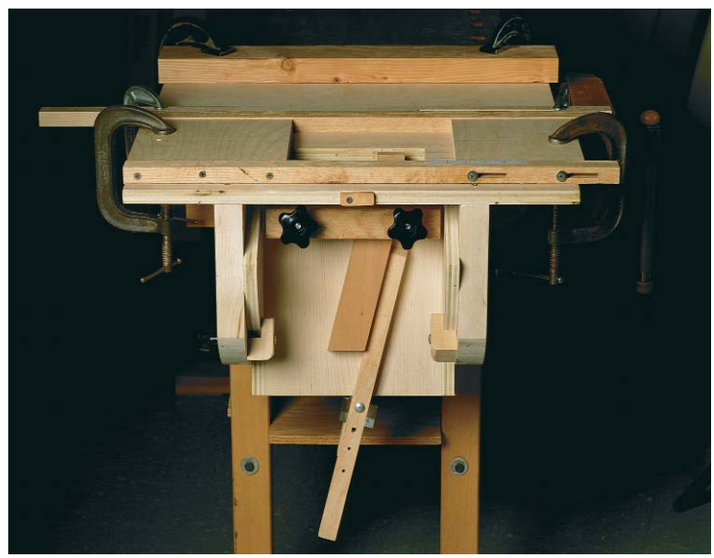
Router Fixture Takes on Angled Tenons

Versatile device ensures tight joints every time

by Edward Koizumi



We live in a turn-of-the-century Arts-and-Crafts house, so it seemed quite natural to furnish it with pieces from that era. My wife bought a pair of Mission armchairs a couple of years ago to go with a 9-ft.-long cherry table I'd built for our dining room. Six months later, she bought two side chairs. It would be a while before we could afford a full set. Within earshot of my wife, I heard myself say, "How hard could it be to make these?"

"Oh, could you?" she asked.

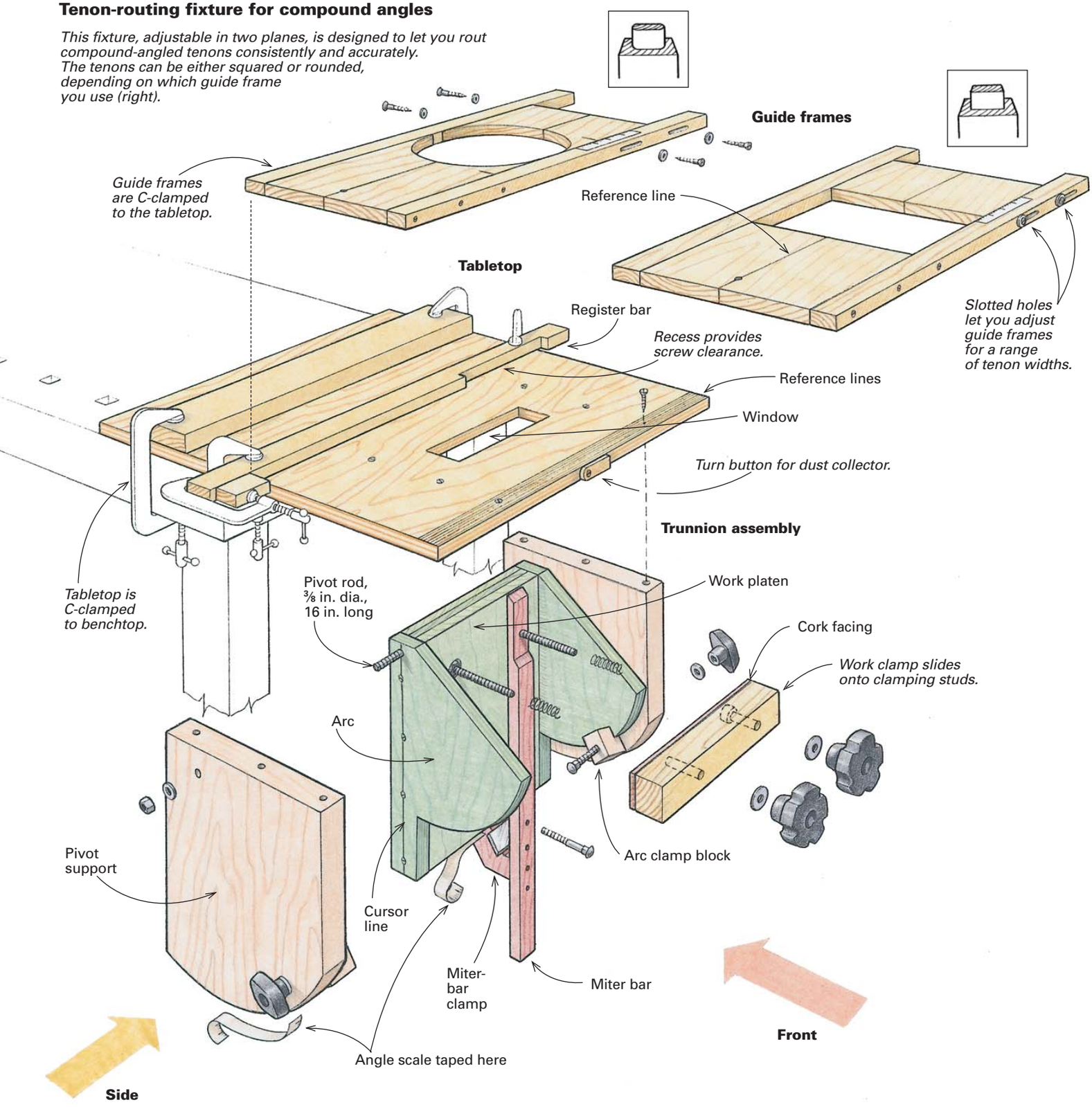
"Sure," I said. The chairs looked straightforward enough, just a cube with a back. Upon closer examination, I realized that the seat was slightly higher and wider in the front than in the back. For the first time, I was faced with compound-angled joinery. I thought about dowels, biscuits and loose tenons, so I could keep the joinery simple, but I wasn't confident in the strength or longevity of these methods.

I wanted good, old-fashioned, dependable mortise-and-tenon joints. After some thought, I decided an adjustable router fixture would be the simplest solution that would let me make tenons of

Bottom photo: Boyd Hagen

Tenon-routing fixture for compound angles

This fixture, adjustable in two planes, is designed to let you rout compound-angled tenons consistently and accurately. The tenons can be either squared or rounded, depending on which guide frame you use (right).



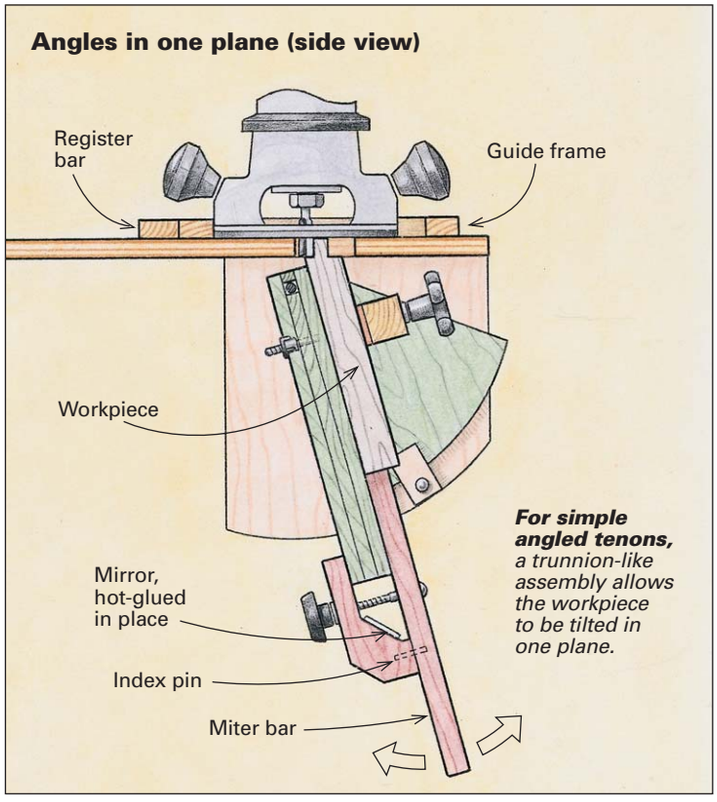
widely varying sizes and angles (see the photos on p. 77).

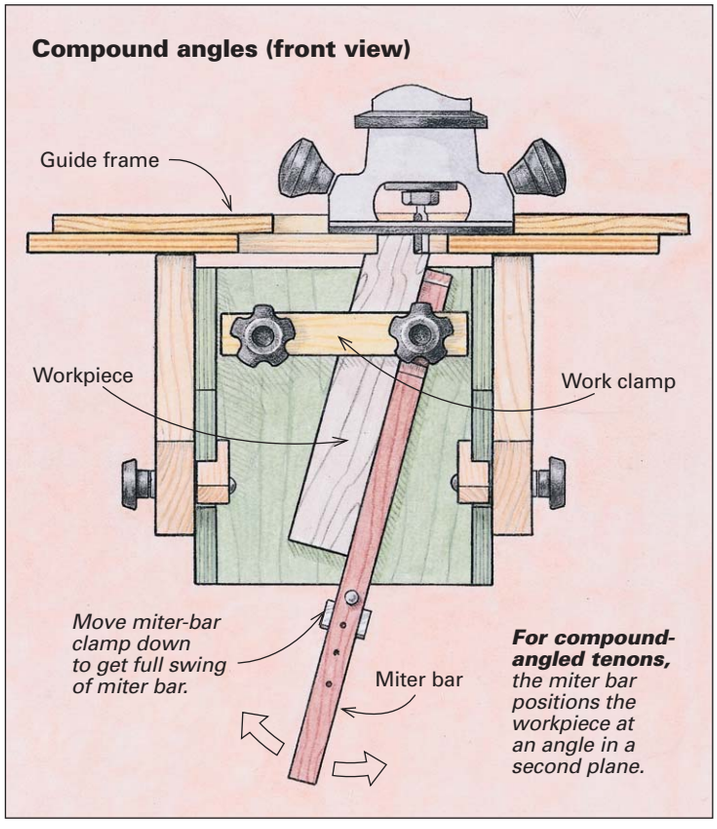
The fixture I came up with is as easy to set up as a tablesaw. In fact, there are some similarities (see the drawing above). The workpiece is held below a tabletop in a trunnion-type assembly that adjusts the tilt angle (see the bottom photo on p. 77). For compound angles, a miter bar rotates the workpiece in the other plane. The fixture can handle stock up to 2 in. thick and 5 in. wide (at 0°-0°) and angles up to 25° in one plane and 20° in the other. This is sufficient for chairs, which seldom have angles more than 5°.

To guide the router during the cut, I clamp a guide frame to the fixture over the window in the tabletop (more on positioning it later). And I plunge rout around the tenon on the end of the workpiece. The guide frame determines the tenon's width and length, as well as whether the ends will be square or round (see the photo on p. 81). I made two frames, both adjustable, one for round-cornered tenons, the other for square tenons.

The fixture and guide frames took me just over a day to make, once I'd figured out the design. Then I spent about an hour align-

Drawings: Heather Lambert





ing the fixture and making test tenons in preparation for routing the tenons on the chair parts. The fixture worked just as planned and allowed this relatively inexperienced woodworker to produce eight chairs that match the originals perfectly.

Making the fixture and guide frames

The fixture is simple to build. It consists of only two main parts, the trunnion assembly and the tabletop. The trunnion assembly (see the drawing on the facing page) is essentially a pair of arcs nestled between two pivot supports. Between the two arcs is a work platen, or surface, against which I clamp the component to be tenoned. There are other parts, but basically, the fixture is just a table to slide the router on and a movable platen to mount the workpiece on.

I built the fixture from the inside out, beginning with the work platen (see the drawing on the facing page). Because I didn't have any means of boring a 10-in.-long hole for the threaded rod on which the arcs pivot, I dadoed a slot in the platen and then glued in a filler strip. Next I located, center punched and drilled the holes for the T-nuts and retaining nuts that hold the clamping studs in place. Center punching ensures that the holes are exactly where they're supposed to be, which is important for a fixture that's going to be used over and over again. I center-punched the location for every hole in this fixture before drilling.

Before attaching the clamping studs to the work platen, I made the arcs, which go on the sides of the work platen. I laid out the arcs (and the pivot supports) with a compass, bandsawed and sanded the arcs, and drilled a hole for the pivot rod through the pair. I glued and screwed the arcs to the platen. After giving the glue an hour or so to set, I tapped the T-nuts into the back of the work platen, screwed in the clamping studs and twisted on retaining nuts, which I tightened with a socket and a pair of pliers.

I made the pivot supports next. Then I cut a piece of threaded rod 16 in. long and deburred its ends with a mill file. I slipped the threaded rod through the pivot supports, arcs and work platen, capped it at both ends with a nut and washer, and made and attached the arc clamps (see the top drawing at left).

Then came the tabletop. I cut it to size, cut a window in it and marked reference lines every ⅛ in. along the front edge for the first 2 in. With the tabletop upside down on a pair of sawhorses, I put the trunnion assembly upside down on the underside of the tabletop. Then I positioned the front of the pivot supports against the front edge of the tabletop and made sure the work platen was precisely parallel to the front edge and centered left to right. That done, I drilled and countersunk holes for connecting screws through the tabletop into the pivot supports. I glued and screwed the pivot supports to the tabletop.

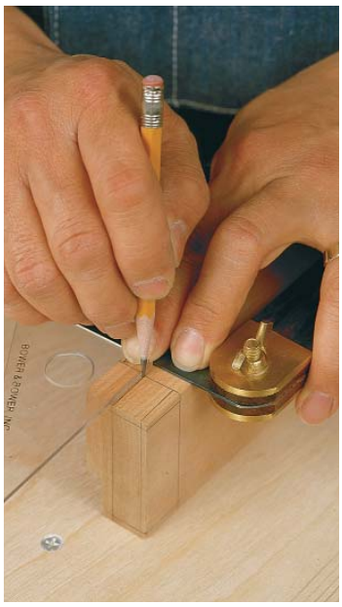
Then it was time to make the miter bar, miter-bar clamp and the work clamp (see the drawings at left). The mirror on the miter-bar clamp makes it easy to read the angle scale from above. I faced the work clamp with cork to prevent marring workpieces and counterbored it to take up the release springs. The release springs are a nice touch. They exert a slight outward pressure on the work clamp, causing it to move away from the platen when loosening the knobs to remove a workpiece.

The guide frames—Now for the guide frames, which clamp to the tabletop and limit the travel of the router. I made the frames adjustable lengthwise to handle a variety of tenoning situations. But their width is fixed. To determine the width of the frames, I added together the desired tenon width, the diameter of the bit I was using and the diameter of the router base. If your plunge router doesn't have a round base, you should either make one from acrylic or polycarbonate (you can cut it with a circle-cutting jig on a bandsaw), or buy an aftermarket version. I screwed the frame together in case I need to alter the opening later (for a new router bit, for example). I marked a centerline along the length of the frame on both ends.

Initial alignment

Before I could use the fixture, I had to get everything in proper alignment and put some angle scales on it. I printed out some an-

SETTING UP FOR ANGLED TENONS



Mark out the tenon on a test piece. *The test piece should be the same thickness and width as the actual components, but length isn't important.*

Make the workpiece flush with the tabletop. *The author uses a piece of milled steel, but the edge of a 6-in. ruler would work as well.*

Make a pattern. *An outline of the tenon traced on acetate helps align the guide frame for cutting any tenons of the same size.*

gle scales from my personal computer and taped them to my fixture with double-faced tape. But a protractor and bevel gauge also will work just fine to create angle scales for both the tilt angle and the miter angle.

To align the parts of the fixture, I flipped it upside down on the end of my bench and clamped it there. I used a framing square to set both the work platen and the miter bar at 90°, sticking the blade of the square up through the window of the tabletop and resting the tongue of the square flush against the inverted face of the tabletop. Then I stuck the angle scales on the two pivot supports and on the bottom of the work platen.

Routing test tenons

Next I routed test tenons with the fixture set at 0°-0°. I positioned the guide frame parallel to the front edge and centered on the window in the tabletop and clamped it to the fixture. I clamped a test piece the same thickness and width as the actual component in the fixture, with one end flush with the top surface of the tabletop. To do this, I brought the test piece up so that it just touched a flat bar lying across the window (see the near left photo). I set my plunge router for the correct depth and routed the tenon clockwise to prevent tearout.

I made a test mortise using the same bit I planned to use for the mortises in the chair. The fit wasn't quite right. So I adjusted and shimmed the frame until the tenon fit perfectly. If you rout away too much material and end up with a sloppy tenon on your test piece, you can just lop off the end and start over.

Once I had a tenon that was dead-on, I made an acetate pattern that allowed me to position the guide frame accurately for all tenons of the same size, regardless of the angle. I cut a heavy sheet of acetate (available at most art-supply stores) so that it would just fit into the guide-frame opening. I marked a centerline along the length of the acetate that lines up with the centerline down both ends of the guide frames. I also indicated which end was up and where the acetate registered against the guide frame. Then I put the test piece with the perfectly fitted tenon back into the fixture, laid the acetate into the opening in the guide frame and traced around the perimeter of the tenon end using a fine-tip permanent marker.

Routing angled tenons

With the pattern, routing angled tenons is pretty straightforward. I crosscut the ends of all the pieces I was tenoning at the appropriate angles and marked out the first tenon of each type on two adjacent sides, taking the angles off a set of full-scale plans. Then I extended the lines up and across the end of the workpiece (see the top left photo).

Having set the fixture to the correct angles, I brought the workpiece flush with the tabletop using a flat piece of steel as a reference (see the top right photo). Then I clamped the workpiece in place. Finally, I set the acetate pattern in the guide-frame opening and positioned the guide frame so that the pattern and the marked tenon were perfectly aligned (see the photo at left). With the guide frame clamped in place, I removed the acetate and routed that tenon. All other identical tenons needed only to be flushed up and routed. After the first, it was quick work.

There are pitfalls though. I found it important to chalk orientation marks on each workpiece. It can get confusing with two angles, each with two possible directions. And I had to be especially careful when routing the second end of a component. Make sure it's oriented correctly relative to the first. I messed up a couple of times and have learned to plan for mistakes by milling extra parts and test pieces. You might even end up with an extra chair.

Photos except where noted: Vincent Laurence

Guide frame determines thickness and width of tenons. *The author keeps the router's base against the inner edges of the guide frame and routs clockwise to prevent tearout. Guide frames can produce round-cornered or square-cornered tenons.*

To get flat surfaces on curved parts so I could clamp them in the fixture, I saved the complementary offcuts and taped them to the piece I was tenoning. Or I could have tenoned first and bandsawed the curves later.

For pieces with shoulders wider than the bit I'm using to remove waste, I clamp a straight piece of wood—a register bar—against the guide frame (a small pocket for screw clearance may need to be made), as shown in the drawing on p. 78. That way I can rout most of the tenon, unclamp the guide frame, slide it forward (using the reference lines at the forward end of the tabletop to keep it parallel), clamp it down and then rout the remainder. I start the next piece in the same place and return the guide frame to the original position to finish the tenon. □

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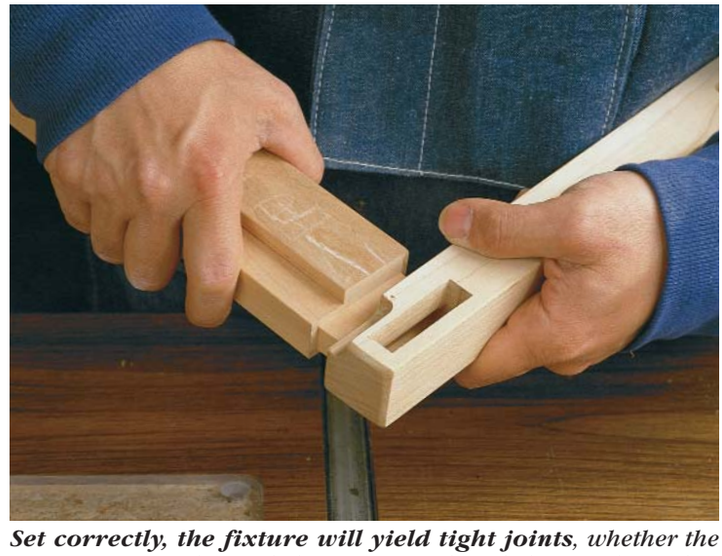

Set correctly, the fixture will yield tight joints*, whether the tenons are straight, angled or compound-angled. Here, the author tests the fit of a seat-rail tenon into a leg mortise.*