Indexing

David Reed Smith

adjust the position of other sets of elements opens up all sorts of possibilities in design space.

Introduction

Many mini lathes don’t come with an indexing head, so the utility of making one for such a lathe is obvious. But the indexing heads on even top of the line lathes leave something to be desired from both a design and use standpoint. A popular number of divisions for indexing heads is 24. Which is fine if your design calls for 6 elements, but what if it calls for 5 or 7 elements? Even if your design will work with 6 elements, what if you want a spiral? With a 24 division indexing head you’re stuck with 15° or one of its multiples. Adding an indexing head with more holes isn’t an optimal solution either, because more holes makes it more likely that at some point you’ll pick the wrong one.

This article will describe two related indexing systems you can make. The Basic system lets you design for any number of elements you wish. For the Basic system you simply drill a hole to fit your lathe spindle in a plywood disk and cut V-notches on the rim with your band saw. If you want five elements, cut five notches, if you want eight, cut eight, etc. You can pick any number of elements you like, and you don’t have to worry about picking the wrong indexing position because you use them all. The disk is locked in position with a tapered V block that slides on your lathe bed.

The Adjustable System lets you infinitely adjust the relationship between subsequent sets of elements. You can pick any spiral you like or follow a freeform curve. For the Adjustable system you make a single SubDisk, including a degree scale if you like, and mount Notched Rings on the sub-disk. It uses the same block to lock the system. The Notched Ring is mounted to the SubDisk with three screws, allowing you to rotate it to any position and lock it in place. Being able to pick any number of elements you like and subsequently

Neither system requires permanent modifications to your lathe, as the indexing disks mount on your lathe spindle behind your chuck or faceplate, and the locking mechanism slides in the lathe ways. The basic concepts could be easily adapted to a permanently mounted system by changing the disk location and locking mechanism.

Basic Disk

To make the Basic Disk you can select almost any stable material. I recommend ¼” plywood as it’s light, cheap, stable, and strong for its size. Once you have the material you need a pattern.

To manually lay out a pattern for the Basic Disk, use a compass to draw a 7” circle right on your plywood. Draw another circle 6-1/4” in diameter with the same center to mark the height of the V-notches you’ll make later. Mark the center so you can easily find it again. Decide how many divisions you want, then use a compass or dividers to divide the circumference. Mark a starting point, make a guess setting the dividers, and walk them around the circumference. Correct your setting by dividing your error by the number of divisions and try again. Three trials should get you the accuracy you need. Mark the divisions, and then draw a right angle notch, vertex pointing to the center, height determined by the 6-1/4” circle, at each division.

You can also photo-copy Drawing1 and use spray adhesive to attach the copy to your plywood. Change the number of notches to suit your needs.

If you have a CAD program for your computer, you’ll probably find it easier and far quicker to draft the pattern on your PC. While I can’t pretend to know how to use every CAD program, in TurboCAD it’s quick work to draw a 7” circle, then use draw straight lines for the notch, and then use Radial Copy to make the number of notches you want. You can print the drawing out on plain paper and use spray adhesive to fasten it to your plywood as in Fig01, or print it on 8-1/2x11 label stock.

Once you have the pattern on plywood, move to your drill press and drill a hole in the center that matches the spindle diameter of your lathe as in Fig02.
FIG02: Drilling a hole that matches the lathe spindle diameter in the center of the Basic Disk. Note that the Disk is securely clamped to the drill press table, for both safety and accuracy.

The final step is to cut out the Basic Disk on your bandsaw. Saw it to a circle first, as in Fig03, then cut the notches as in Fig04. The completed Basic Disk is shown in Fig05.

FIG03: Cutting out the Basic Disk on the Bandsaw. Cut it to a circle first.

FIG04: Cutting the notches in the Basic Disk. Cut the notches, especially the peaks, as accurately as you can.

FIG05: The completed Basic Disk.

Locking Slide

Mini to Midi Lathes

The disks are locked in place by a sliding block with a tapered V that fits on the ways of the lathe bed. It has two pieces; a horizontal part that slides along the bed, and a vertical tapered V. Make the horizontal piece first. Start with a block of wood as long as the width of your lathe bed, 2” wide, and at least 1” thick. Hold it up against the tailstock end of your lathe bed so that the bottom of the block is aligned with the bottom edges of the bed rails. Trace the opening between the rails and the top of the rails directly onto the block, as in Fig06 and Fig07. Then cut along the traced lines with your bandsaw. Test the fit in the lathe ways. You want it to slide easily but not sloppily.

FIG06: Tracing the bed profile onto the horizontal part.

FIG07: The horizontal part after tracing the bed profile.

To make the vertical V part, first mount an indexing disk on your lathe. Hold it in place with a faceplate or chuck body. Put the horizontal sliding block in the lathe bed under the indexing disk. Cut a block of wood that is 2” long, 1” thick, and about ½” wider than the distance between the top of the horizontal block and the top of a notch on the indexing disk when it is directly over the center of the lathe bed. Hold the vertical block in place and trace the outline of the V-notch on the Indexing Disk onto the block. Draw a pair of cutting lines 1/8” higher than the traced lines. Alternately, measure the distance between the horizontal block and the top of the V-notch, add 1/8” to that distance, mark it on the block and draw a V. Next draw a line from the bottom corner of one side to a point ¼” up from the bottom corner of the opposite side. Fig08 shows the block with cutting lines.
Cut the vertical block on your band saw. Stand it on end to cut it into a V, then cut along the diagonal line at the bottom to make it tapered. Take the vertical block back to lathe and try out the fit as in Fig09. Make any needed adjustments and then glue the blocks together as in Fig10. Fig11 shows the completed Basic Disk and Locking Slide mounted on the lathe.

**Large Lathes**

I had my small lathe in mind when I got the idea for the Indexing Disk, and I wasn’t sure if it would work at all on my large (26" swing) bowl lathe. That’s why the Locking Slide I made for it is, well, temporary and crude looking. Enough excuses. To make one, proceed more or less the same way, only with bigger pieces.

Cut a horizontal block about 2” wide, 2” thick, that is as long as your lathe bed is wide. Trace the outline of your lathe bed at the tailstock end and cut along the lines and check the fit.

Cut a vertical piece that is 2” wide and ½” longer than the distance between the top of the horizontal block and the top of a V-notch on the mounted Indexing Disk. I used MDF. Glue the vertical block to the horizontal block, using a right angle block to reinforce the joint as in Fig14.

When the glue is dry, mount it in the lathe bed ways, and trace where the top of the V-Notch is. Draw a pair of cutting lines 1/8” below the traced lines. Move to your band saw. Attach a scrap block with tape to the base end of the Locking Slide and adjust its placement so that when the top of the Locking Slide and the bottom of the scrap block rest on the saw table you have a taper somewhere in the neighborhood of 1:8. Now cut on the cutting lines to create the tapered V as in Fig12. Try it out on your lathe and make any required adjustments. The completed Large Locking Slide is shown mounted in Fig13.

FIG08: The vertical part after drawing the cutting lines.

FIG09: Test fitting the Locking Slide before gluing together.

FIG10: Clamping the Locking Slide together until the glue sets.

FIG11: The completed Locking Slide and Basic Disk mounted on the lathe.

FIG12: Cutting the tapered V on the Large Locking Slide. Tape a scrap block to the lower part of the slide to maintain a constant angle, and then cut the V.

FIG13: The Large Locking Slide mounted in the lathe bed ways.

FIG14: The Large Locking Slide. I didn’t take a picture before I cut the tapered V, so pretend…
Concept is material independent, so I’ll just tell you the pluses and minuses and let you make your own choice.

Aluminum is durable, accepts threading well, and comes flat and true. But I had trouble drilling big holes accurately in it. To do so I had to clamp it down hard enough to mess up my degree scale (added it later instead). A multispur bit cut a good hole but I may have dulled it a bit. I tried a hole saw but ended up with a ragged oversize hole.

⅛" Plywood is easily available, cheap, and easy for a woodworker to work with. You’ll have to be careful to clean up any ragged edges around the center hole so your faceplate or chuck will run true. The main drawback is threading. Actually plywood taps quite well, but the threads won’t last long enough to pass along to your grandchildren if you habitually over-torque screws.

⅛" Plexiglas works easily enough with woodworking tools if approached gently to avoid invoking its brittle nature. It forms stronger threads than plywood and comes flat and true. You can find it in most big-box hardware stores.

The Adjustable Indexing system used a SubDisk that mounts on your lathe spindle. It has three threaded holes that accept round head socket machine screws to lock a Notched Ring in place. Adding a degree scale is a nice but simple option. The Notched Ring is the same as a Basic Disk except for a much bigger center hole. It uses the same Locking Slide to lock the lathe spindle in place.

Materials

The first consideration is what material to make the SubDisk out of. There is no ideal material of course; the primary trade-offs are durability versus ease of machining. I’ve tried 1/8” aluminum, ¼” plywood, and ¼” Plexiglas. The basic

Adjustable Indexing

Having an infinitely adjustable locking mechanism for an indexing system makes for much more design flexibility. My first thought for converting the Basic Disk to adjustable locking involved a pivoting arm with an adjustable pivot point. It did work, and I could convert it to foot operated…but it was rather complicated, fussy, and of limited range because the arm would foul on the lathe bed. Using a SubDisk to hold a Notched Ring that can rotate turned out to be a much simpler and more elegant solution.

The Adjustable Indexing system used a SubDisk that mounts on your lathe spindle. It has three threaded holes that accept round head socket machine screws to lock a Notched Ring in place. Adding a degree scale is a nice but simple option. The Notched Ring is the same as a Basic Disk except for a much bigger center hole. It uses the same Locking Slide to lock the lathe spindle in place.

Materials

The first consideration is what material to make the SubDisk out of. There is no ideal material of course; the primary trade-offs are durability versus ease of machining. I’ve tried 1/8” aluminum, ¼” plywood, and ¼” Plexiglas. The basic

Once you’ve picked the material for your SubDisk, attach the pattern to it. You can copy Drawing2 or Drawing3 or download it from www.davidreedsmith.com and attach it to the material with spray cement as in Fig15. The pattern will stay legible longer if you protect it with some sort of transparent film. I usually use clear packing tape.

Drill a hole at the center of the SubDisk using a drill that matches the diameter of your headstock spindle. Back up the SubDisk and drill slowly so you don’t get tear out on the bottom side as in Fig16. A Forstner or multFigspur bit will be most accurate. If you’re using aluminum, go ahead and use a Forstner or MultFigspur bit and plan on sharpening it.
Clamp the SubDisk on your drill press, and drill a hole with a #7 drill bit at one of the marked locations for the Notched Ring locking hardware as in Fig17. Remove the drill bit, insert a miniFigtap guide, and tap the threads with a 1/4x20 tap as in Fig18. Repeat for the other two mounting holes.

After the holes are drilled, cut out the SubDisk. How you do this depends on what material you selected. Cutting out Plywood or Plexiglas will be easiest on your bandsaw as in Fig19. Aluminum would be too, if you have the appropriate speed and blade options available… I don’t. If your bandsaw is intended solely for wood, you can cut out the aluminum using a bench mounted scroll saw, or a hand held scroll saw, with metal cutting blades. If you’re impatient (and both of these options take a while) you might try making a series of straight cuts with a more aggressive cutting reciprocating saw and spend a little more time turning the SubDisk true.

Mount the SubDisk on your lathe. You can hold it in place with a faceplate, chuck, or a nut that fits your lathe spindle if you have one. Turn the rim of the SubDisk true as in Fig20. If you are using Aluminum or Plexiglas, keep the speed slow and cuts very light. I found a small bowl gouge worked well for all three materials.

If you don’t have a scroll saw, mount a wooden disk with a diameter greater than 7” to your lathe. Pin the Notched Disk to the wooden disk using your tailstock live center. Dimpling the center of the Notched Disk with a drill or center punch will make it easier to accurately center it. You may wish to secure the rim of the Notched Disk to the wooden disk with tape so it doesn’t rattle around when cut through. Turn the lathe on at a moderate speed and cut through on the inside of the line with a parting tool as in Fig22.

**Notched Ring**

To make a Notched Ring, start with a pattern following the instructions for the Basic Disk (Drawing1). The only difference is that the center hole will be 5” in diameter instead of the diameter of your lathe spindle. Again, you have a choice of materials. Aluminum is probably overkill. ¼” plywood will work well. You could use 1/8” or ¼” Plexiglas, although you would have to be very careful cutting it out on a bandsaw, because the large tooth blades woodturners tend to have mounted can break away chunks of at least the thinner Plexiglas. After you’ve mounted the pattern to your material, cut it out on your band saw. Pay particular attention to the V-notches and try to get the peak of the notch cut accurately.

If you have a bench mounted scroll saw you can cut out the interior of the Notched Ring using it as in Fig21.

If you don’t have a scroll saw, mount a wooden disk with a diameter greater than 7” to your lathe. Pin the Notched Disk to the wooden disk using your tailstock live center. Dimpling the center of the Notched Disk with a drill or center punch will make it easier to accurately center it. You may wish to secure the rim of the Notched Disk to the wooden disk with tape so it doesn’t rattle around when cut through. Turn the lathe on at a moderate speed and cut through on the inside of the line with a parting tool as in Fig22.

**Notched Ring**

To make a Notched Ring, start with a pattern following the instructions for the Basic Disk (Drawing1). The only
FIG22: The set-up to cut out the interior of the Notched Ring with a parting tool on the lathe.

You can make a mark on the inside of the Notched ring, either with a marker or a file, to aid in changing the settings by a specific amount. You can attach the Notched Ring to the SubDisk using any 1/4x20 thread size hardware. Round head socket machine screws are probably safest if you intend to turn on the lathe with the Indexing System attached. Collared thumb screws are probably most convenient. Fig23 shows the completed system mounted on the lathe.

FIG23: The completed Adjustable Indexing System mounted on the lathe.

Using

To use either indexing system, mount the disk on your lathe spindle using a faceplate, chuck, or nut. Make sure it is securely tightened so that there will be no slippage. If your hands will be anywhere near the headstock when turning, it will be safer to complete the turning prior to mounting the disk, and remount the project using the Indexing system only for use when power is off. You may also wish to unplug your lathe when the indexing system is locked to avoid inadvertently starting the lathe.

With the Basic Disk, if you want a particular orientation when starting, you can allow the disk to slip until that position is reached.

To lock the Indexing System, slide the Locking Slide towards the headstock until the tapered V of the Locking Slide mates securely in the center of a V-notch in the Basic Disk or Notched Ring. To unlock, slide the Locking Slide towards the Tailstock.

When using the Advanced system, you can adjust the offset of the second or subsequent sets. Loosen the screws holding the Notched Ring in place, rotate it by the required amount, and retighten the screws. You can change the offset by a set number of degrees using a mark on the Notched Ring and the scale on the SubDisk. You can also layout the positions you wish to index to, say by drawing a freeform curve and marking dots along it, and then adjust the indexing system so that it locks at the position of each dot.

Have fun. I think you’ll find that either Indexing System opens up all sorts of new opportunities in design space. When laying out the notches for a particular project, consider that you don’t HAVE to use single regular elements. You can also use SETS of elements at regular intervals, single elements at irregular intervals, or both.

FIG24: Can your Indexing head do this? An example of what can be done with the Advanced Indexing System and a drill guide. The drilled holes were filled with plaster mixed with black acrylic paint.

Tools and Materials

Basic

¼” plywood
Hardwood for locking slide
Drill matching spindle diameter
Bandsaw
Compass

Adjustable

1/8” aluminum or ¼” plywood or ¼” Plexiglas
1/4x20 round socket head screws
1/4x20 tap
#7 drill

Fig24 shows a simple example of what the adjustable indexing system can do with a bowl.

Drawings in PDF format

Drawings in pdf format are available on my web site.