Router-Assisted Cockleshell Carving

A swinging jig shapes the interior and defines the flutes

by Howard Wing

The key to making a profit on a complicated piece like a shell-top cabinet is to control labor hours. When researching shell design before my first attempt at carving one, I read an article by Franklin Gottshall, an experienced carver and period furniture maker. Gottshall acknowledged putting two weeks of labor into carving a shell, and I got the impression he worked long days. If I took that long just to carve the large cockleshell, the cabinet would be a sure budget-buster. So I began to think about a router set-up that could shape the basic spherical surface of the shell as well as rough out the flutes.

The two-axis router jig I developed worked well to shape the interior of the shell and to define the flutes for the cabinet shown at right. However, I did notice some undesirable flexing in the jig, so when the next shell-carving job came along, for a smaller shell to top off a clock, I reworked the jig to eliminate these problems. The new jig, shown in the top photo on p. 89, worked perfectly. I first cut the inside of the shell to a spherical shape with a straight bit mounted in the jig-held router. Next, I changed to a core-box bit to outline both edges of the flutes. Then, by shifting the vertical pivot point, as shown in the drawing on the next page, I was able to cut the bottom of the flute with decreasing depth from front to back. Although I could have continued to rout away the waste in each flute, I found it quicker to hand-carve the waste with a gouge, connecting the router cuts along the edges of each flute with the bottom cut that defined the flute's depth. The total time to make the shell, including building the jig, was just 36 hours.

Stack-laminating the shell

The blank for carving the shell is glued up from a series of decreasing diameter brick-layered arches. I made a full-size drawing so I could determine the inside and outside diameters of each layer, as shown on the next page. From the drawing I was also able to determine the approximate angle of the inside face of each layer. To minimize the amount of material I would need to remove with the router, I bandsawed the inner diameters to these angles. The angle for the top layer is too acute to bandsaw, so I left it as a solid slab for glue-up and later chiseled away enough waste to provide clearance for the router jig. After bandsawing the semi-circular bottom layer, but before cutting its inside face, I used an extended fence on my tablesaw's miter gauge to guide the piece while crosscutting flat reference surfaces on the outer ends. These surfaces are used later to mount the router jig on the shell. I also ripped a flat reference face along the center of the back edge of the bottom layer, so I could screw the shell blank to a mounting board. I then glued, stacked and screwed the individual layers as shown.

Building the router jig

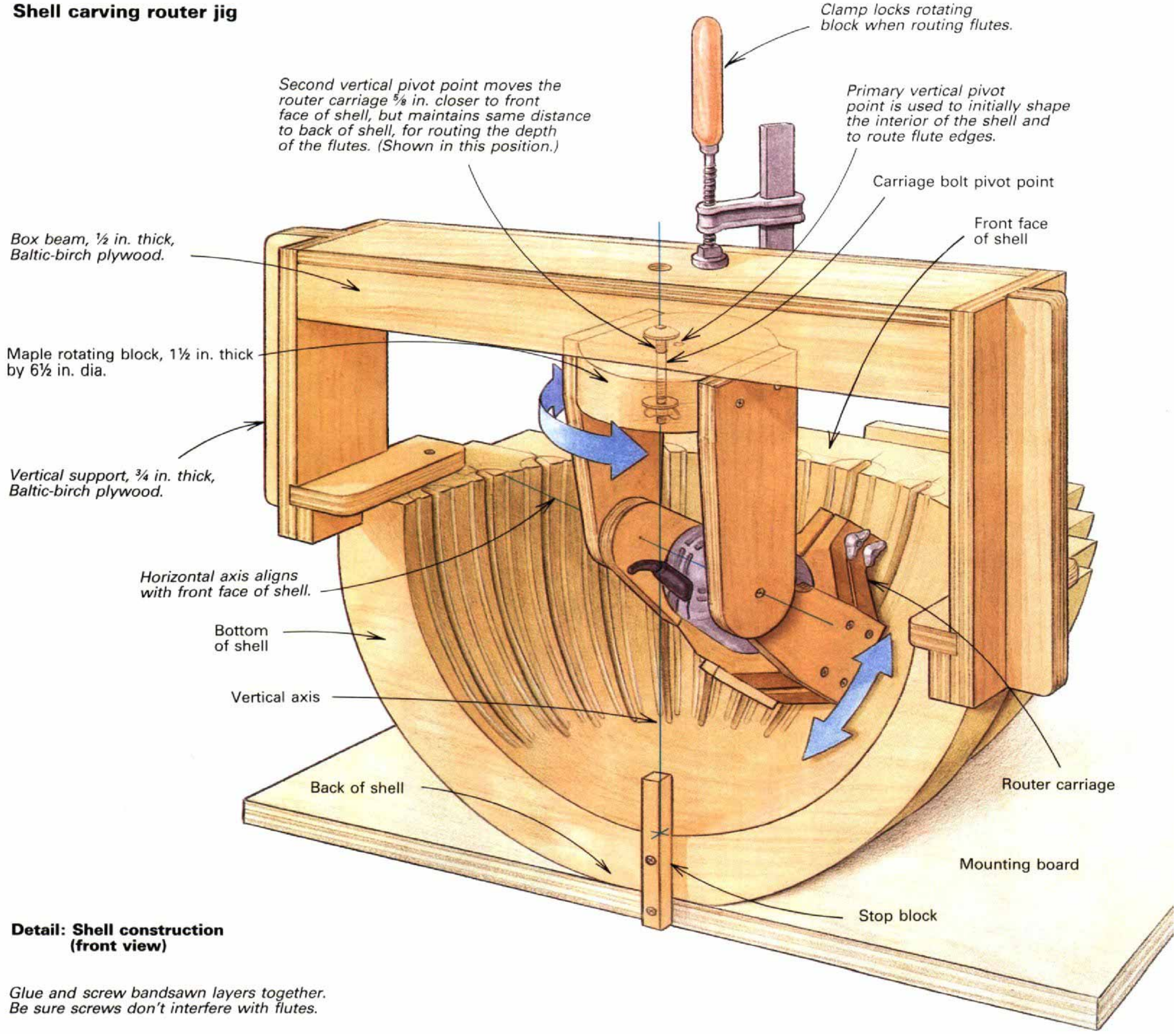
Although the jig in the top photo on p. 89 is for a much smaller shell than I used for the cabinet shown below, the principles are the same. The dimensions are immaterial as long as the jig is designed so that the pivot points are located directly on the shell blank's vertical and horizontal axes.

The jig has a fixed box beam that bridges the front of the shell and provides a mounting-and-pivoting point for a swinging arm that carries a router. The box beam is held by vertical supports screwed to the shell blank and supports the swinging router carriage so that the router bit is aligned with the vertical axis of the quartersphere, The

Cockleshells traditionally required many hours of skilled hand-carving. *But the author devised a router jig that helped him cut the time in half for making the shell in this cabinet.*

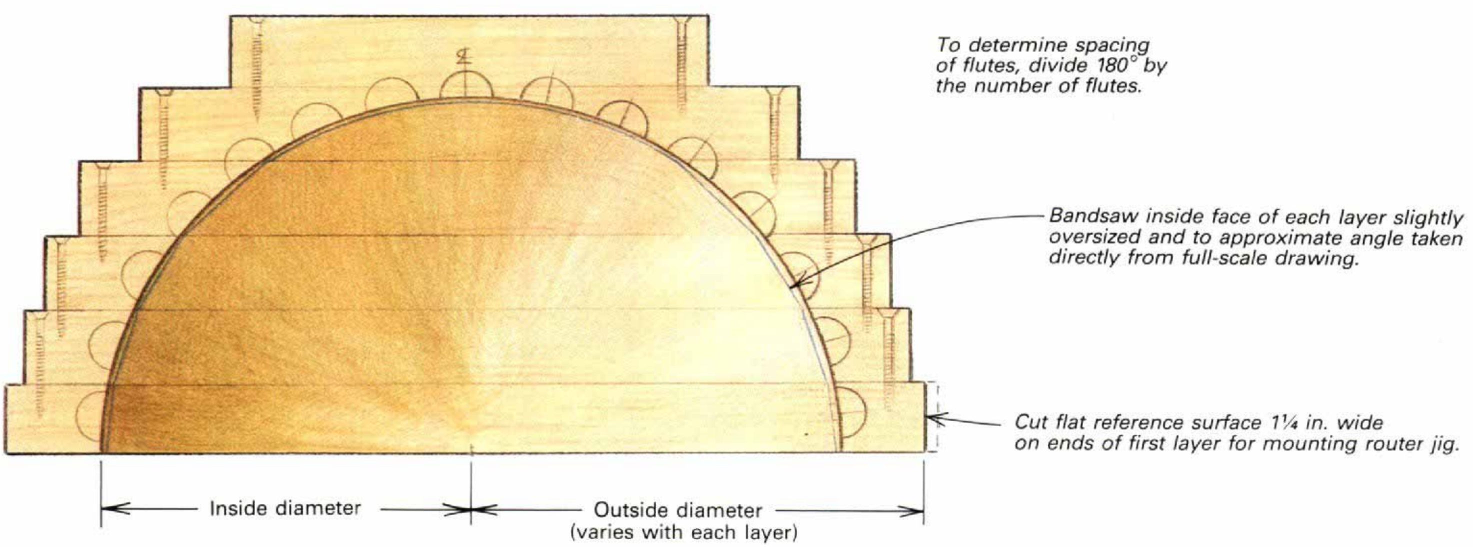
photo this page: Wolfgang Motzafi-Haller

Shell carving router jig



Detail: Shell construction (front view)

Glue and screw bandsawn layers together. Be sure screws don't interfere with flutes.



beam's key design consideration is to ensure it doesn't interfere with the swinging arm that carries the router through 90° of front-to-back movement and 180° of side-to-side movement.

The router carriage consists of split rings that hold the router and a pair of articulated plywood arms suspended from the rotating block bolted to the box beam. The arms are dimensioned so that their pivot point falls on the horizontal axis. It is important to eliminate vibration and play in the rotating axes and in the router hanging at the end of the swinging arm. For the pivot point at the vertical axis, I used a ⅜-in.-dia. bolt that fits tightly through holes in the beam and the rotating block to which the swinging-arm router carriage is attached. For the horizontal pivot points, I used two #10 flat-head wood screws. By slightly adjusting the screws, I can remove all play yet maintain smooth movement.

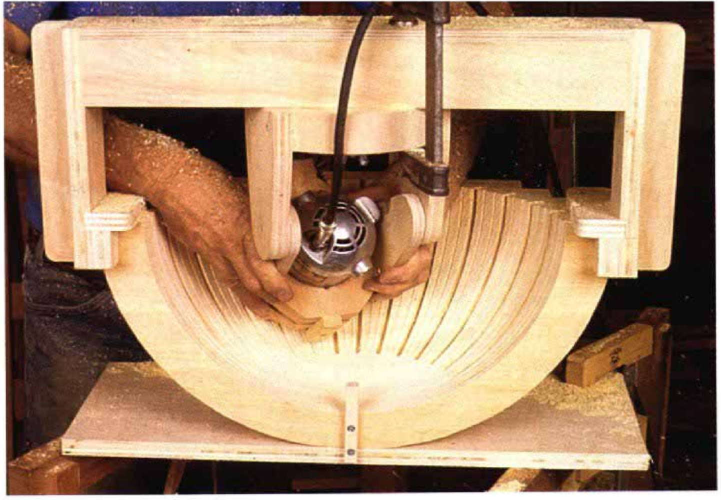
To rout the sides of each flute, the rotating block can be clamped to the beam to restrict movement about the vertical axis, and then the router carriage can be swung about the horizontal axis. While the bottom of the flutes have the same radius as the basic spherical section, they are deeper at the shell's front edge than at the back So, I drilled a second vertical pivot point in the rotating block, ⅝ in. behind the first pivot point, to shift the jig's horizontal axis of rotation toward the front of the shell while maintaining the same relationship to the back. This allows the router to cut flutes that become shallower as they move from front to back.

Using the router jig

To hold the shell for routing (and later carving), I screwed it to a mounting board. I then aligned the jig on the shell, as shown in the drawing, so that the router bit lined up with the vertical axis and the router-carriage pivot points lined up with the horizontal axis. Because the jig is used to rout the internal surface of the sphere, this alignment was not critical; anything within 1/16 in. of the layout lines would be fine. Then I screwed the jig to the shell.

I started cutting the spherical interior surface with a ½-in.-dia. straight mortising bit adjusted to cut ⅛ in. deep. Depth of cut is adjusted by loosening the wing nuts that secure the router carriage's split wooden rings, sliding the router to desired depth and then tightening the nuts. I guided the router in both axes' directions using my hand to support the swing arm. I adjusted the depth and repeated this process until the inside surface was completely shaped. This went quickly, and in less than an hour, I had a nice spherical surface with only slight tool marks. I thought I might need to switch to a large core-box bit after rough-cutting with the mortising bit to get a better finish, but the straight bit worked very well. I then hand-sanded the shell down to 120-grit to get a paint-quality surface (only 15% is used because the rest is cut away in making the flutes).

Before cutting the 15 flutes, I laid them out along the front edge of the shell. I put a ¼-in.-dia. core-box bit in the router and, after aligning the bit to one of the layout lines, clamped the rotating block to the box beam to prevent any movement in the vertical axis. I adjusted the depth of cut until the bit was just shy of the inside surface of the sphere and swung the router toward the back of the shell to determine where to position a stop block to limit the length of the flutes. Because I wanted to leave room for a carved, semicircular design at the back of the shell, I needed a stop to prevent the flutes from converging. With the stop block in place, I swung the router back to the front edge, adjusted the router to cut ⅛ in. deep and made the pass from front to back to define one edge of a flute. Next, I undamped the rotating block, realigned the bit with the other edge of the flute layout line and made a second pass to outline that edge. I repeated this procedure 28 more times to outline all the flutes. I found that having a helper work the clamps while I controlled the router cut the time required for this process in half.



A two-axis router jig is used to define the edges *and bottom of each flute. By shifting the horizontal axis, the flutes are routed progressively deeper from front to back. The jig was also used to shape the interior of the shell before fluting.*

Hand-carving the flutes on the shell with a gouge is fairly easy *after their sides and the depth have been defined by router cuts. A sharp gouge is essential to minimize tearout when carving endgrain, and a spoon gouge or bent gouge is helpful in tight areas.*

To rout the grooves that define the bottom of the flutes, I had to remove the router carriage from the bridge and remount it using the second vertical pivot point I had drilled in the carriage's rotating block. This moved the horizontal axis forward and allowed the router to cut the flutes deeper at the front of the shell than at the back. To cut the flutes to final depth, I used the previously described technique of aligning the bit, clamping the rotating block and swinging the router through the horizontal axis. Since I couldn't cut to the full ⅝ in. depth in a single pass, I had to make the circuit around the shell five times, increasing the depth of cut by ⅛ in. after each completed circuit.

Carving the flutes

After the machine work came a day of hand-chopping the flutes with gouges, as shown in the bottom photo above, and then scraping and sanding the flutes smooth. But it only took about 20 minutes to do each flute, because the router cuts had done the difficult work of making clean, straight edges and establishing the depth of each flute.

At this point I realized the biggest advantage of my router technique was the guarantee of a high-quality spherical surface as the starting point for the flutes. This was confirmed when I looked at museum pieces with hand-carved shells and saw that flutes with tiny imperfections tended to have slight wanderings in the lands between flutes. Aberrations like this are expected and charming in true period pieces, but I suspect that even oldtime carvers used every means available to make their flutes as straight and true as possible. □

Howard Wing is a professional woodworker in Boxborough, Mass.

Photos this page: Charley Robinson; drawings: Bob La Pointe

Gluing up a shell with tapered segments

by Philip C. Lowe and Justin P. Smith

Fig. 1: Determining angles and dimensions for shell segments

All the dimensions and angles necessary to make the two patterns and the three jigs shown in Fig. 2 for planing the segments to the compound angles required to make a shell of radiating segments (shown in the photo on the facing page) can be developed from two views of the shell, a front view and a top view through a section of the shell, by following these steps:

Step 1: Determine angle X by dividing 180° by the number of flutes in the shell, and draw a full-scale front view of the shell.

Step 2: Draw top view of segment (2) at section AA directly under front view of segment (1) as shown in this drawing.

Step 3: Create segment (3) by projecting front view (1) below top view (2) and align as shown in drawing.

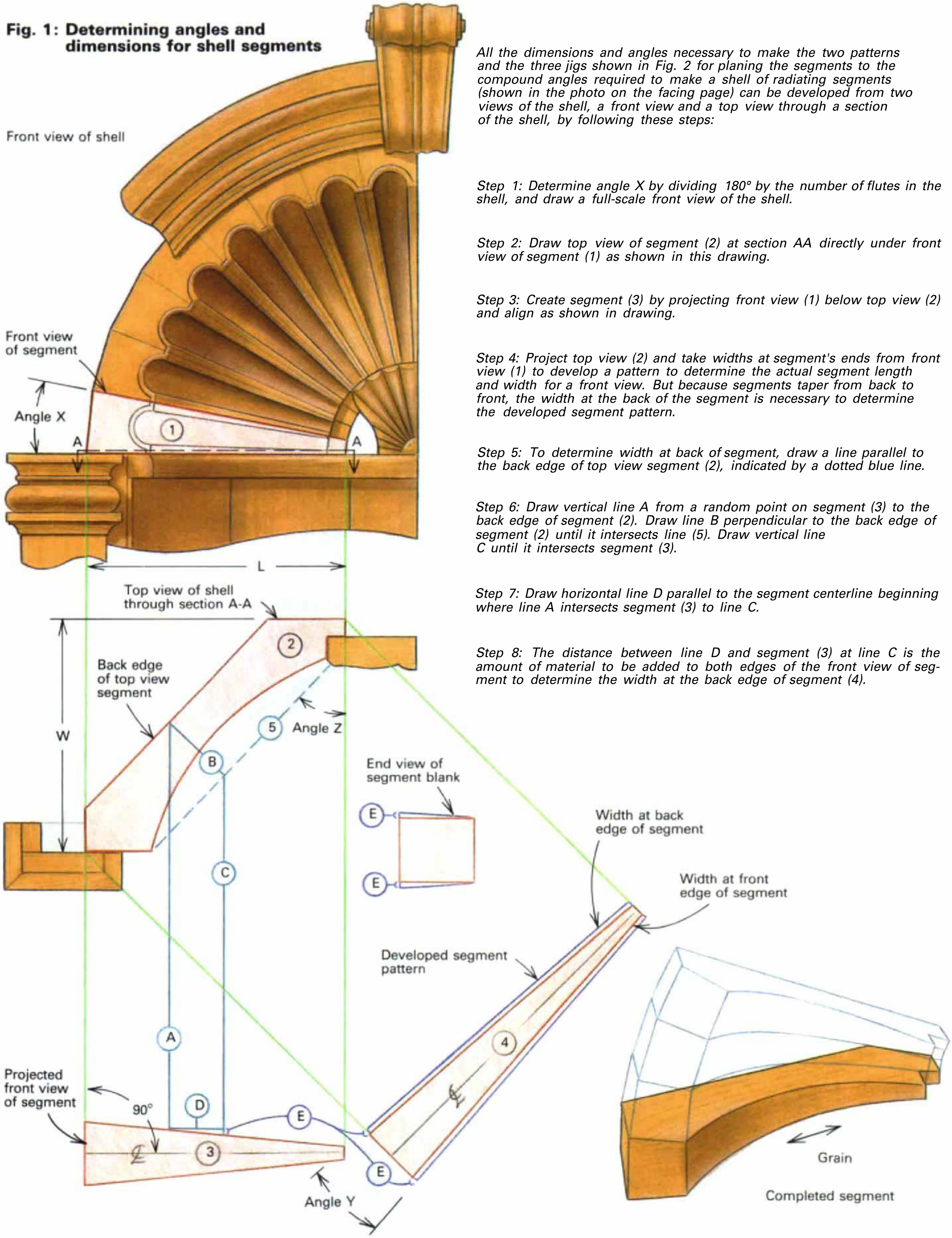
Step 4: Project top view (2) and take widths at segment's ends from front view (1) to develop a pattern to determine the actual segment length and width for a front view. But because segments taper from back to front, the width at the back of the segment is necessary to determine the developed segment pattern.

Step 5: To determine width at back of segment, draw a line parallel to the back edge of top view segment (2), indicated by a dotted blue line.

Step 6: Draw vertical line A from a random point on segment (3) to the back edge of segment (2). Draw line B perpendicular to the back edge of segment (2) until it intersects line (5). Draw vertical line C until it intersects segment (3).

Step 7: Draw horizontal line D parallel to the segment centerline beginning where line A intersects segment (3) to line C.

Step 8: The distance between line D and segment (3) at line C is the amount of material to be added to both edges of the front view of segment to determine the width at the back edge of segment (4).



A shell can be constructed with stacked, crescent-shaped pieces, as long as the resultant checkerboard grain pattern is covered with paint. When we make shells that will have a clear finish, like the one shown at right, we glue up radiating segments (one for each flute) to provide a more uniform appearance and to make carving with the grain easier.

The shell's blank is comprised of compound-angle segments that taper from outside end to inside end and from back to front. To cut the blanks for these segments, we developed patterns following the step-by-step procedures given in figure 1. It's easy to come up with a top-view segment pattern and a front-view pattern based on a full-scale drawing. But because the segment is wider at its back face, we used a boatbuilders trick known as lofting to determine the front-to-back taper without resorting to complicated mathematical formulas (see steps 3 through 8 in figure 1). Using the patterns, we laid out and cut the segment blanks and then we planed the compound angles on the sides of the segments using the jigs shown in figure 2.

Before gluing the segments together, we bandsawed the front face of each to rough shape. A spare segment, ripped along its centerline and placed under each segment when bandsawing, ensured that the cut was perpendicular to the segment's centerline.

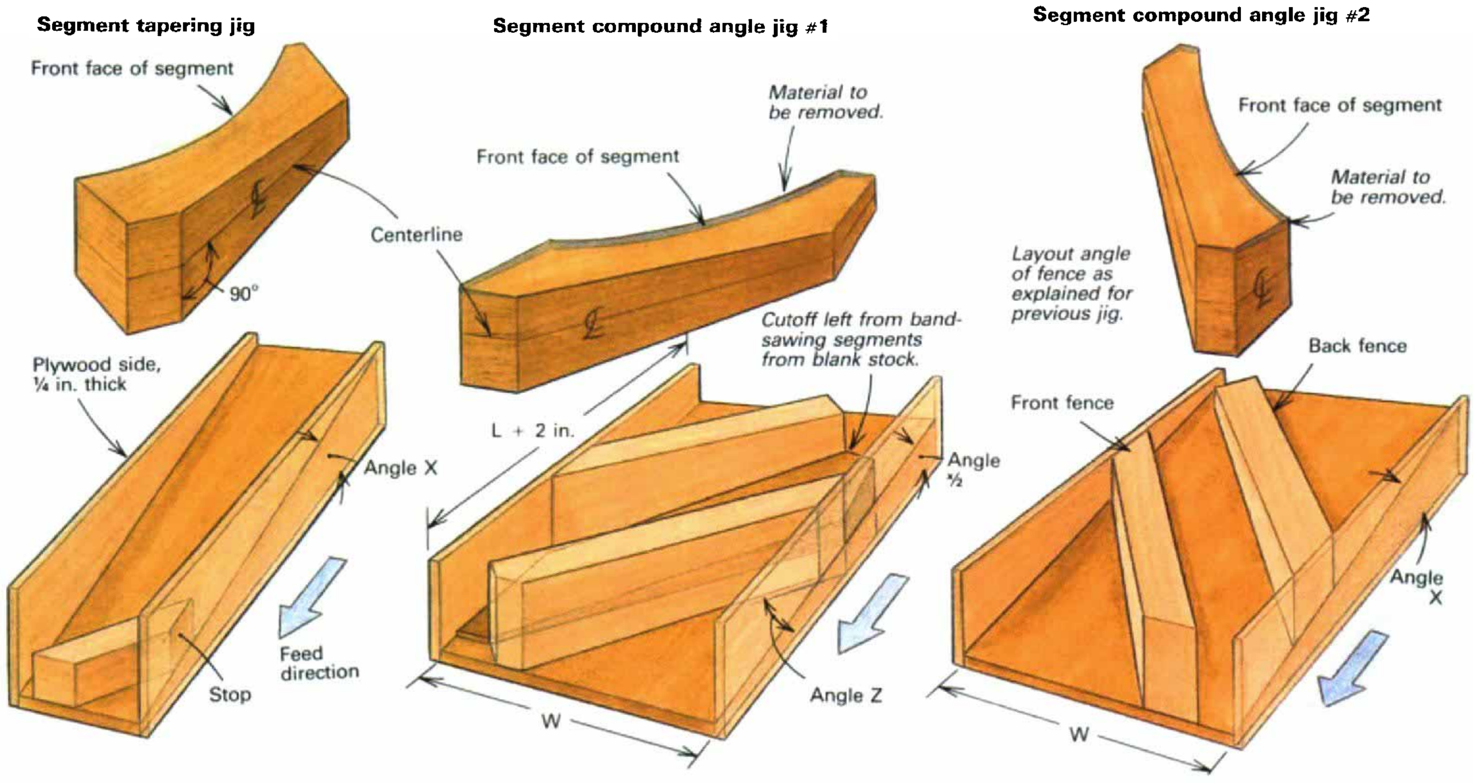
We glued up the segments in pairs with hot hide glue by rubbing the segments together until the glue just began to grab and then quickly aligning the pieces. If the joints are good, clamps are not necessary. We then glued pairs of pairs together until the shell was completed.

When we developed these methods we were making two cabinets, and so we glued the two shell blanks together with paper between them to form a bowl shape and then turned the interior on a lathe. Turning a blank this size requires a low speed on a large, well-anchored lathe. For a single shell, we normally hand-carve the interior shape before carving the flutes, but the jig shown in the previous article is an attractive alternative. □

Phil Lowe and Justin Smith specialize in designing, fabricating and restoring fine furniture in Beverly, Mass.

A clear-finished shell glued up from compound, angled segments *has a more consistent color across the interior of the shell than the checkerboard pattern of endgrain and long grain found in the typical layered shell.*

Fig. 2: Angle jigs for preparing shell segments (angles and dimensions taken from Fig. 1)



This jig is used to plane all segments to the same dimension and create uniform end-to-end tapers as determined from full-scale drawings. Prepare the blanks by first planing stock to thickness and then layout each piece using the developed segment pattern. Bandsaw the segments from the blanks and save two cutoffs: one is used in the compound angle jig #1 and one is placed under the segments so that bandsaw cuts are perpendicular to the segment. Joint one face of the segment and then place it, jointed face down, in the jig.

When run through the planer, this jig adds a back-to-front taper creating a compound angle on one side of the segment.

Lay out angle of fence (angle Z from top view in Fig. 1) on flat bottom surface of base, transfer lines up sides with square and connect with straight edge.

This jig positions the segment for planing to final dimension and produces the required compound angle on the second side so that the segments, when assembled, will form the shell blank.

Note that the angle of the fences is reversed from previous jig for planing the opposite side of the segment.

Photo this page: Philip C. Lowe