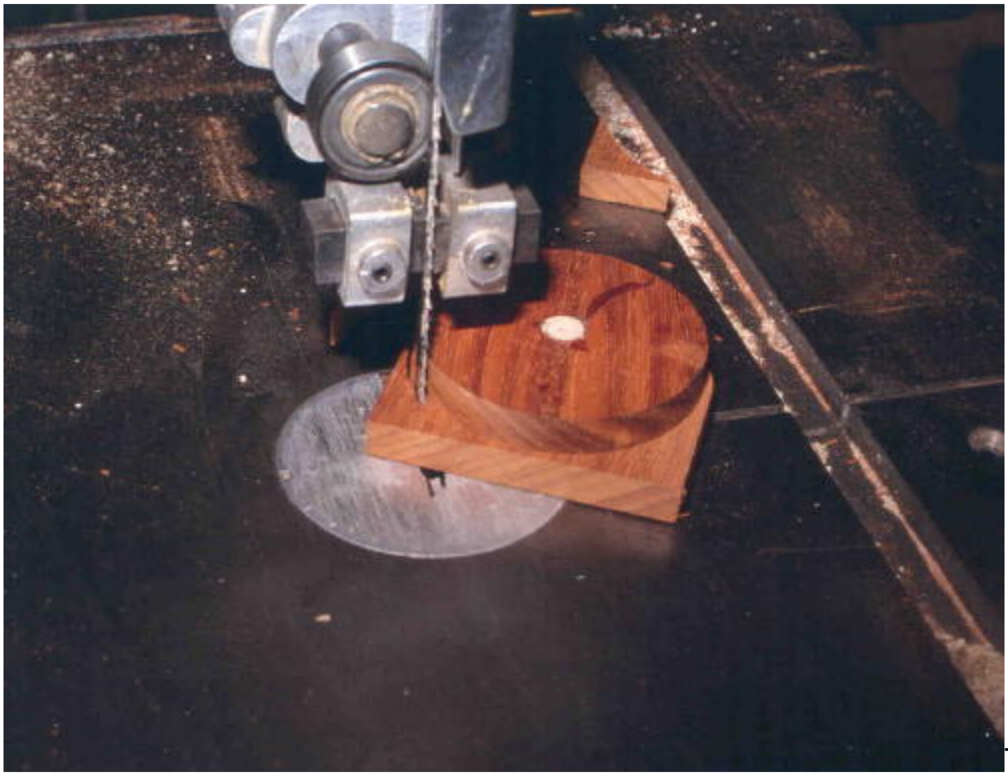


This time I cut the board into squares, then drilled the hole for mounting the shaft on my drill press (a drill press is more or less a hand drill on steroids). By cutting the blank square first, I could use a jig to accurately and quickly locate the hole for drilling

Drilling a hole for the shaft. The square whorl blank fits into the L shaped jig to mechanically locate the hole center.

After drilling, I cut the blanks to a roughly circular shape on the bandsaw. As a template for cutting the whorl, I use a whorl left over from previous work which includes a very short and slightly undersized shaft glued into the center hole. I set the template into the drilled blank and cut, making sure that the sawblade stays slightly outside the template. I find that cutting the whorl using a three-dimensional template is easier and faster than drawing a pencil line, then cutting.

Using a template to saw the square whorl blank roughly circular.

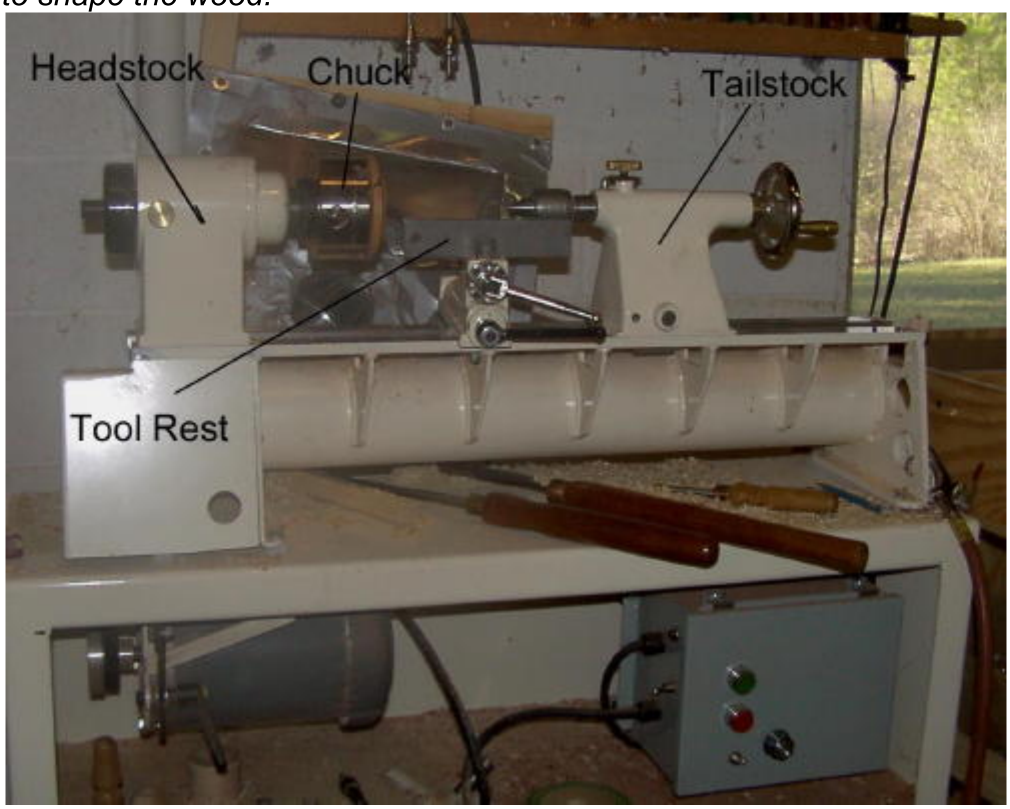
There's also work to be done to ready the shaft stock for turning. First I plane the maple boards down to 1/2 inch (12mm). Then I rip the boards into strips 1/2 inch (12mm) wide.

The last step is to cross cut the strips into shaft blanks 10 1/2 inches (27cm) long.

First Turning

Turning is done on a lathe. The lathe, probably the first woodworking machine, holds and spins a piece of wood. The turner guides hand held tools into the spinning wood to shape it. The lathe motor supplies most of the power, the turner supplies the control.

The Headstock spins the wood. The Chuck is used to hold the wood. The Tailstock supports the other end of the wood. The Toolrest steadies the tool that the turner uses to shape the wood.

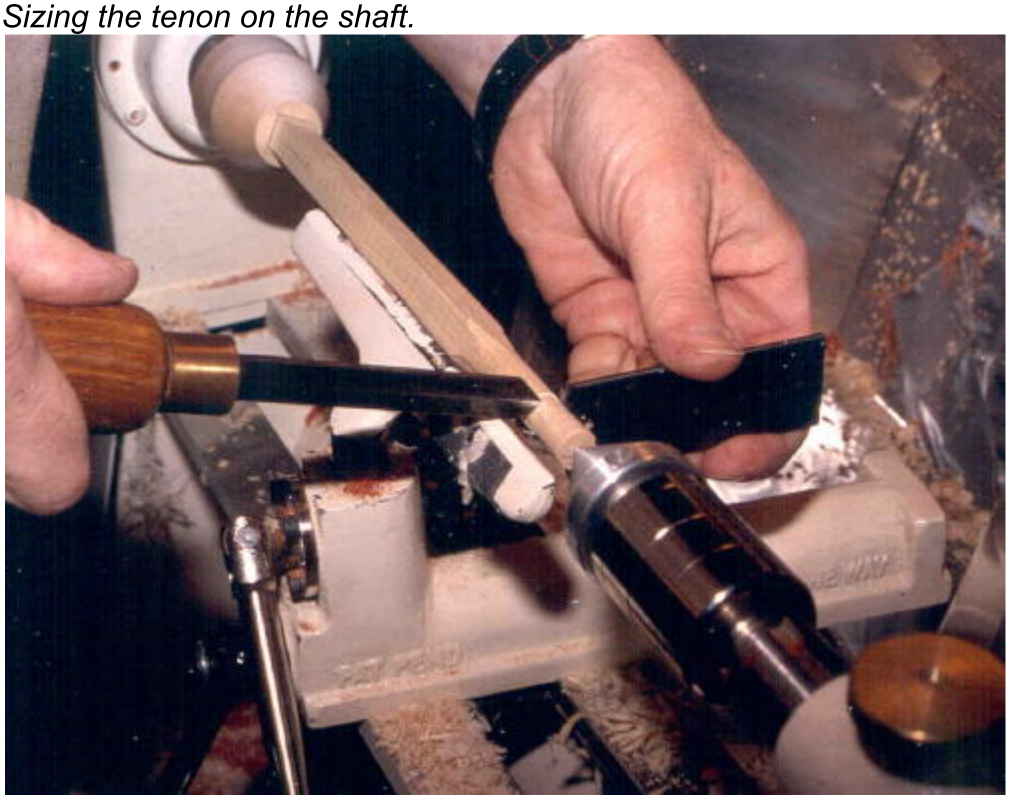


Since the whorls are only roughly circular in shape (and are so even with the circle-cutting jig) the first step in turning is to make them perfectly circular and exactly centered on the hole for the shaft. To do this I mount a plain disk on the lathe, and hold the whorl up against it with the tailstock pressure through the hole in the whorl. The tailstock is centered exactly to the rotation of the lathe, and the cone mounted on the tailstock centers itself in the drilled hole in the whorl.

Shear Scraping to smooth the trued rim:

Next I prepare the shafts for gluing into the whorls. I mount the shaft between the tailstock and a wooden faceplate with a square recess on the headstock. I turn the last 2 inches (5 cm) or so of the shaft to a roughly cylindrical shape. Then I use a gauge (made from 1/8 inch [3 mm] steel with a recess cut and filed to match the hole drilled in the whorls) and a parting tool (a tool that cuts a narrow groove) to start cutting the tenons (the narrowing of the shaft that allows it to be glued into the hole in the whorl). The photo below shows the piece of duct tape on the tool rest that I use as a stop to indicate how long to make the tenon. I finish by cutting the rest of the tenon to match the size of the initial groove cut with the parting tool.

Sizing the tenon on the shaft.



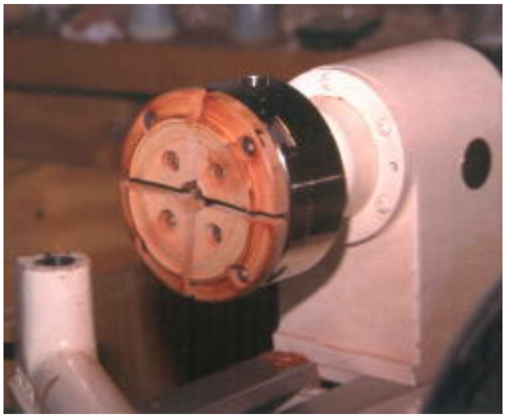
After truing the whorls and cutting the tenons on the shafts I glue the shafts into the whorls. I spread some wood glue into the hole in the whorl then tap the shaft into the hole using a wooden mallet. The homemade parting gauge has a tendency to compress the tenon a bit. After the wood is dampened by the glue it expands and locks in place nicely, so it doesn't need to be clamped. Unfortunately, it won't self-center as it does this, so I still have to worry about inaccuracies resulting from the gap which allows it to be inserted it in the first place.

Tapping the shaft into the whorl. You can see my glue spreader in the lower right:

Second Turning

After the glue has a day or so to dry well I mount the spindle on my lathe to turn the bottom of the whorl and the shaft. I use a four-jaw scroll chuck with homemade wooden jaws to hold the whorl by its already trued rim.

Chuck with wooden jaws:



The wooden jaws won't mar the spindle even after it's finished. I mount the spindle securely in the chuck and then bring up the tailstock rather than forcing the tailstock into the center of the shaft. This takes account of any errors in gluing. I use a roughing gouge (a woodturning tool with a U shaped cross-section) to turn the shaft to a cylindrical shape then finish the surface with a skew (a woodturning chisel made from flat steel that is sharpened from both sides so that the edge is about 15 degrees from being straight across), steadying the shaft with my hands to suppress vibration.

Taking a finishing cut on the shaft with a skew.

This picture shows a handy idea I've come up with since the article was written. It's a quick mount center steady that makes it easier to turn the long thin shaft without burning my fingers.

I next use a small bowl gouge (a turning tool with a U shaped groove cut into a round metal rod) and a shear scraper (a homemade tool used with the cutting edge about 45 degrees from the direction the wood moves into the tool) to smooth the bottom surface of the whorl, then sand it with progressively finer sandpaper. After sanding I cut off the little nib on the end of the shaft and apply a rubbing finish (a finish designed to be applied with a rag, the polish resulting from friction between the rag and wood) with a rag. You'll notice in the picture below that the end of the shaft isn't supported now. If the spindle turns without wobbling here at close to 2000 revolutions per minute, I'm fairly confident that it will run well at the speeds of hand spinning.

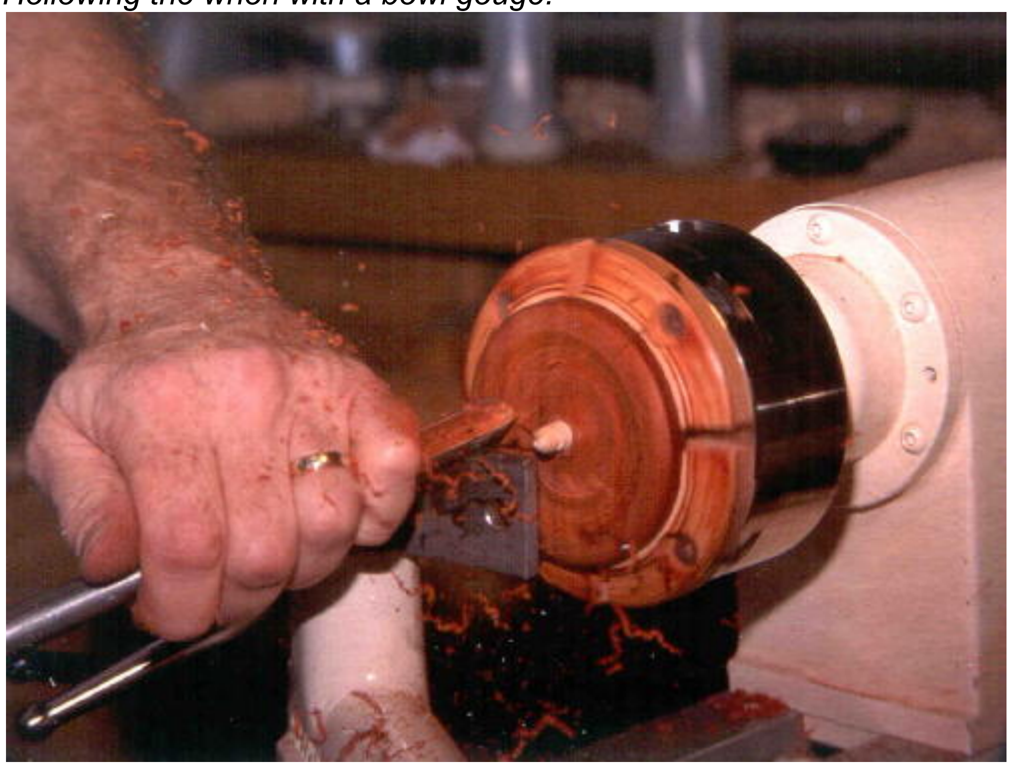
Third Turning

After the second turning is completed I reverse the spindle in the chuck to turn the top of the shaft and whorl. Since the headstock of the lathe is hollowed to 3/8 inch (9.5mm) the shaft will fit inside. First I turn the top of the shaft while it is still well supported by the full thickness of the whorl.

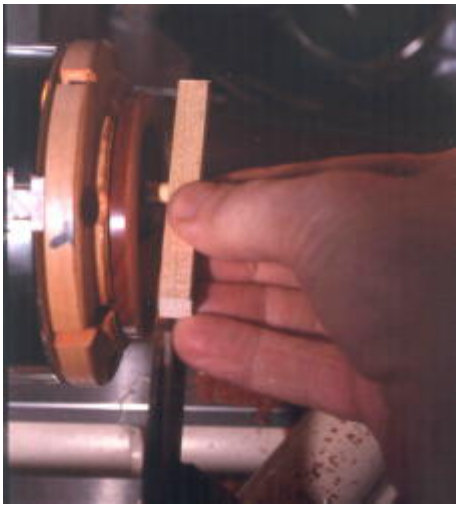
Cutting a cove on the shaft:

Then I use a bowl gouge to rough out the hollow of the whorl.

Hollowing the whorl with a bowl gouge.

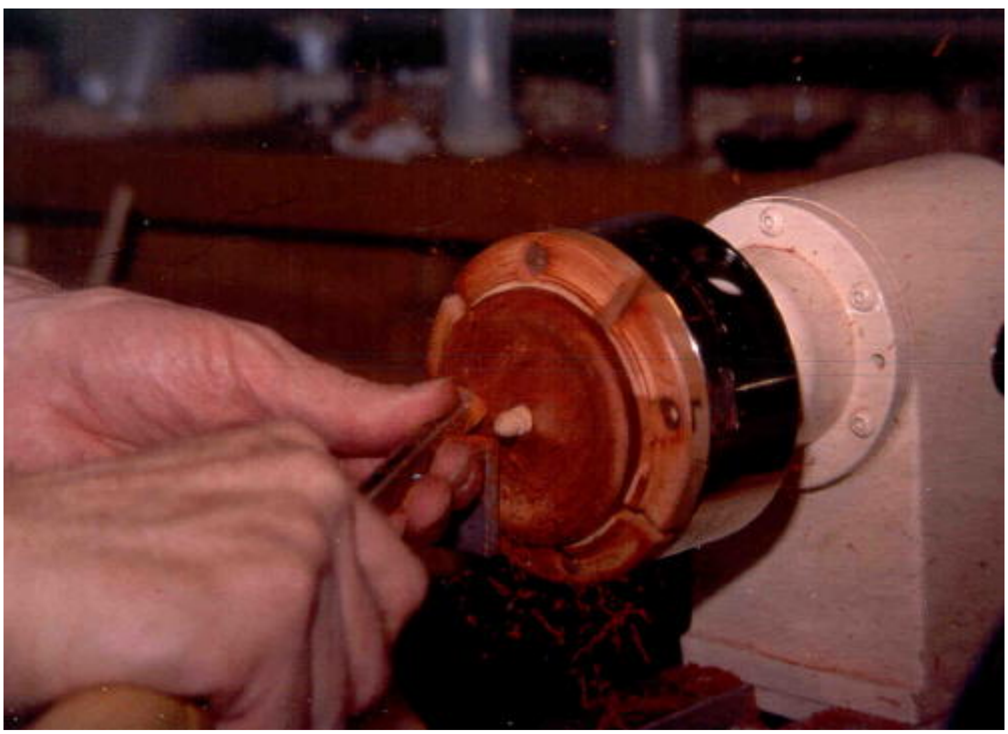


Testing the depth of the whorl hollowing:



Next, I use a round nose shear scraper to refine the surface so that it doesn't require as much sanding.

Refining the whorl surface with a shear scraper.



After the whorl is shaped I sand and apply the rubbing finish to the top of the spindle. The last step on the lathe is to drill a hole for the hook. I use a drill bit that matches the size of the stainless steel wire I use for the hooks. The drill bit, mounted in a wooden handle, is pushed into the spinning spindle to create the hole for the hook.

Drilling a hole for the hook.

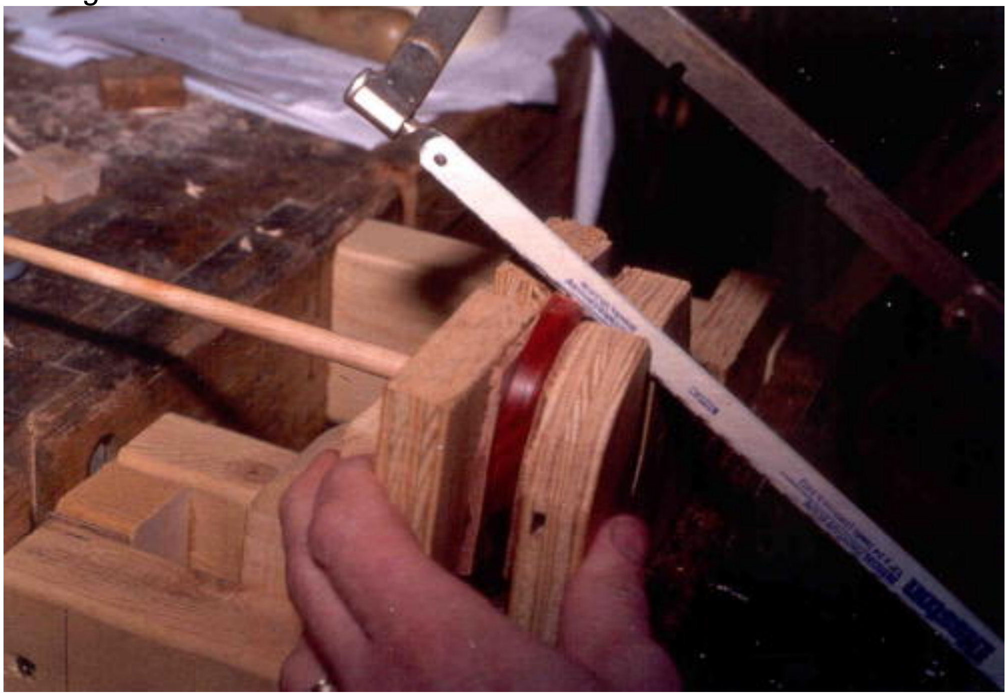
To make the hooks I cut the wire to a length that allows for the depth of the hole and the bends in the hook. Then I use a grinder to round one end of the hook so that it won't be sharp enough to cut fingers. Next I bend the hook to shape with needle nose pliers.

Two hand bent hooks of 0.043 inch (1.09mm) stainless steel wire. The hook on the right is bent as described in the article. The hook on the left is an experimental version *intended to center and attach the yarn more accurately and quickly.*

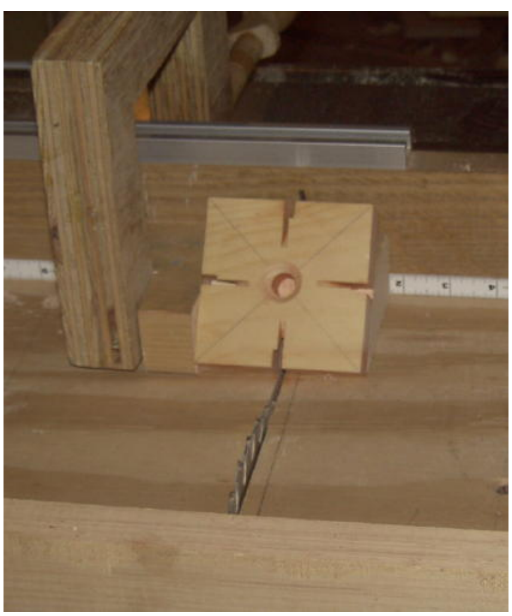
Last Touches

There are a few more things to do after the turning is finished. I glue the hooks in place with cyanoacrylic (super) glue. I find it easiest to apply the glue by putting a drop or two on a plastic card, then dipping the hook into the glue before inserting it into the shaft. Next for some spindles I use my scroll saw to cut a narrow slot in the bottom of the shaft. This slot can be used as a yarn-end keeper to use in wind on a cop which, after being removed from the spindle, automatically becomes a handy flat-bottomed center-pull ball for plying or skeining.

Cutting notches in the whorl.



The last step is to cut notches in the whorl. I like the notches to have square sides so that the yarn is less likely to slip out during spinning. I use what may very well be the ugliest jig in the known universe to hold the spindle. The jig is loosely based on the old-fashioned shaving horse, with a foot-operated lever that holds the spindle between leather pads. I've marked the interval between notches on the jig so that I don't have to measure each time. To cut the notch I use two hacksaw blades mounted together in the hacksaw frame. It works nicely but the notches look a little rough. In the future I want to experiment with a different method.



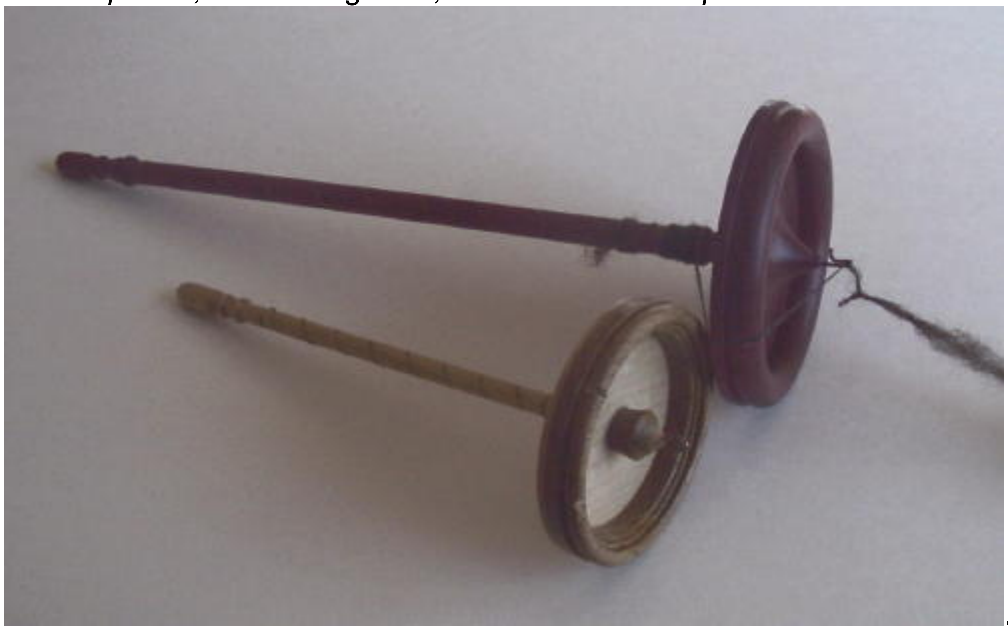
This is my new notch cutting jig, which uses the table saw. Susan wanted to have four notches, so the spinner could use a notch in front, in back, or directly to the side of the hook. Four notches have to be spaced more accurately to look right so I made a carrier the spindle can be attached to (with masking tape so far) as well as a block that tilts the spindle.

This is an even newer notch jig. This one locks on the shaft with a wooden screw, and the notch depth doesn't vary with minor changes in whorl size, which was a problem with the last jig. Using a different saw blade flattened out the bottom of the notch too.

Possible Variations
The ideas of hollowing the whorl and turning the pre-assembled spindle can be used to create a variety of drop spindles. The size, wood selection, and details of the shaft and whorl can easily be changed to give a wide range of designs. The spindles in the photograph below are made in much the same way as the minimalist Judi, but the details of the whorl and the spiral-inlaid brass wire on the shaft make them appear to be a very different spindles. The Judi weighs about 1.4 ounces (40 g), but the basic design can be scaled up or down easily to create spindles of different weights.

Anke spindle, about 40 grams, Purpleheart with brass wire inlaid on the shaft, and

Leslie spindle, about 15 grams, white oak and maple with brass wire inlay.

.