Introduction

A Square-In-Circle Inlay has a lot more visual interest than a dot, but is still almost as easy to install as it’s round like a dot on the outside so it can fit into a simple drilled hole. A stick of Square-In-Circle is made by gluing rectangular pieces in windmill fashion around a square core, then turning round on the lathe. There are a couple of major problems to solve in making Square-In-Circle Inlay: gluing it together and centering it for turning. It’s taken me a while to put this article together as the solutions didn’t come all at once.

The first problem I solved was centering the inlay blank for turning when I realized that a square only fits one way in a circle that has a diameter equal its diagonal measurement, and that a circle only fits one way in a square with sides equal to its diameter. I guess that’s rather cryptic. What I did was extend the square core of the inlay blank so it stuck out of one end and gripped it in my collet chuck (I’ll also tell you other mounting methods). This automatically centered the inlay blank at the headstock end. I did the opposite at the other end, leaving the core a little short. Once that end was trimmed the cone tailstock would fit in to it automatically centering the tailstock end.

I had originally tried gluing the inlay blank up using small Quick Clamps, but the pieces tended to slide around and my fingers ended up covered in glue. I tried some L-shaped cauls singly and in opposition and I don’t remember how many other ideas before I came up with the simple assembly jig in this article requiring only a few table saw cuts and a couple of rubber bands.

I was planning to describe a sled-ripping adaptor, but while making the gluing jig I got a nice bonus. It was obvious that the same procedure would allow ripping small squares and rectangles safely on the table saw with nothing more than a little masking tape.

Briefly this article will tell you how to make the assembly jig, then how to rip the small pieces required without getting your hands near the blade. Then the assembly jig will be used to glue up the inlay blank and the blank will be mounted on the lathe and turned to size. Last comes aligning the blank for inlaying and a couple of examples.

Assembly Jig

Start making the assembly jig by cutting a short (6” to 8”) piece of 2x4 construction lumber, hopefully with flat parallel large faces. Cross cut the ends square on your table saw and then set your fence just closer to the blade than the width of the blank and rip the blank so the narrow side has square edges and is perpendicular to it. Move the fence a little closer, turn the blank around and rip again so that the other narrow side is also square cornered and perpendicular.

Now set your fence so that it is 5/8” from the blade (this plus the blade kerf is probably ¾”) and set the blade height to ¾”. Check the blank for the best right angle cornered edge and put an “F” on the two faces that make up that edge. Put the blank on the table saw so that the wide “F” side is down and the narrow “F” side is against the fence and make a buried ripping cut as in Fig01. You’ll probably have to remove table saw guards for this cut so keep your hands on the other side of the blade and don’t stand directly behind it. Without moving the blade or fence turn the blank so the narrow “F” side is against the table and the wide “F” side is against the fence and rip again as in Fig02. It’s possible the square removed will come shooting out, so stay to the side of the blade.

Hopefully you’ll have a blank with a perfect 3/4” rebate. You may have to move the fence or blade slightly and re-cut—don’t stop until you have a rebate with right angle walls, as the accuracy of the inlay blank depends on it.
Use your band saw to cut two 45 degree right triangles out of scrap 2x4. Use hot melt glue or double stick tape to fasten them to the jig so that one 45 degree apex is aligned with the edge of the rebate at each end of the wide side as in Fig03. Set the blank on your table saw sled as in Fig04 and adjust the blade height so that it’s just higher than the corner of the rebate. Now use the table saw to cut slots in the blank for the clamping rubber bands. Set your stop ¾” from the blade, place the blank against the back fence and stop and pass it through the blade. Move the stop ¾” further from the blade and keep repeating this (see Fig05) until the entire blank has slots every ¼” or so. The finished assembly jig is shown in Fig06.

Fig03. After adding 45° blocks to the Assembly Jig to stabilize the jig while cutting the slots.

Fig04. Setting the blade height to just above the corner of the rebate.

Fig05. Cutting the slots in the Assembly Jig using a table saw sled.

Fig06. The completed Assembly Jig.

Milling

Ripping small pieces can be difficult to do accurately and safely. One solution would be a ripping sled such as the Vacuum Ripping sled I wrote about in the Summer 2004 edition of Woodturning Design (or see my web site www.DavidReedSmith.com). If you’ve made one it will work fine without the vacuum using just the top fence to keep the stock in place. I had planned to describe making the simplified add-on ripping jig for an ordinary sled (illustrated in Fig07 & Fig08). But with the addition of a little masking tape the way I cut the rebate in the Assembly jig was so much simpler at the small cost of using a bit more stock that I’ll devote the space to it instead.

Fig07. I was going to include making this Rip Adaptor for a table saw sled. The piece on the left is the vertical fence. It’s a ¾” inch board with 2mm craft foam on the bottom. The right piece is the fence made of two pieces of 2x8 laminated and milled to the maximum blade height. It has three (plus one mistaken) 1-3/8” holes for clamping the vertical fence to the fence, and the fence to the sled.

Fig08. The Rip Adaptor in use. The fence is positioned the correct distance from the blade. The wood to be ripped is placed in position against the fence. The vertical fence is pressed down against the wood while it is clamped in position.

Find two contrasting woods to use for the inlay blank. Select stock ¼”-1” thickness and wide enough to keep your fingers away from the blade. Mill the stock so that the faces are flat and parallel, and the edges are perpendicular to the faces. You can do this by ripping the edges as with the Assembly Jig.
First decide what size square to use for the inner core (I suggest around 1/8” for anything pen sized. The pictures and directions follow making inlay with a ¼” core). Set your rip fence the square dimension away from the blade. Set the blade height slightly higher than the square dimension. Place a face of the stock on the table and an edge against the fence. Keep your hands on the part of the board well away from the blade and pass the stock through the blade as in Fig09. After making the cut burnish a piece of masking tape over the cut area on both ends of the board. This will help keep the stock in place during the second rip. If you would prefer something more secure than tape, squeeze a bead of hot-melt glue into the kerf—just be sure to trim away any glue proud of the kerf. Now place the face of the board with the saw kerf against the fence and the edge on the table. Keep your hands high on the stock away from the blade and be sure to stand so that you’re not behind the blade. Pass the stock through the blade as in Fig10. Fig11 shows the board after the second rip. Remove the tape and you should have an accurately cut square core.

The rectangular out pieces should be the same dimension as the square stock on the narrower side, and twice the square dimension on the wider side. It’s okay if the wider side is slightly less than twice the square dimension, but if it’s even a little larger it will make it very difficult to assemble the inlay accurately. Leave the rip fence at the same setting, but raise the blade to slightly more than twice the square dimension. Place a wide face of the board on the table with a narrow side against the fence and pass it through the blade as in Fig12. As you need more of the rectangular pieces, you may want to rip both sides of the board. Apply tape over the kerf on the ends of the board and burnish well to ensure a good grip. Move the fence so that it is twice the square dimension (or slightly less) from the blade. Lower the blade to slightly more than the square dimension in height. Place the narrow side of the board on the table and the wide side against the fence and pass through the blade as in Fig13. Again, keep your fingers higher than the blade and stand to the side of the fence.

The last milling step is to cut the pieces to length. You can make the length you want but don’t be greedy, as you have to be able to turn it without chatter and vibration. A reasonable length for 1/8” square core is 2” to 3”. A ¼” square core can be around 5”. Cut the square core 1” longer than the rectangular pieces. For example for a ¼” square core inlay I cut one ¼” square piece 6” long, and four ¼” x < ½” rectangular pieces 5” long.

Assembly

To glue up the Square-In-Circle Inlay blank gather together everything you’ll need as shown in Fig14. You’ll need glue (Ordinary wood glue is fine for all wood inlay blanks, but use Polyurethane glue if you’re incorporating soft metals or plastics. I’ve not had good results trying to use CA glue in this application), the five milled pieces, the assembly jig, some strong rubber bands, and some waxed paper. A glue spreader is helpful. My glue spreader, which you can see on top of the assembly jig in Fig14, is a simple spindle turning with a small rectangle of plastic cut out of a milk jug glued in a slot.
It’s flexible, spreads glue well on small surfaces, and dried wood glue comes right off.

Cut a piece of waxed paper that will fit into and cover the rebate in the assembly jig and fold it in the middle so it will stay put until you put the milled pieces in place. In the pictures that follow of the gluing sequence I didn’t use waxed paper because it obscured the position of the pieces. I coated the jig liberally with paraffin instead, but waxed paper is easier and less likely to fail.

Coat one edge of the square core with a thin coat of glue and place it on one of the rectangular pieces so the edges line up. The square should be about ½” short of the rectangular piece on one end and stick about 1” past the rectangular piece on the other end. Place it into the rebate of the assembly jig as in Fig15. Wind rubber bands around the assembly jig so that they fall into the slots, pushing both pieces down and into the side of the rebate. Visually check the position of the pieces and push them around if needed with your fingers. Set the jig aside until the glue has a chance to set.

Unwind the rubber bands and remove the glued pieces from the jig. Check for and remove any glue squeeze out in the rebate formed by the two glued up pieces. Coat the rebate formed by the two glued up pieces with a thin coat of glue. Insert the second rectangular piece into the rebate and line up the second rectangular piece end to end with the first piece. Replace the waxed paper shield in the assembly jig and place the glue-up into the rebate of the jig so that the second piece is down and the first piece is against the side of the rebate. Wind rubber bands around the assembly jig thru the slots so that the glue-up is pulled into the bottom and side of the rebate as in Fig16. Check the position of the pieces and then give the glue a chance to set.

Remove the glue-up from the jig. Check for and remove any glue squeeze out that will get in the way of the third piece. Coat the rebate formed by the square and second rectangular piece with a thin coat of glue. Insert the third rectangular piece into the rebate so that it lines up end to end with the first and second pieces. Replace the waxed paper shield and place the glue-up into the assembly jig so that the third piece is against the bottom and the second piece is against the side of the assembly jig rebate. Wind rubber bands around the jig through the slots to clamp the third piece in place as in Fig17. Check the piece position and give the glue a chance to set.
Remove the completed glue-up from the assembly jig. The hollow formed by the four rectangular pieces at the end the core is recessed must be an exact square at right angles to the axis of the inlay blank for the tailstock to center the glue-up properly. Straight from the assembly jig or band saw trimming isn’t accurate enough, so place the glue-up on your table saw sled as in Fig19 and trim the end.

**Turning**

To automatically and accurately center the inlay blank on the lathe you need a tailstock center with a conical point and a means of accurately gripping the square core that sticks out. The out and out best method to do this is the Beall Collet Chuck. I highly recommend it for holding small work. You can get additional collet sizes if needed by searching for ER32 collets at any industrial supplier website. Pick the smallest collet that the core will fit into. Line up the corners with expansion slots in the collet, and then gently tighten the chuck. Lightly bring up the tailstock to center the other end, and then securely tighten the collet. Snug up the tailstock (but don’t apply lots of pressure as it may split the inlay blank apart) and you’re ready to turn the blank as in Fig20.

- Mount #1 jaws on your four-jaw chuck as in Fig21. A One-Way Stronghold will hold down to about a ¼” core this way—your chuck may vary. The disadvantage is dodging the large chuck and sharp edged jaws close to where you’re working.

- Use a flexible pipe liner in a drill chuck. Find some PVC or plastic pipe that’s a little bigger than your square core. Cut a piece about as long as your square core sticks out. Cut a V-notch in the end of a scrap piece of wood and temporarily...
glue the pipe into the notch. This will hole the pipe straight up and down and keep your fingers out of the way. Make two band saw cuts through the pipe as in Fig22. The edges of the slot shouldn’t touch when it’s wrapped tightly around the core—you may have to try more than once to get this right. Mount your drill chuck in the lathe headstock and insert the slotted pipe into your drill chuck so that the slot is between jaws as in Fig23. Insert the end of the inlay blank so that the slot is over a flat and tighten the drill chuck. Then snugly bring up the tailstock center as in Fig24. The disadvantage is all the extra steps and a slight loss of accuracy.

Fig22. Using scrap construction lumber to safely slot a piece of PVC pipe to adapt a drill chuck for driving the square inlay core.

Fig23. The slotted PVC has been inserted in the drill chuck and aligned so that the slot is between jaws. The jaws have been pre-tightened to just wider than the square core.

Fig24. The inlay blank mounted with a drill chuck and slotted PVC for turning.

- Use a four jaw chuck with no top jaws. If the bottom jaws on your four jaw chuck have flats rather than points on the inside you can remove the top jaws and use the bottom jaws to grip the square core as in Fig25. My Stronghold will hold down to about 1/8” this way—your chuck may vary. This should be very accurate but you have to work small close to the relatively huge chuck.

Fig25. The inlay blank mounted for turning in a four jaw chuck with top jaws removed.

- Use a waste block on a faceplate. Mount a scrap piece of wood on a faceplate (or in a chuck) and turn it round and tapered with a small flat in the middle. Make a small drill starting dimple as in Fig26. Measure diagonally across the corners of your square core (or do the math) and select a drill slightly smaller. Drill through the waste block on the lathe as in Fig27. Use your skew to slightly chamfer the drilled hole as in Fig28. Find another wood scrap to use as a ram and put glue on the corners of the exposed square core as in Fig29. Line up the inlay blank and use the scrap wood ram and your tailstock to press the inlay blank into the hole as in Fig30—using the tailstock directly might split the blank and ruin your day. Allow the glue to cure, then remove the ram and snug up the tailstock as in Fig31.

Fig26. A scrap drive block mounted on a faceplate, turned round, faced, and dimpled for drilling.

Fig27. Drilling a hole slightly smaller than the diagonal of the square core.

Fig28. Chamfering the entrance of the hole to guide the square core in. Yes, I’m cutting on the “wrong” side, but it’s a very light cut and the speed is low.
However you mount the piece, begin to turn the inlay blank round with a spindle roughing gouge. I couldn’t remove the glued inlay blank from the waste block so the rest of the turning pictures follow this method. Cut gently at first to avoid breaking off any of the pieces and continue until the piece is round as in Fig32. Decide what final diameter you want. A diameter close to the diagonal measurement of the square core is more dramatic, but will accentuate even very minor centering errors. A diameter about twice the square side is a reasonable compromise. Set your calipers for slightly more than the diameter you want and use the calipers and a parting tool to pre-size the blank at reasonable intervals as in Fig33. Then use your spindle roughing gouge or skew to turn down to the parting tool cuts and slightly taper the tailstock end as in Fig34.

Final sizing will be done using a drill gauge, one of many things I learned at a terrific class given by Michael Mocho (you can check for classes on his web site: www.mmocho.com). This kind of use constitutes abuse, so don’t buy Starrett. You need a metal drill gauge card—Grizzly has a cheap set of all three (fractional, letter, number). Take a close look at the gauge. On one side the holes will be rounded so lead with the other side. If you’re going to do this a lot you could try lapping the back to sharpen it. Remove your center from the tailstock. Slide a hole of the drill gauge onto the tapered end of the inlay blank with the square edged side facing the headstock. You can remove about 1/64” at a time this way, so you may have to make more than one pass. Retract the tailstock ram all the way and slide the tailstock up until the ram contacts the gauge and lock the tailstock in place. Turn on the lathe at a slow speed and advance the ram as in Fig35. The flat front of the tailstock ram keeps the gauge perpendicular to the inlay blank to keep the cut accurate. If your blank is longer than your ram travel you may be able to stop the lathe, retract the ram and advance and relock the tailstock to finish sizing the blank. Fig36 shows the inlay after sizing.
Prepare the material to be inlaid by drilling the appropriate sized hole as in Fig38. Apply glue appropriate to the material around the rim of the hole and insert and orient the inlay as in Fig39. After the glue has a chance to set cut off the inlay with a saw as in Fig40. Repeat if more inlay is to be inserted, then turn, sand and finish the inlay as in Fig41.

Using

I suggest you glue the inlay in place and then cut it off rather than cut little discs and glue them in place. With discs you have no leverage to reorient the inlay if it goes in rotated or crooked. When using the inlay it is important to orient the square core intentionally rather than randomly. For some reason, perhaps parallax error, it proves to be difficult to insure correct orientation looking at the other end of the inlay blank. I suggest you use a pencil at both ends of the inlay blank to extend the diagonals of the square core to the rim and then join these lines with another line along the cylinder of the blank as in Fig37.

A line traced around the material will both locate the hole and help orient the blank.

Fig36. After sizing the inlay blank. I wrote the size on the barrel so I'd know what drill to use.

Fig37. An orientation line has been drawn on the side of the inlay blank.

Fig38. After drilling a hole to mount the inlay in a sample spindle.

Fig39. After gluing in the inlay. I’ve lined up the orientation line with the line on the spindle to locate the hole.

Fig40. Sawing off the inlay blank just above the spindle surface.

Fig41. After turning the inlay flush, sanding and finishing.

Fig42 shows a pair of tatting accessories with square in circle inlay. The square core is 1/8” square pewter wire. The inlay blank was glued into a brass pen tube to add a rim. For my first try (a sample, thankfully) I naturally used a 7mm drill. For short pieces a slightly smaller drill gives a tighter fit.

Fig43 shows a maple bowl with nine maple/padouk inlays. Perhaps I should call them thru-lays? Rather than drill through the bowl side and risk blow out as the drill exited, I installed the inlay into stopped holes while the wall was still very thick and then finished turning the inside of the bowl.
A Hard Maple bowl with Square-In-Circle Inlay. The core is Maple, the outer pieces are Padouk.

Once you’ve mastered making Square-In-Circle Inlay out of wood you can try other materials such as Corian, acrylics, and soft metals. You could also try laminating more than one wood together before milling the pieces. Have fun. Send me some pictures.

**Tools and Materials**

- Lathe (with collet chuck preferred)
- Conical point tailstock center
- Table saw (with sled preferred)
- Construction lumber scraps for Assembly Jig
- Contrasting wood for inlay
- Glue
- Rubber Bands
- Hand saw (flush cutting preferred)

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