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March/April 1986, No. 57, $3.75

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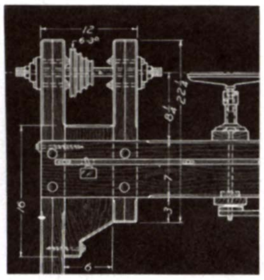


Cover: Carlyle Lynch's readily buildable lathe is suitable for turning everything from delicate bowls to a 6-ft. bedpost. Plans are on p. 44.

Fine Woodworking (ISSN 0361-3453) is published bimonthly, January, March, May, July, September and November, by The Taunton Press, Inc., Newtown, CT 06470. Telephone (203) 426-8171. Second-class postage paid at Newtown, CT 06470, and additional mailing offices. Subscription rates: United States and possessions, $18 for one year, $34 for two years; Canada and other countries, $21 for one year, $40 for two years (in U.S. dollars, please). Single copy, $3.75. Single copies outside U.S. and possessions, $4.25. Send to Subscription Dept., The Taunton Press, PO Box 355, Newtown, CT 06470. Address all correspondence to the appropriate department (Subscription, Editorial, or Advertising), The Taunton Press, 63 South Main Street, PO Box 355, Newtown, CT 06470. U.S. newsstand distribution by Eastern News Distributors, Inc., 1130 Cleveland Road, Sandusky, OH 44870.

DEPARTMENTS

ARTICLES

Postmaster: Send address changes to The Taunton Press, Inc., PO Box 355, Newtown, CT 06470.

The wooden clockworks article in *FWW* #56 reminds me of my uncle who was an impecunious professor at Davidson College around 1920. He had a grandfather clock that didn't keep time, so he took it to the local clocksmith and told him to put in some good works, which he did. A few weeks later my uncle saw in the clocksmith's window a grandfather clock with an unbelievably high price tag on it. My uncle went in and asked why a clock that looked just like his was for sale at such an extravagant price. The clocksmith said, "Because it has wooden works." My uncle replied, "Well, my clock had wooden works." The clocksmith answered, "Yes, they are your works." *—Pendleton Tompkins, San Mateo, Calif.*

I read, with great interest, Glenn Gordon's article on James Krenov and his work (*FWW* #55). As an amateur woodworker with no formal training, I have used books as my teacher, Krenov's among them. I find myself constantly drawn to them because they are incredibly inspirational.

To me, craftsmanship of Krenov's caliber is not drawn from inspiration, but rather from the unsettled emotion to create to an inner satisfaction . . . a rare quality in a world that equates success with material possessions and financial status. Consciously or not, Krenov seems to be a true romantic concerned, as Aristotle stated, not with things as they are, but rather as they should be. Because he knows no other way, his legacy to craft will endure and provide countless many with an example of the unlimited potential of the human spirit. I know of at least one person whose world has been enriched knowing that James Krenov is in it. *—Edward Carpp, Mentor, Ohio*

One of the first woodworking books I read was Krenov's *The Fine Art of Cabinetmaking*. No book has influenced my attitude toward woodworking more than Krenov's. I built a small wooden plane according to his plans and it works like no other in taking fine shavings, even from difficult wood. Many times I am tempted to take shortcuts, but there, always, is the spirit of James Krenov, reminding me to do it the right way, even if it's more difficult. I've made several large tables with hand-planed surfaces which give me satisfaction whenever I see or feel them.

So, I read the article by Glenn Gordon on James Krenov in *FWW* #55. What's this? He doesn't like to build large pieces of furniture? The best chairs have already been built? Come on Jim, get off the pedestal and lighten up. Run, don't walk, to the nearest drawing board to plan and build a Queen Anne highboy (like in *FWW* #42), or a dining table four feet wide and long enough to seat twelve. Krenov has become comfortable making little cabinets and it seems as though instead of playing to win, he is playing not to lose. It sounds as if he needs a new (or old) challenge to open up his horizons, and share his insights. He, and we, would be the better for it.
—John Toffaletti, Durham, N.C.

Glenn Gordon's article on James Krenov was totally outstanding. I, too, have read and been deeply influenced by Mr. Krenov's writing and his cabinetry. I also sensed the paradox inherent by following his line of thinking on craftsmanship.

The illuminating thing in Gordon's article was that doing strict, high-minded work can have a stifling effect on the maker and on the work. That was probably a barrier I felt since reading Krenov's books. I certainly became much more judgmental of my own work, and sometimes inhibited, if I didn't think the job would have any great significance or add to the body of the creative cabinet pool.

There does need to be a balance between the artistry we wish to express when we build something and the service it should provide its users. *—Brad Schwartz, Santa Ana, Calif.*

I enjoyed the tablesaw article by Rich Preiss. He says he sees no arguable difference between Powermatic and the Unisaw. An enormous difference is that the Powermatic arbor tilts away from the fence opposed to virtually every other saw, the Unisaw included, which tilt toward the fence. Tilting toward the fence traps the material if there's any imprecision in either saw setup, material or operator feed. Also, doing bevel cuts is awkward when the tapered edges tend to go under the fence.

Lastly, a double question. How many of us use the safety equipment on tablesaws? I don't. How often has anyone experienced kick-back? In twenty years in the business, I have once. If safety is your big concern in ripping, use a bandsaw.
—M.F. Marti, Monroe, Ore.

Your article on tablesaws is disappointing. I would suggest in the future that you follow the outline from your article on thickness planers. That had some meat to it and got the attention of both readers and manufacturers. We still don't know the advantages and disadvantages among several saws such as Delta, Grizzly, General and Powermatic. This article must have been written for the benefit of the advertising department. It certainly wasn't written for the serious woodworker.
—Lawrence J. Raleigh, Casco, Me.

Re the letter from Dale E. Grossnickle, *FWW* #55, on plug cutters burning out. I have two suggestions: First, I always overlap the previous hole or cut the plug at the edge of the stock, allowing part of the cutter to be exposed outside the hole. This allows the heat to escape. Second, I reduce friction by occasionally rubbing paste wax on the outside of the cutter.
—Gerry Drewicz, Greenfield, Wisc.

I, too, have had problems while drilling deep holes in hardwoods with my Forstner bits. I have found a company that will take your *sharpened* tool and Metaloy it with chromium to an equivalent hardness in excess of 70 Rockwell "C." Other good characteristics are resistance to heat, corrosion and wear. It's like having a carbide tool at a fraction of the cost. If anyone is interested, they can send a SASE and description of the tool to be treated to OK Products of Tulsa, Inc., 4295 West 50th St. South, Tulsa, Okla. 74107, and they will send you a brochure and price list. *—Jerry Ernce, Broken Arrow, Okla.*

For those of us who enjoy woodworking but don't have the money and/or space for top-quality equipment, yet enjoy what we can do with the cheaper plastic models, this experience will help "keep-'em-running."

Recently the plastic hub of one of the idler wheels in my bandsaw cracked and expanded, causing a bad wobble. I repaired it using epoxy glue as a filler to repair the expanded hole and anchor the metal bushing. I filed a herringbone pattern around the outside of the metal bushing and made deep scratches inside the plastic hub. A short piece of wood dowel kept glue out of the center of the bushing, and off my fingers, as I applied a thick coat of epoxy and inserted the bushing in the hub. After letting the glue set for about 10 minutes, I scraped off the excess, removed the dowels and put the wheel back on its axle in the saw frame. There was still enough give in the wet glue to allow for adjustments in making the wheel turn true. After overnight drying I am back in business, as good as new. *—Walter Johnson, DeKalb, Tex.*

Two weeks ago, I attended my first woodworking show at the O'Hare Expo Center in Chicago. I was awestruck to see the great names in woodworking machines for the first time, like Ulmia tablesaws, Hegner scrollsaws and lathes and the

Delta products. I had a great day with my Dad, a woodworker for 45 years. However, I couldn't help leaving the show feeling a disappointment that gradually turned into a slow burn.

I went to this show to learn some things and see new machines, and hoped to come home with something my shop needed. Well, I found it: the new Paralok rip fence. In my mind, it's the best of its kind and the one thing that would double my small shop's efficiency. However, I could not afford it and felt it was overpriced. What burns me most is that many of the woodworking products you advertise and write about are for the "serious woodworker." How in the hell can anybody afford to be a serious woodworker? The article about survivors in your November issue is a good example. With what they must pay in overhead, it has to be tough for woodworkers to survive.

I don't know who is to blame, the dealers, the marketing people, the advertisers, the unions. Until I'm rich and famous or until prices come down, I, like many others, will keep struggling for perfection with my homeowner tool-equipped shop. —*Keith Gansel, Chicago, Ill.*

The photos of the quilted mahogany in *FWW* #54 were wonderful. If Mark Berry learns more about veneering in the future, he will regret that he did not cut six or seven veneers from each 1-in. plank. This would require ripping the 18-in.-wide boards into several narrower boards prior to cutting veneers, and then carefully edge-gluing them back together. The loss of 1/16 in. to 1/8 in. would be virtually undetectable in the dresser sides. Not only was his method wasteful, but gluing 1/4-in.-thick veneers on a stable plywood core will most likely result in the mahogany panels pulling in at the edges, warping, and cracking or splitting in the middle of the panel.
—*Monroe Robinson, Ft. Bragg, Calif.*

The eradication of the tropical rain forests is going to be one of the greatest disasters that mankind has ever brought upon itself. Total energy patterns and planet climate will be disrupted as the biomass of the equatorial green belt disappears.

America is blessed with diverse and numerous species of commercially acceptable wood. Domestic trees can fulfill most woodworkers' needs. In fact, we export various woods that are found nowhere else. With these facts apparent, I ask why do you, as one of the major forces in trade literature, ignore this problem? Why, indeed, do you carry articles that glorify the shortsighted entrepreneurs who profit as the deserts grow?

I would like to see a bit more balance in your suggestions as far as total costs for choices of materials. Of course, the woodworkers have the ultimate say on what we import and use. If a wood is in one of the crisis areas, please have the consciousness to mention it. —*Howard Bruner, Astoria, Ore.*

In response to the recent article by Rick Walter commenting on "The Primary Source" there are a couple of points one should consider. A recent government publication on "Wood Use" by the Office of Technology Assessment gives the following statistics:

Countries with largest forest areas

	Growing stock (million cu. ft. over bark)	**Industrial harvest (million cu. ft.)**	**% broad-leaved**
U.S.S.R.	2,638,010	10,000	17
Brazil	1,662,677	1,500	99
United States	710,860	11,500	35
Canada	693,664	5,100	21

Clearly, the implication one should avoid tropical woods has an exception—Brazil. The deforestation issue is valid, however. Indiana once had 90% of its total area in prime hardwood. Now near 15%, it is because of conversion to agriculture, not exploitation by the forest industry for timber. In many cases, the wood was piled and burned if no use existed.

I believe this is happening in many third world countries. We should support usage of wood from these countries to help develop their economies and conserve the U.S. resource. The clearing of land will continue as their agriculture expands to meet the population growth. The United States is growing more timber than it is harvesting, according to the Forest Service. Tropical forests are considerably more productive than temperate forests. The problem with commercial farming to a large scale in the tropics is access. Very few and primitive roads exist. I believe the problems associated with harvesting are the reason for high prices, not scarcity of the resouce. —*Toby J. Seiler, Bloomington, Ind.*

"Survivors" by Roger Holmes (*FWW* #55) was very timely for my wife and me, who, after years of fighting the urge, embarked on a full-time cabinetmaking and lumber business one year ago, leaving behind a reasonably secure position with the postal service. We were very nervous, to say the least. Each month has brought increased business and additional rewards. We currently have orders to fill through next fall. The risks we have come to enjoy, and after the initial decision of being self-employed, all other decisions of business came easier. Next to our getting married, self-employment in the wood industry was the best decision we have ever made!
—*Thomas and Linda Turnbull, Stanton, Mich.*

Re the sidebar "Saw it Straight," (*FWW* #55): In your sketch, the saw kerf is on the infeed side of the blade. How did you guys do that? —*Timothy D. Anderson, St. Paul, Minn.*

EDITOR'S NOTE: We did it with our eyes closed. So intent were we on correctly rendering the tablesaw's details that the misplaced kerf got by us entirely. Besides Tim Anderson, a half-dozen other sharp-eyed readers spotted the gaffe.

I enjoyed John Kriegshauser's article on the three-way miter joint (*FWW* #56) because I had recently completed such a table myself. But, instead of mortises and tenons, I secured each miter with three Lamello biscuits. The whole table took me only about 2½ hours.
—*Rick Turner, Petaluma, Calif.*

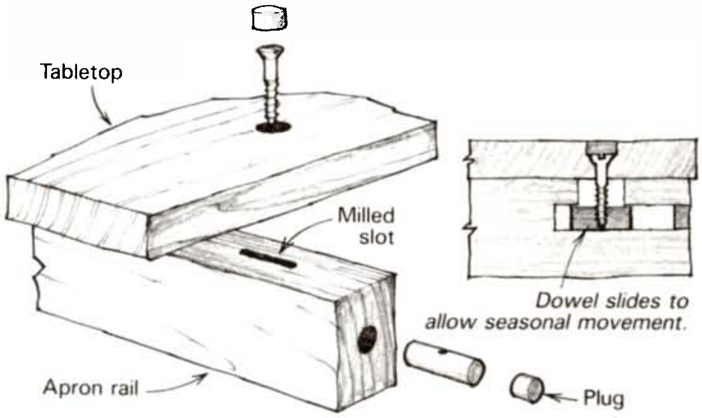
Your woodworking information is superlative. I cannot say the same for your chemical information. Michael McCann's comments on possible formaldehyde hazards from burning materials like plywood are all wrong. Formaldehyde is made by a catalytic, partial oxidation of methanol; too strenuous conditions and you get nothing but carbon dioxide and water.

When you burn hardwoods in a stove or fireplace, various chemicals evolve as the wood heats up. The only evidence of their presence are the flames they make as they burn coming out of the wood; a chemical symphony that makes Faraday's *Chemical History of a Candle* really simple. The point of all this is that McCann's advice not to burn plywood, particleboard, or fiberboard in a wood stove because of the possible formaldehyde exposure is unwarranted because even if formaldehyde is evolved, it will burn more rapidly than the other volatile products that are already being burned completely as they evolve. —*David W. Carnell, Wilmington, N.C.*

Erratum: The telephone number for Powermatic in the tablesaw article in *FWW #56* should be (615) 473-5551.

edited and drawn by Jim Richey

Hidden floating-dowel joint

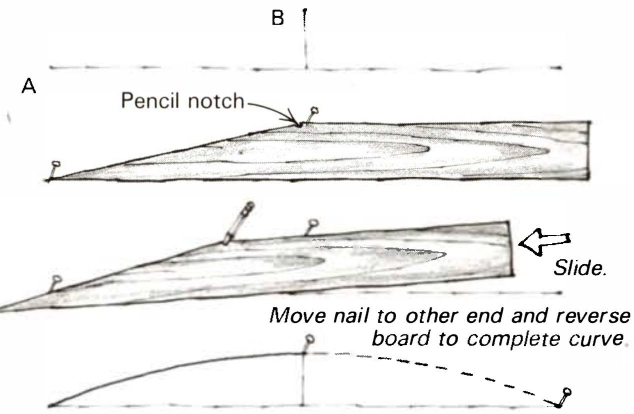


This hidden joint discretely accommodates the seasonal movement of a solid-wood tabletop in relation to its apron. It could also be used to fasten a seat to its rails or a shelf to its brackets. Start by drilling a hole lengthways into the end of the apron. Then mill a narrow slot all the way down into the hole cavity, as shown. Insert a short dowel that's loose enough to slide easily into the hole, and center it under the slot. Plug the hole in the apron and finish as desired.

To fasten the tabletop to the apron, drive a countersunk and plugged screw through the top, through the milled slot and into the dowel. If you don't want screw plugs to show on the top, the construction of the joint can be reversed with the dowel installed in the top and the screw driven through the apron from below. —*Sandor Nagyszalanczy, Santa Cruz, Calif.*

Quick tip: Even if your shop doesn't have a place to wash your hands, you can still avoid leaving oily fingerprints on light woods if you "wash" your hands in a box of fine sawdust from time to time. It works just like sawdust on oil spots in your garage. —*Jeff Gyving, Point Arena, Calif.*

Drawing large shallow curves



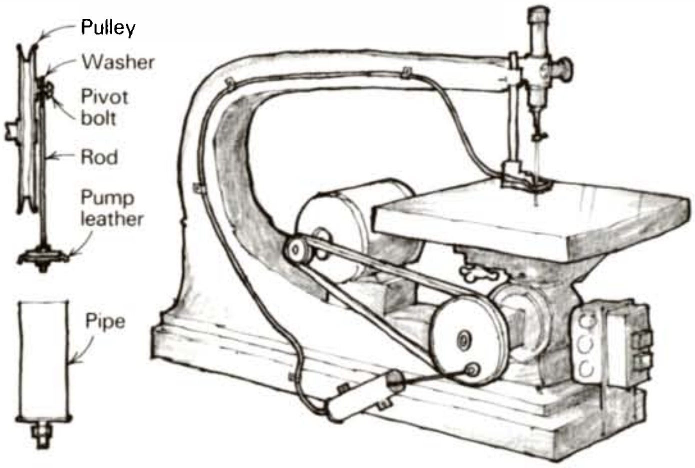
When I was a boatbuilder we used this shallow-curve drawing method to set out the deck beams of yachts. The trick works for drawing any such curve with a known rise and run.

You'll need two nails and a "spile board." Cut the spile board as wide as the curve's rise and taper the board on one end with the length of the taper equal to the curve's run. Notch the board at the location shown to catch a pencil point.

Drive one nail at point A and another at point B. With a pencil in the notch and the spile board positioned as shown in the sketch, slide the board toward the nail at A to draw the curve. Nail A can be removed and driven in the other end to complete the curve. In our situation the method was used to make a template from which all the shorter beams and carlings could be marked. —*Ernie Ives, Sproughton, Ipswich, Eng.*

Clearing jigsaw sawdust with a flit gun

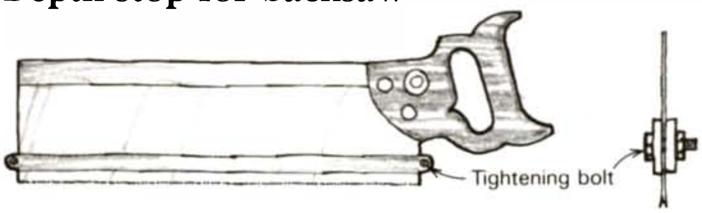
I've seen a couple of methods recently for clearing jigsaw sawdust with a hair dryer and with a vacuum. The "flit gun" method I have been using for 15 years does the job very effectively. The device doesn't consume much energy, is practically noiseless and produces short puffs of air to clear only the immediate area on the workpiece.



To build the flit gun, start with a length of 1½-in. brass sink drain pipe. I soldered a brass plate with a compression fitting to one end of the pipe, as shown in the sketch, but a wooden plug epoxied into the end of the pipe would work just as well. Now make up a plunger with a pump-leather on one end and a washer for a crank pivot on the other. Locate a crank bolt about 2-in. from the center of the jigsaw's pulley. The gun's cylinder can be fastened at any convenient location on the jigsaw, either horizontally or vertically. Run plastic tubing from the end of the flit gun to a spot above the worktable. Turn on the jigsaw and let the flit gun fire away at the sawdust. —*Edward J. Daly, Wyckoff, N.J.*

Quick tip: A plastic squeeze bottle with a cone-shaped top and small opening, like those used for mustard and ketchup, gives a strong, well directed shot of air for blowing dust out of hard-to-reach places. —*Denny Kemp, Dallas, Tex.*

Depth-stop for backsaw



This adjustable depth-stop for the backsaw aids in cutting accurate dados, rabbets, and half-lap joints. The idea is adapted from an antique saw I have. The stop is a couple of lengths of ⅜-in.-thick steel bar stock fitted with bolts on each end to tighten the stop on the blade at the desired setting. Alternatively, I suspect that the two bars could be made of wood if they were crowned slightly in the middle to clamp the entire blade length when tightened. If I have only a few dados to make I nearly always use this saw. It is easier and quicker than setting up the tablesaw with dado blades. —*Bert Whitchurch, Hemet, Calif.*

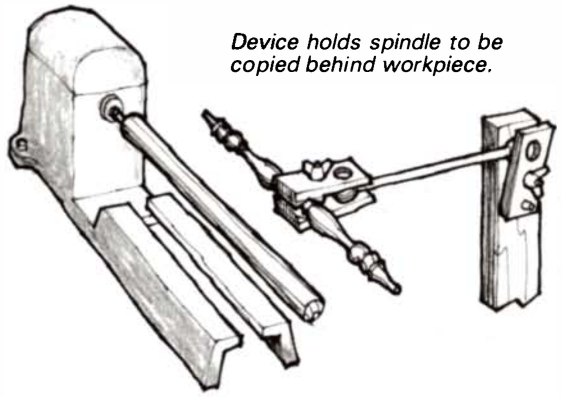
Lubricating tablesaw adjustment gears

To lubricate tight, binding adjusting gears in the tablesaw, first vacuum and then brush the mechanism with a nylon parts-cleaning brush. Then spray the gears with a chain lube such as

Whitmore's Open Chain Lubricant or PJ-1 Heavy Duty Chain Lube. These slippery-film lubricants are well adapted to the dusty environment under the saw's table. An occasional application will provide continued smooth adjustment action, even when cutting abrasive materials like fiberboard or Masonite.

—John Grew-Sheridan, San Francisco, Calif.

Third hand for spindle copying

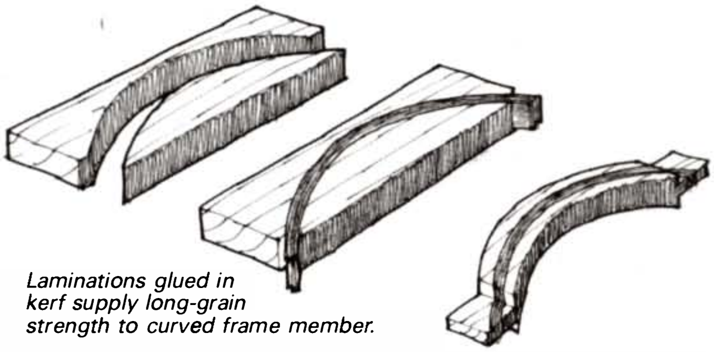


This simple device, by holding a master spindle in full view directly behind the workpiece, eliminates much of the tedious measuring and template making that's usually required to duplicate a turned spindle. With the master copy registered near the work you can accurately judge lengths, critical layout cuts and even diameters and shapes by eye.

To make the device, turn a foot-long dowel "arm" with 1-in. balls on each end. Make up two pinch-blocks, as shown in the sketch, to lock the arm at any setting needed. The rear pinch-block may be attached to the lathe bed or fixed to a floor stand behind the lathe. *—A. D. Goode, Sapphire, N.S.W., Australia*

Quick tip: I added a foot-treadle to my drill press by wrapping some plastic-covered cable around the quill and hooking it up with some other odds and ends from the hardware store. Now I can lower and raise the quill without taking one hand off the work. *—Harold L. Wilcox, Binghamton, N.Y.*

Strengthening curved frame members

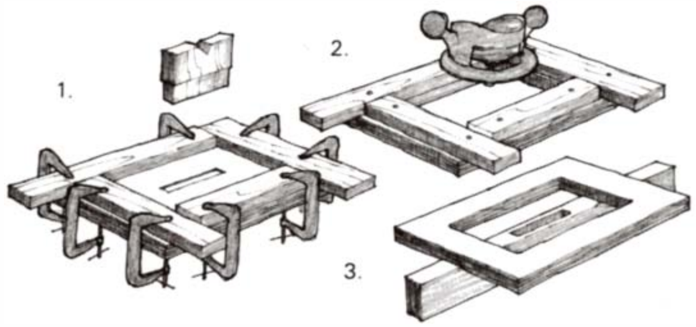


Laminations glued in kerf supply long-grain strength to curved frame member.

Curved frame members can look attractive. But when curves are cut from solid wood they may be structurally unsound, because the long grain is severed. Fully laminating the piece adds the necessary strength but requires special forms and much fussing. In addition, the laminated workpieces are difficult to machine further. Here's a procedure that solves these problems. It adds strength where needed, no forms are required, and the resulting workpiece is easy to machine.

To make the frame member, first saw the workpiece blank into two pieces, following the midline of the curve. Using three or four $\frac{1}{10}$-in.-thick plys, glue up a sandwich as shown. When the glue sets, trim off the excess laminations, cut the member to shape and machine. *—Jim Fawcett, Rosendale, N.Y.*

Self-made mortising template



This procedure for making a router template is quite accurate because in the early stages the template uses itself for the set-up and quality control. First lay out the mortise dimensions on the template stock. Now, with the router and bit you intend to use for the actual mortising, line up the cutting circle of the bit with one wall of the mortise. Clamp a strip parallel to the mortise side so it butts against the router base, thus defining that mortise wall. Repeat the process on the other three sides.

Now, as a test, rout a shallow mortise in the template stock. If the tenon does not fit, move and reclamp the guide boards. If the mortise is slightly oversized, you can add shims. Then cut another test mortise, a little deeper, and repeat until you have the fit you want. Next screw the guide strips in position, countersink the screw heads and remove the clamps.

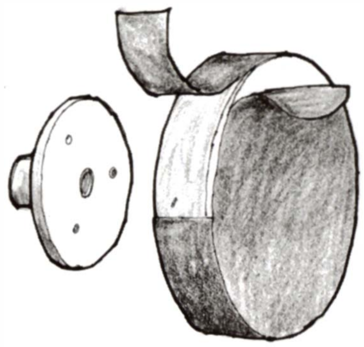
To finish the template, cut out the center of the blank and trim the edges flush with a router and a flush-cutting bit as shown in step 2, then remove the guide strips.

—Patrick Warner, Escondido, Calif.

Quick tip: To form ferrules of any size on shopmade handles for files or carving tools, wrap some copper wire around and coat with solder. *—Donald E. Wigfield, Moneta, Va.*

Lathe-based sharpening wheel

Some time ago I decided to reshape my lathe skew chisels to Mike Darlow's specifications (*FWW* #36). I devised this simple-to-make grinding wheel that uses the lathe itself to produce the 8-in.-dia. hollow grind Darlow recommends.



First, glue two 9-in.-dia., $\frac{3}{4}$-in.-thick plywood discs together and permanently screw them to a faceplate. Mount this on the lathe and turn the edge and face true.

Laminate a piece of $\frac{1}{8}$-in. acrylic plastic to the face and smear a $\frac{1}{8}$-in.-thick coat of epoxy around the full edge. When the epoxy is hard, turn the edge until it is true and flat, leaving as much epoxy as possible. True the face of the disc if needed. Using sanding-disc adhesive, glue coarse emery cloth to the face and edge of the disc to complete the grinding wheel.

To use the wheel, set the lathe at its slowest speed and rest the tool to be sharpened on the tool rest. Use the edge of the wheel for a hollow grind and the face of the wheel for a flat grind. *—Dwight G. Gorrell, Centerville, Kan.*

Methods of Work buys readers' tips, jigs and tricks. Send details, sketches (we'll redraw them) and photos to Methods, Fine Woodworking, *Box 355, Newtown, Conn. 06470. We can acknowledge contributions only when the final decision has been made. We'll return those that include an SASE.*

Oil spots ruin finish

I am restoring a walnut gate-leg table that has a large oil stain in the center of its top. The stain goes all the way through the wood. I've been able to temporarily dry the stain with alcohol and lacquer thinner, but after a few days the oil seeps out again. Will anything remove the oil?
—Homer G. Tordoff, Leavenworth, Kan.

David Shaw replies: Such oil spots are a finisher's nightmare. I had a similar problem that kept bringing a little end table back to my shop again and again. No matter what finish I used, the oil would seep through. I finally solved the problem after seeing one of my customers clean her butcher-block table with ordinary table salt, which absorbed all of the oil and gunk that had settled into the wood.

All you have to do is dump a generous amount of salt over the spot and leave it there until it's saturated with oil and turns brown. After removing the salt, lightly sand the area to reopen any wood pores that may have been sealed by oil drying on the surface and add a fresh dose of salt. Since the stain goes through the wood, apply the salt to both surfaces of the top and work the oil out from both sides.

I used a heat gun to force the oil out and keep it flowing, but the process still took three days of wiping, sanding and resalting. If you don't have a heat gun, use a hair dryer or at least put the table in a warm spot. When I couldn't force any more oil out of the wood, I bleached the top with oxalic acid to even out the color. Once the oil is gone, you can use any finish you like. I used lacquer on my small table, and the customer hasn't had any problems for three years.

[David Shaw is a writer and finisher in Cherry Corners, N.Y. He wrote about catalyzed lacquer in *FWW* #54.]

Applying cross-grain molding

I am currently working on a reproduction of a Chippendale five-drawer chest. I'm a little concerned about the crown molding around the top, which is applied cross grain to the sides. It appears to be nailed on, but won't this restrict the sides as they change in width with the seasons, possibly causing them to crack? *—Jon Brandon, Amissville, Va.*

Carlyle Lynch replies: The crown molding around a chest could conceivably cause a side to split, but these moldings are generally small and attached with nails and brads that are flexible enough to give as the humidity causes the sides to expand or contract. I use glue and a brad for the first two or three inches of molding at the front of the sides, and brads alone for the rest of the molding. This arrangement keeps the miter joint at the front sound, while allowing movement at the back. The Moravians in North Carolina fastened cross-grained moldings with small wooden pins instead of brads, which were probably fairly expensive in the late 1700s. Driven in at a slight angle, these wood pins probably gave readily when the sides moved.

For large crown and base moldings I like to glue on the first couple of inches and screw the molding from the inside of the case. I make the shank holes larger than usual. For exceptionally heavy base moldings, I put the screws in slots rather than oversize holes and use round-head screws and washers.

[Carlyle Lynch is a retired draftsman, teacher and designer in Broadway, Va.]

No luster with oil finishes

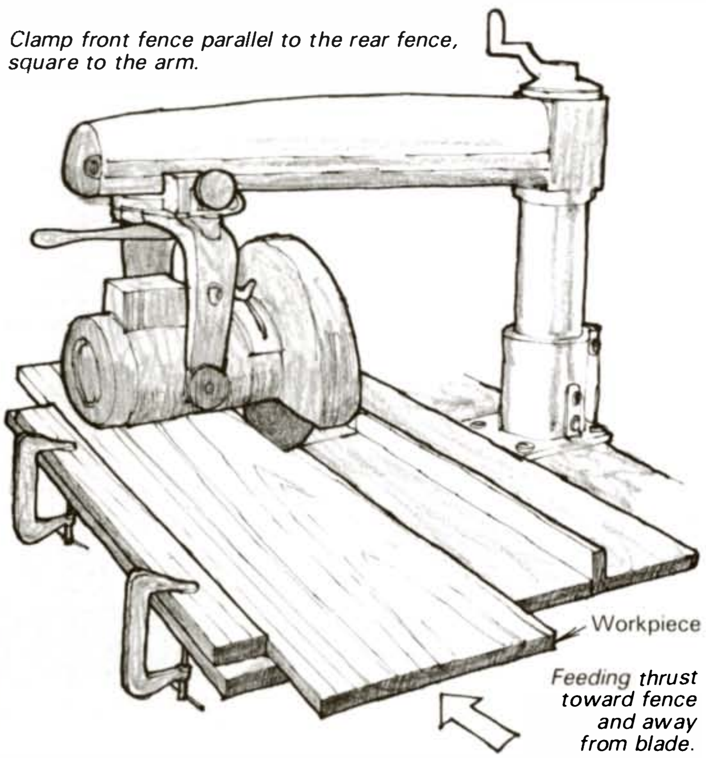
I'm having trouble with oil finishes. All the depth and luster that appears when I flood the wood with oil seems to disappear when I wipe off the excess. I've been using Watco oil. What am I doing wrong? *—Mike Boehm, Madison, Wisc.*

Bruce Hoadley replies: I suspect the problem is not due to the oil but to the fact that your wood surface is not smooth enough. When you are dealing with oil finishes, remember that the finish is mainly in the wood, not on the surface. Oil has much less to do with the development of surface quality than other finishes—it just enhances what's already there. I suggest that you sand your wood more with progessively finer grits, finishing up with a 220-, 280- or even 320-grit before applying the oil.

[R. Bruce Hoadley is professor of wood science at the University of Massachusetts at Amherst.]

Front fence for ripping

Curtis Erpelding did a good job of explaining how to safely use a radial-arm saw for ripping (*FWW* #51), but he left out what I think is the safest method of all: the front fence.



Clamp a straightedge to the front of the saw table parallel to the rear fence (assuming the rear fence is square to the arm). As the wood is being ripped, the feeding thrust and pressure is toward the rip fence and away from the blade. You have a clear view of the line of cut, as well as of your hands and fingers. I've used this method in my shop for 15 years and found it to be extremly accurate and free from the tension that radial-arm ripping once created. *—John Auger, Ortonville, Mich.*

Flattening oilstones

How can I flatten a hollowed oilstone? Also, is a waterstone any better than oil? *—Mark Pratt, Nickliff, Ohio*

Ian Kirby replies: All you have to do to flatten an oilstone is take a flat piece of plate glass or steel, sprinkle about ¼ cup of 80-grit carborundum powder (available from any lapidary supply house) onto the center of the glass and pour about ¼ cup of water into the grit. Grind the stone in a circular motion, using as much of the glass surface as possible. Keep heavy pressure on the stone as you grind. I always flatten the coarsest stone first, while the grit is cutting fastest, then move on to the fine stones as the grit wears. Check the stone with a straightedge after washing the grit off and drying the stone with paper towels. After flattening about a dozen stones, the glass itself will probably become slightly hollow and must be replaced.

Waterstones are even easier to flatten. Some workers flatten

Drawing: Jim Richey

them by rubbing two waterstones together. You can also put a piece of 220-grit wet/dry sandpaper on a piece of plate glass, flood the paper with water and grind the stone with a circular motion on the paper. If you have both waterstones and oilstones, use different pieces of glass. You don't want to contaminate the waterstones with oil. Wash the stone and paper frequently by dipping them in a bucket of water, and dry the stone with paper towels before checking with a straightedge.

The type of stone you use is a matter of preference. For years I recommended a medium India, then a fine Arkansas oilstone as the best method to get a good best edge. I now think the edges possible with waterstones are even better.

[Ian Kirby is an educator, designer and author of the 12-volume *Woodworking* (Lignum Press Ltd., PO Box 900217, Atlanta, Ga. 30329). He operates Kirby Studios in Cumming, Ga.]

Finishes for leather inlays

I was thinking of making small jewelry boxes, using leather panels for sides and top, but was wondering if the chemicals or tanning agents used to process the leather would have any harmful effects on jewelry stored in the box. Also, what would be the best way to finish these boxes? I'd like to use Danish or tung oil. Would these finishes stain the leather, if some spilled on the leather by accident?

—E.J. Blumenthal, Northport, N.Y.

Seth Stem replies: I've used Watco Danish oil, varnish/linseed oil and varnish/tung oil finishes with great success on wood and leather. I usually apply the finish to both the wood and the leather. The varnish content of these finishes increases the luster of the leather surface when the oil dries. Pure oils don't stain the leather as much as create a difference in surface sheen, so caution must be observed in applying an oil finish to just the wood, especially if the leather has a porous or dull surface. Leather can be purchased with a finish already on it, giving it a glossy or hard surface. With these leathers, oil spills can be wiped off and the leather will remain unaffected.

As far as I know, leather or any residual chemicals that might remain in the leather from the tanning process do not harm jewelry. Leather boxes and leather/silver combinations long have been popular for jewelry boxes.

[Seth Stem teaches furniture design and construction at the Rhode Island School of Design in Providence, R.I. He wrote about combining leather and wood in *FWW* #53.]

Routers for raised-panel doors

Is it feasible to make good-looking raised-panel doors with a router instead of a shaper? How much horsepower does the router need? I would prefer to buy an American-made machine, so I'm curious about how they compare with the imports. ***—John Kelly, Overland Park, Kan.***

Bernard Maas replies: I prefer the router over the tablesaw, radial saw, jointer or shaper for raising panels—it is much easier and more accurate to pass a router over a panel than to feed the panel into the cutter of a stationary machine, unless you have an industrial-grade power-feed mechanism to move the panel.

Routers today, especially the newer plunge routers, are excellent tools. Plunge routers, which allow you to accurately lower the bit while the machine is running, open a world of woodworking joinery beyond the range of stationary machines and greatly simplify many operations, such as stopped rabbets, deep mortises, and blind dadoes. If you're a serious wood-

worker, I would recommend you seriously consider a plunge model. As to horsepower, higher horsepower units have one minus and many pluses. On the negative side is weight. Until you get used to the size, these routers can feel cumbersome. But this weight and mass serves to dampen vibration and increases stability. Increased power means the router won't lug down under load. The bit's RPMs stay higher and the resulting cuts are smoother with less tear out and burning. The larger units can also accept bits with ½-in. shanks, which vibrate less than their ¼-in. and ⅜-in. cousins. Increased bit size also tends to have a "flywheel effect," generating greater momentum for the cutter and a steadier cut. The ½-in. bits are also available in such a variety of shapes that they can make the router as versatile as any shaper.

There are several methods for raising panels with a router. Many companies offer panel-raising cutters. Until a few years ago, these bits were the kitchen cabinet-door variety with bevels of ½ in. to ¾ in. Specialty grinding houses, quick to fill the demand created by the new generation of plunge routers, now offer panel cutters suitable for upscale furniture. These bits with ball-bearing pilots sell in the $100-plus range, and can cut bevels and contours up to 1½ in. wide. Since these bits can be up to 3½ in. in diameter, manufacturers urge caution in their use, and suggest they be used with some type of router table. Basically, this "under-the-table-router" is a shaper and subject to the same inherent dangers and safety considerations as a shaper.

Before investing in these larger bits, check with the router manufacturer to make sure the bits are compatible with your machine. On some models, the resistance of the larger bits might cause the motor bearings to overheat and could destroy the armature as well, via heat transference. Also, the increased ampere draw would generate heat of its own, resulting in damage to, or failure of, various motor components.

Aside from specially designed bits, panels can also be raised using conventional double-fluted straight bits with a hand-held router and appropriate jigs. The jig must be designed to regulate the bit feed laterally and vertically, so that wood can be removed gradually in controlled increments. A jig for milling the bevel of a raised panel was shown in *FWW* #45, p. 10, and another jig, which uses a long bit like a planer cutterhead is shown in this issue, p. 70. These straight bits have the advantage of being modestly priced and can be used for other jobs besides raising panels. The only disadvantage is speed. But even though the large raising bits are faster, I think their cost, limited application, risk to the router, and the skill and expertise needed to use them make them unsuitable for most workers.

Many of us prefer to "buy American" and I can appreciate your concern. Numerous domestic manufacturers, including Milwaukee, Black & Decker, Skil, and Porter Cable produce high quality machines. Choice here is largely based on design preference and brand loyalty. However, as far as I know, only Black & Decker markets a plunge router and this is in the lower horsepower range. At present, the Japanese have captured the lion's share of the plunge router market, with Makita, Hitachi and Ryobi vying for first place. One final note: eye, ear and dust protection should always be worn when using any router.
[Bernard Mass is an associate professor of art and woodworking at Edinboro University of Pennsylvania.]

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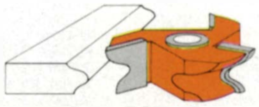

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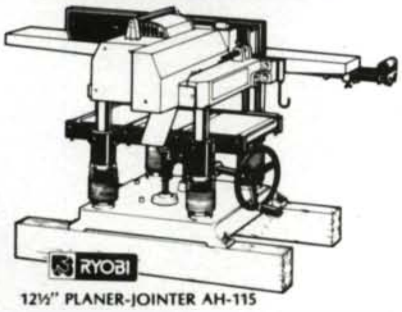

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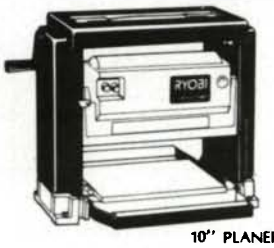

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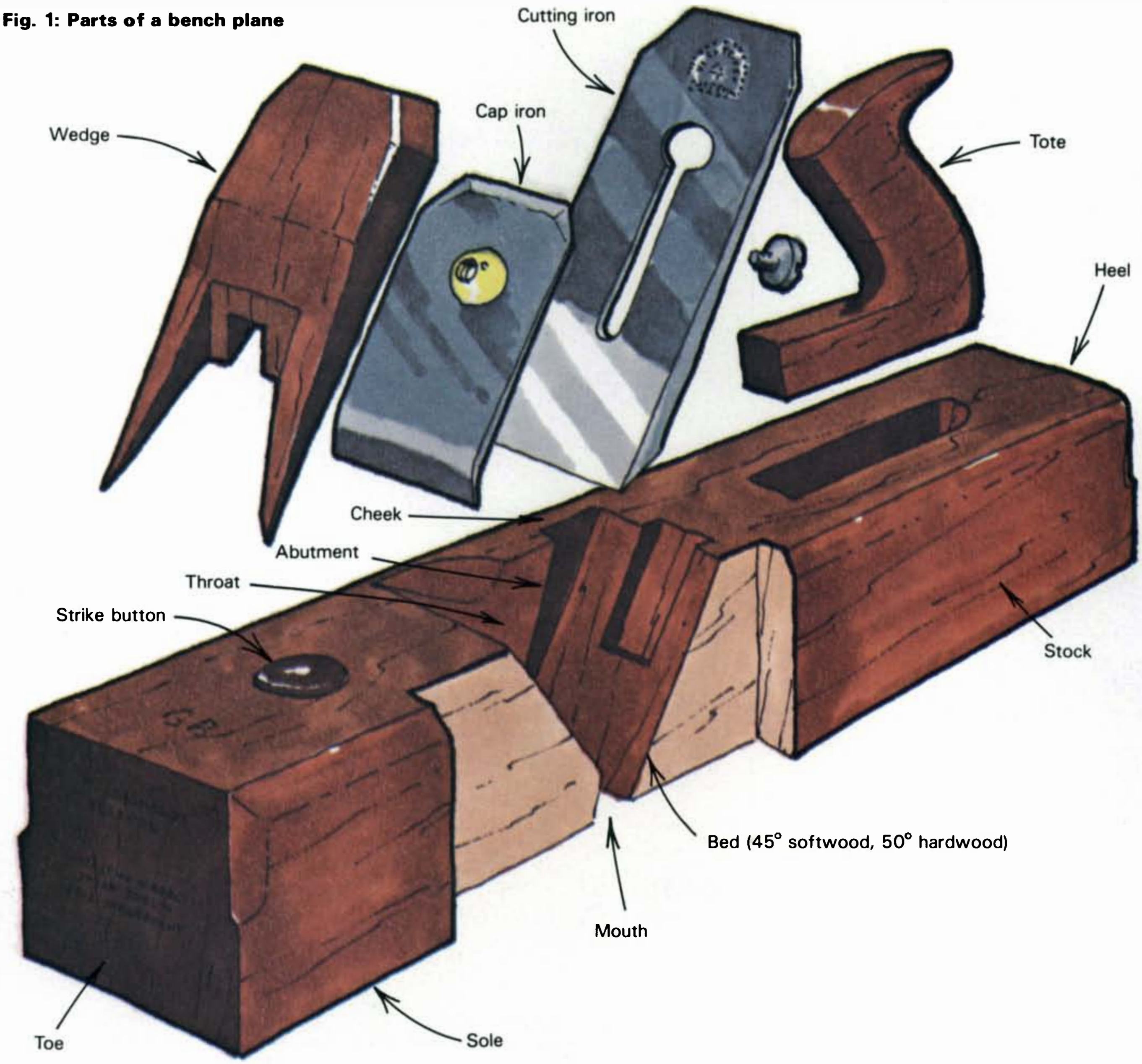
Old Wooden Planes

Reworking brings rewards

by Graham Blackburn

Fig. 1: Parts of a bench plane



When I was first taught woodworking as a boy in England, metal planes and power saws had long been the order of the day, but we still began with wooden bench planes and the whole array of hand saws. In the years since, the older tools have all but disappeared—not only from the more traditional classroom and tradesman's toolbox, but from circulation in general. Today, many woodworkers don't even know their names, far less their application and the techniques of using them.

Old wooden planes, meaning not only secondhand planes but also planes that may be obsolete and even genuine antiques, can constitute an invaluable workshop resource for today's woodworker. Moreover, these old tools are, in many cases, the last link with an age that saw some of the finest woodworking ever produced. Old wooden planes are usually much cheaper than their modern successors. But they have more to offer than economy, and that has to do with pride, personal satisfaction, and a love of the material. You benefit greatly if you can work with tools and materials that you respect, tools you appreciate for their beauty and their rich history.

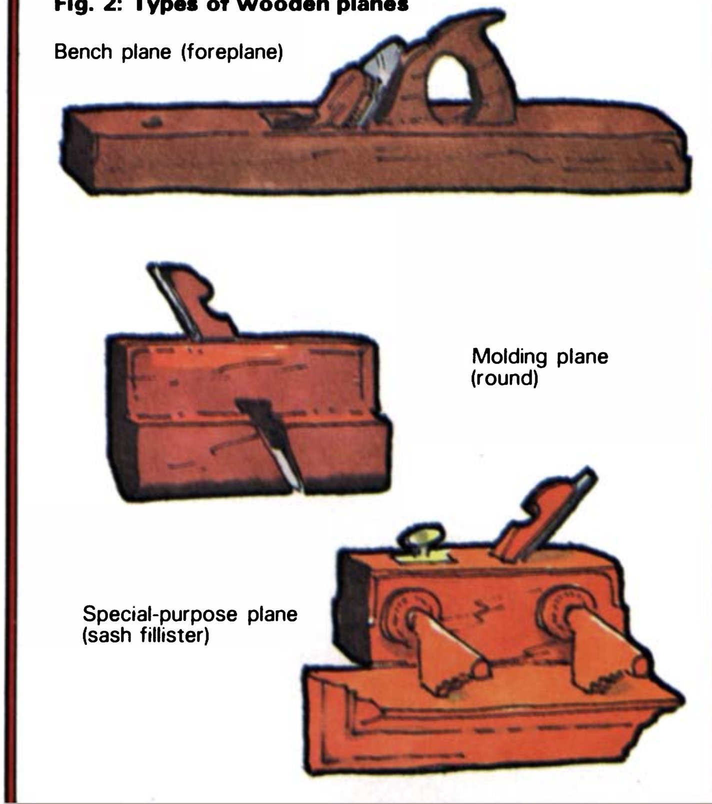
Anyone seeking to incorporate a tool from the past into his or her work, for whatever reason, faces the problem of where to find and how to recognize a usable or refurbishable tool. Once you start looking, finding old tools is the easiest part. They crop up all over the place: in antique shops, junk shops, flea markets, yard sales, auctions, and even in modern tool supply houses. What is harder is being able to know if what you have found might be of any use. Buying an old tool isn't like buying your first router, complete in its box with attachments and instructions. Resist the temptation to buy the first old plane you come across until you have studied the matter a little.

Hand in hand with potential utility goes the question of price. Collectors and antique hunters have helped preserve many tools that might otherwise have disappeared, but their interest has often raised the price capriciously, so that utility is no longer commensurate with cost. Collectors frequently look for qualities other than utility, which often means that an eminently worthwhile, but uncollectible tool may be offered for a song. For example, a plane with lots of shiny brass screws but a hopelessly checked wooden stock may be more expensive than a simpler, less-adorned plane in solid condition. The prices of the two are, therefore, in inverse relation to their use to the craftsman. Then again, collectors are often greatly concerned with makers. A perfectly usable plane produced by one manufacturer may cost significantly less than an inferior one made by a more sought-after firm.

In addition to gaining an understanding of how the tool works, you should also remember that its true cost must also include the time you may have to spend refurbishing it. Fixing a tool may seem inconvenient, an extra time-wasting obstacle, but it is, in fact, a very worthwhile process that will give you a more complete knowledge of the tool's functions and capabilities than had you bought the whole marvel complete and pristine in a box. You will make fewer mistakes in learning to use the tool, and be less likely to force it to do something it's not fit for.

At first, the variety of wooden planes may seem endless, but many were made in sets, differing not in function but only in size. You could, in fact, divide all planes into just three basic groups: bench planes, molding planes, and special-purpose planes (figure 2). Bench planes are the long, squarish planes used for smoothing and straightening wood; molding planes are thin upright planes used for molding the edges or faces of boards; and special-purpose planes comprise everything else—they make grooves, rabbets, tongue-and-groove boards, window sash, raised panels, and a host of other things.

Fig. 2: Types of wooden planes



Planes that were needed by virtually every woodworker are far more abundant than seldom-used, specialized planes. This means that the planes easiest to find, namely the bench planes, are likely to be of greatest use to you, and, generally, the cheapest to buy. Wooden bench planes exist in a much greater variety of types, sizes, and qualities than modern metal planes and offer niceties not possible with machines or metal planes. For example, it is sometimes difficult to avoid tearout on rowed or curly wood on the jointer, whereas there are bench planes designed specifically for such awkward wood. Remember that much of the following discussion about old bench planes applies to all planes.

There was a time, before the advent of the power planer, when all wood arrived at the bench, or on the site, just as it was sawn from the tree—rough and not necessarily straight or flat, and in varying thicknesses. Before much else could be done to it, it had to be dressed, that is, tried, trued, and made smooth, and it was the bench planes that did this. Most of this work is now done by machine, but for small, individual jobs, as well as for the very best results, most wood must still come under the plane.

The smallest of the bench planes is the smoother, or smooth plane. Its job is to put the final finish on a piece of wood. Wooden smooth planes are 6 in. to 9 in. long, straight-sided or coffin-shaped, and the iron (blade) may be bedded at 45° or 50°—the steeper angle produces a better surface on hard wood.

The jack plane is 12 in. to 18 in. in length and is frequently the first to be used when dressing down the stock. British and American jacks are usually fitted with a handle (called a tote), which is most often of the open type. When the tote is set on a lowered portion of the stock, the plane is called a razee jack in America and a technical jack in Britain. The next size includes

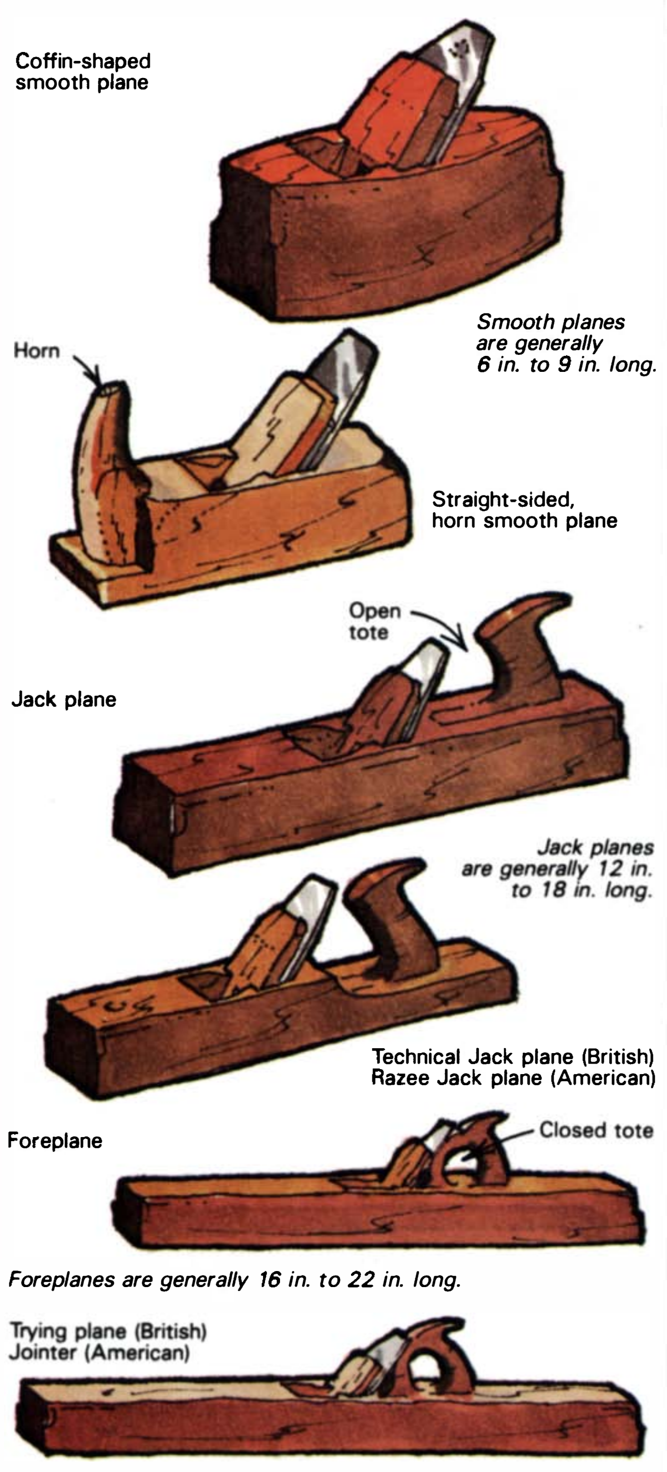
Drawings: Author

planes from 16 in. to 22 in. long. These are variously referred to as panel planes, foreplanes, or trying planes. Their size overlaps not only with some jack planes but also with some jointer planes—the next larger type. In fact, over the last 300 years names have been far from standard; I'll call them foreplanes. Whatever they're called, these planes are used for finer work than the jack: removing the ridges left by the jack, truing the surfaces, and trying (making straight and square) the board's edges.

The fourth, and last, of the bench planes may be anything from 20 in. to 30 in. long, and is known in America as the jointer, in Britain as a trying plane. It is differentiated from foreplanes only by size. Its job, however, is primarily to prepare the edges of boards to be joined to each other—the longer the plane, the easier it is to obtain a perfectly straight edge.

In real life, personal preferences, coupled with a large selection of patterns and sizes, make any absolute rules about the uses of planes ultimately impossible. The jobs to be done remain the same, however, and every woodworker is free to select his or her own slightly different combination of planes to do them.

Fig. 3: Types of bench planes



At first glance, the typical wooden bench plane discovered on a blanket at a flea market might not appear to be capable of anything but the coarsest class of work. However, excepting truly hopeless and unrestorable ones, I think that when refurbished it will probably perform many times better than most contemporary store-bought iron planes.

Several things can render the tool fit for nothing more than decoration or exhibition, and of these the most immediately apparent is the lack of a cutting iron. You might find a replacement iron elsewhere, but it's usually not worth the effort, given the ease with which you could find a plane with its iron. The reverse is true of the iron—that is, the plane might be worth buying for the iron alone, even if the rest of the tool is useless!

Until the 18th century, all planes had only a cutting iron. Thereafter, a second iron, called variously the top iron, the break iron, the back iron, or most commonly the cap iron, was added to stiffen the cutting iron and break the shaving. For this reason, bench planes with double irons are preferable. (Single irons continue to be used for block planes and molding planes.) Cap irons are almost always screwed to the cutting iron, which will have a slot cut in it for this purpose. If your plane has a solid iron there never was a cap iron; if there is a slot but no cap iron, it is missing and you should look for another plane, just as you should if the cap iron isn't the same width as the cutting iron.

Next, examine the back of the cutting iron. It doesn't matter if the edge is in horrible shape, it usually is, but if the back of the iron is deeply pitted with rust, rather than merely rusted on the surface, you should pass it by. To obtain a truly sharp edge, the back of the cutting iron must be perfectly flat. Sooner or later every part of the back will be at the edge, and a pitted back will result in a pitted "saw" edge rather than a smooth "knife" edge.

The most common mystery associated with wooden planes is how to get the iron out of the stock. Jacks and bigger planes must be rapped on the top of the stock near the toe, as shown in figure 4. There is often a strike button inset here for the purpose. Short planes, like smoothers, must be knocked on the back end, and you will usually see the marks of previous hammer blows in this area. A mallet works just as well and damages the wood less.

Resist the temptation to wiggle the wedge as this risks damaging the plane's cheeks and the slot that contains the wedge. If the cheek should already be split or badly checked, there is little you can do to repair it, and the plane will never hold the wedge and iron securely in use. A damaged or missing wedge is another matter; replacement needs to be exact, but isn't difficult.

Look at the body of the plane next. Note the condition of the tote and the areas where the stock has been hit for iron removal. A few moons and dents are to be expected, but beware a plane that has had its toe or back pounded to splinters. A tote can be replaced easily, but, if the stock is too far gone, you must look elsewhere. What consitutes too far gone? Well, it may look worse than it really is. Small checks in the ends are not serious; many can be closed up with liberal applications of linseed oil. Larger checks or

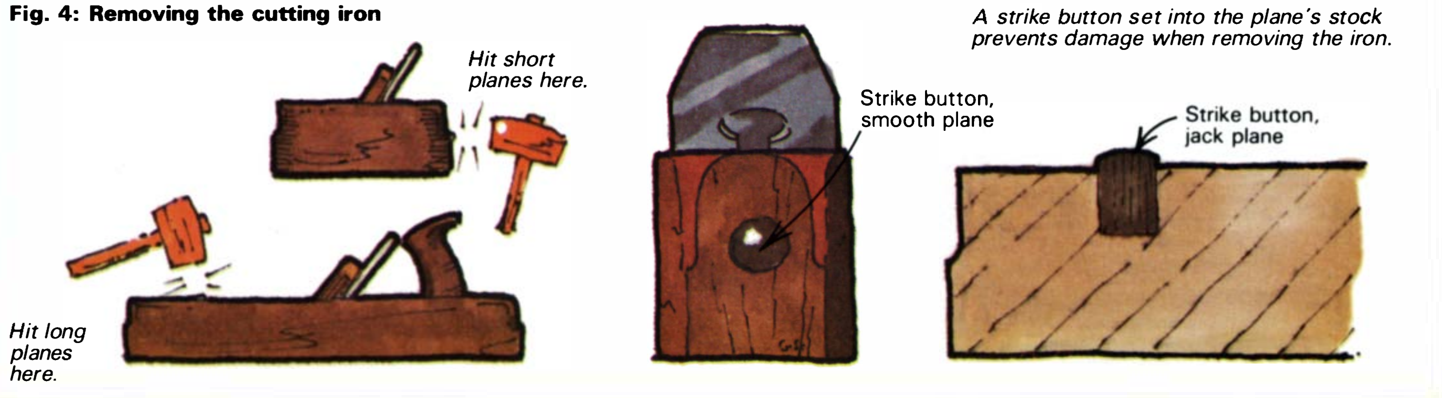


Fig. 4: Removing the cutting iron

A strike button set into the plane's stock prevents damage when removing the iron.

cracks, especially any extending from the corners of the throat where the wedge and iron are seated, are cause for rejection. If the plane has been kept in a damp basement or allowed to dry out over the years, it may appear a deathly gray, but, if the wood isn't spongy, rotted, or riddled with worm holes, you'll be surprised how nice it will look after a sympathetic cleaning and reoiling.

It is unlikely that there will be any checks in the sides, unless these stem from a split throat, since the stock should have been cut so that the annual rings are perpendicular to the sole, thus providing maximum resistance to warping and wear. All other things being equal, ring orientation, as seen on the end of the plane, is a reason for choosing one plane over another.

The ideal sole is perfectly flat and smooth with a narrow mouth—the gap in front of the iron when it is set barely protruding. Here is where you must use some imagination. It has been a long time since most of these tools have been used, and it's extremely unlikely the sole will look anything like it should. First, try to imagine the iron properly sharpened, with the cap iron set right, and everything correctly positioned, and judge how wide the mouth is. If it is wider than the thickest shaving the plane will be expected to take, you must remouth the plane. This might sound like an unpleasant paramedic operation, but it's not too hard, providing the sole is not badly checked or too worn down. (I'll describe the process a little later.) The plane body was originally made square, but use and rejointing—the replaning of the sole to keep it perfectly flat—may have made it somewhat wedge-shaped. It is just possible that there may not be enough body left for more jointing or remouthing. In any event, it is almost certain that you will have to joint the sole, so check it carefully for excessive worm holes (one or two will do little harm) and the odd nail, to be sure you can do this.

If the plane you are considering passes all these tests, and if the asking price is no more than that of a comparably-sized new metal plane, then feel confident about buying it. It will usually cost much less unless the seller believes that he has something "extremely antique" and of interest to collectors.

When you get the plane home, the first thing to do is to disassemble it and clean it. Secondhand planes seem to have an amazing affinity to paint spatters, and these I scrape off with a penknife or razor blade, but if possible, I leave the rest of the patina alone and simply treat the wood with linseed oil. Frequently, however, more is needed. Many people regard removing the finish as a violation of the tool's "antiquity," but unless the tool is a rare or a special example of its class, it is first and foremost a tool, and should be maintained in as good condition as possible, so that it may function as well as it did when new. Wooden planes were mostly made of beech, oiled or varnished. When the varnish wore off, periodic wipings with linseed oil combined with oil from the user's own hands kept the wood in good condition. If too much grime has accumulated on the plane for oil to penetrate, clean it with paint stripper, soak it in linseed oil, and wax it with a paste wax, such as Butcher's or Johnson's. (If you remouth the plane, oil it after making the new mouth.) Even the grayest plane will respond to this treatment, and with use you will soon rebuild the patina, this time on a healthy body.

For extremely dry planes, and planes with open checks in the ends, you can stand the plane on end in a container of linseed oil to allow more oil to be absorbed, and stuff an oil-soaked rag in the throat (seal the container to prevent spontaneous combustion of the rag), since these end-grain areas get thirsty faster.

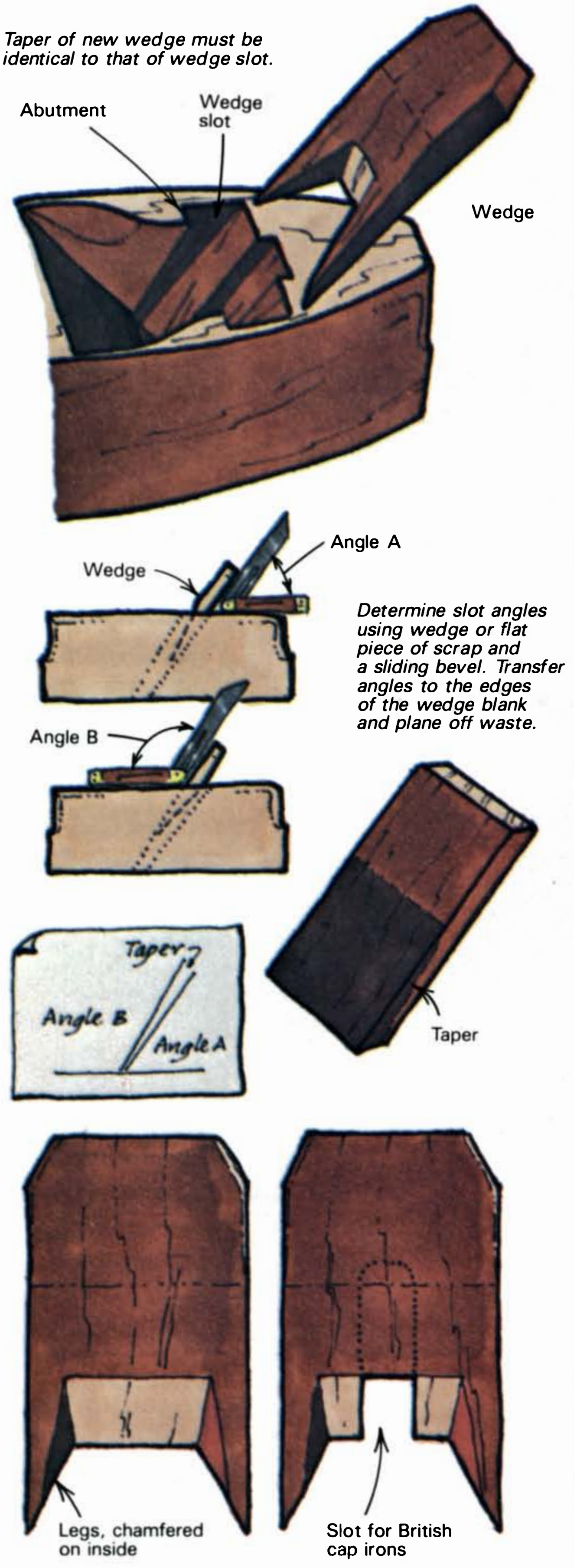
The tote is glued into a shallow mortise in the stock; totes sometimes become loose and need to be reglued. The most common damage is to the tip, which gets broken off. It is astonishing how much more comfortable it is to use a plane with a fully-formed tote than one with a piece missing from the end. Depending on the extent of the damage, it will be very worthwhile either to graft on a new tip, or to make a whole new tote. The easiest way to make a new tote is to copy the profile from another one; experience will tell you whether a slightly different shape is more comfortable for you, but be sure to make the tote fit its mortise snugly or it will work loose again.

Damaged or missing wedges are also easy to replace. The new

Planes by post

Not everyone lives in an area well stocked with old tools. Fortunately, a number of old-tool dealers around the country sell through the mail. In addition to collector's items, the four listed here handle large numbers of tools for use. Vern Ward publishes the **Fine Tool Journal** (RD #2, Poultney, Vt. 05764), a combination magazine/catalog that carries ads for his own Iron Horse Antiques, as well as dealers and auctioneers nationwide; $10 buys six issues a year. **The Mechanick's Workbench** (PO Box 544, Front St., Marion, Mass. 02738) publishes a handsome "magalog" several times a year, usually for $10 each. **Bud Steere** (110 Glenwood Dr., North Kingstown, R.I. 02852) puts out six catalogs a year at $5 each. In the midwest, **Tom Witte's Antiques** (PO Box 399, Mattawan, Mich. 49071) will send a catalog and several supplements for $3.50 per year. □

Fig. 5: Replacing the wedge



Cut out legs, chisel sloping relief between them, then plane top surfaces lightly for final fit. Slot wedge for boss on British cap irons.

wedge, however, must fit its slot exactly or it will not work: either the iron will chatter, you'll damage the abutments, or nothing will ever stay put. The secret is in precisely mating the taper of the wedge to the slot. Cut a wedge blank to width, then plane its back surface flat. Figure 5 shows how to establish the correct taper using a sliding bevel. Transfer the taper to both edges of the wedge blank using carbon paper, then plane away the waste. If you're not copying an existing wedge, you'll need to insert the new wedge and trace the line of the abutments on it to establish the position of the legs. Cut out the legs, and chisel the center slope, which eases the passage of the shavings. Trial-fit the wedge and irons; lightly plane the top surfaces of the legs, where necessary, to give a tight fit against the abutments. (On British planes slot the wedge for the brass boss that holds the cap-iron screw, as shown in figure 5.) Lastly, chamfer the inside edges and tips of the legs and the end of the slope.

Unless the cutting iron rests firmly without rocking on the bed, fine and secure adjustment will be impossible. Check the iron first, for accumulated rust or burrs on the metal. If the bed has warped or moved, careful filing with a flat file, and cautious paring with a chisel, should allow the iron to reseat properly.

Once the stock is clean, the tote and wedge in good shape, and the bed has been checked, all that remains to check is the mouth, but you can't do this until the iron is properly sharpened and the cap iron set. Sharpening is beyond the scope of this article, but make sure the iron is ground to the desired profile—I prefer a slight curve for jack planes and virtually flat for smoothers and foreplanes—and the bevel is ground to the right angle, usually between 25° and 30°, according to the quality of the steel and the hardness of the wood on which you will use this plane. In general, the harder the wood, the greater the angle.

The cap iron must fit perfectly against the back of the iron (figure 6), and, for fine work, exceedingly close to the cutting edge, since not only is it supposed to deflect and break the shaving, but also to put pressure near the cutting edge in order to reduce potential chatter. Furthermore, any gap between the two irons will trap shavings and "choke" the plane. A perfect fit requires that the back of the cutting iron be absolutely flat (if not, work it on a sharpening stone) and the leading edge of the cap iron be straight across its width, and as sharp as possible. You can straighten and square the cap iron with a flat file or diamond plate. A fine sharpening stone will remove file marks and sharpen the edge. It is most important to sharpen so that only the leading edge of the cap iron touches the cutting iron.

Now, slip the iron into the stock so that it barely protrudes from the mouth, to judge whether this gap is too large. It will almost inevitably be so, not only because the sole wears down, and has been possibly rejointed, but also because most irons were themselves wedge-shaped. Being thicker at the cutting end, they were worn to an ever thinner profile by frequent sharpening, thereby increasing the size of the mouth. A wide mouth makes tearout more likely; the remedy is remouthing, which involves inlaying a piece of hard wood into the sole just in front of the iron, as shown in figure 7.

The size of the mouth depends on the type of work expected of the plane—the shavings must be able to pass through. Coarse work producing thick shavings requires a larger mouth than fine work with its thin shavings. For fine work, I prefer a jack plane's mouth to be about $\frac{1}{16}$ in. wide, and smooth plane, foreplane or jointer mouths as small as possible. Make the new mouthpiece $\frac{1}{4}$ in. to $\frac{1}{2}$ in. thick, and wider than the existing mouth to avoid fussy fitting at the corners. Place it on the sole and carefully mark

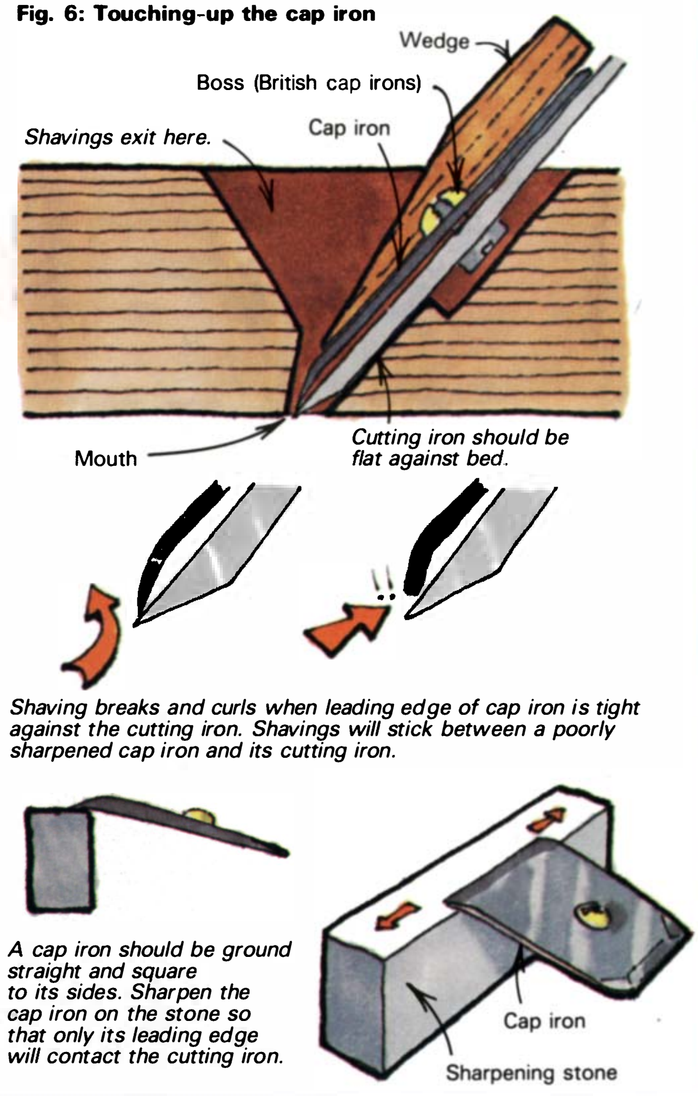


Fig. 6: Touching-up the cap iron

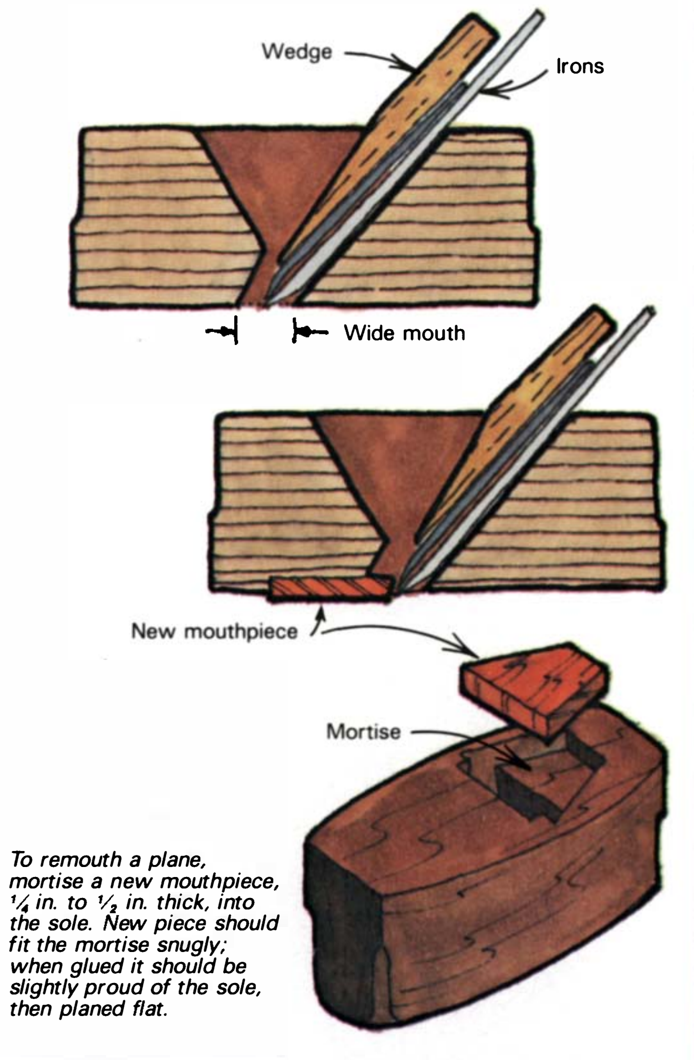


Fig. 7: Remouthing

around it with a sharp scratch awl. Mortise the sole carefully, making the sides square and the bottom level. This is easily done with a light-duty router or Dremel tool, or by hand with a Forstner bit and chisels. The mouthpiece should fit snugly and stand a little proud of the sole—this makes clamping easier. I bevel the edge of the mouth toward the iron, so that subsequent jointing won't widen the mouth unduly.

You can joint the sole of a long plane on a power jointer. But, if yours is a short plane or you don't have a jointer, then secure your longest bench plane upside down in a vise and push the sole over it, the way coopers planed their staves. Sight over the sole by eye and check with a straightedge and square to make sure that it is perfectly flat and square to the sides.

Oil the sole, wipe it dry, then polish it with wax or simply rub a candle over it. Setting the iron is the final step. The theory is simple, but only repeated, patient practice will make you quick and accurate at it. Insert the iron and the wedge so that the iron does not quite protrude, then gently tap the wedge to secure the iron, but only just. To lower the iron, simply tap its top end, then tap the wedge in a little more firmly. Sight along the sole and adjust the iron sideways by tapping its top end to the requisite side. If the iron is protruding too far, simply tap the back of the stock. That's all you need to know: tap the top of the iron to lower it; tap the back of the stock to raise it.

The wedge shape of the blade and the wedge itself are what make the process tricky. As you tap the blade deeper, it necessarily presents a thinner part to the wedge, thereby loosening the latter's grip, causing the iron to slip more deeply than you wanted. The secret is in securing the wedge firmly enough to hold the iron even after you have tapped the iron in some more, but not so firmly that a light tap won't move the iron. This is made a little easier by setting the iron as close to the desired protrusion as possible, before you first secure the wedge.

At this point you should now be in possession of a bench plane that will compare favorably with almost anything you can buy new, and for considerably less outlay. It may take a while before you feel perfectly comfortable with the adjustment process, and, of course, a lot depends on how well you sharpen the iron, which will most likely be of the superior, old-fashioned laminated type. Planing can be taught only partly by words and pictures; experience will teach much more, for the feel of a wooden plane is quite different from that of its metal counterpart. In the long run, I think the potential of wooden planes is far greater, given the wider range of tools making possible a size and shape for almost every job and every hand. □

Graham Blackburn, author of numerous books on woodworking, is a furniture designer and maker in Woodstock, N.Y.

Crowning Glory

Carving pineapple and flame finials

by Ben Bacon

Finials, the graceful, slender summits of many 18th-century furniture classics, are perfect for practicing the simpler aspects of carving, although the expression "simple carving" is something of a paradox. All carving, from the plainest to the most complex, requires the same methodical process of research, drawing, modeling, roughing out, and detail work. Finials are particularly good for beginners to develop these techniques because they are familiar objects—small, easy-to-make, and they incorporate a variety of elements, from decorative leaves to fanciful, spiraling tongues of flame. They also are painless to discard and to start again should things go wrong.

Before you begin, you must learn about what you want to carve to produce a working drawing. This sounds tedious, and it usually requires several trips to libraries, museums and dealers' showrooms, but, if you skip this step you'll likely flounder, get discouraged and quit the project. Since we are more concerned with carving here, I've done the research for you, and given you a drawing of two typical American finials, figure 1.

One finial is a flame, a Goddard-Townsend favorite that was frequently carved on Rhode Island chests, clocks, and highboys. The other is a pineapple finial, which was used in many different forms all over the East Coast. Both finials are designed to cap off a piece of furniture, so the dominant element of each is its uppermost section—the flame and exposed pineapple. Beneath these, each has a circular band of leaves or moldings. These decorative elements visually break-up the surface of a finial so it doesn't look merely turned, but they are regular enough not to detract much from the more important top decoration.

The first step is to turn the basic shape on a lathe. Both finials are made of South American mahogany, but walnut, maple, or cherry would be suitable. Don't get carried away with your turning—leave enough wood to do the carving. Because carving is a subtractive process (rather than an additive one, like cabinetmaking), it's easy to forget that most carvings are the remains of larger pieces of wood. As you work, you must visualize the finished carving, as well as the block needed to produce it. This is easy to see in turned work—find the greatest diameter of any carved section, as shown in the drawing on the facing page, and turn to that diameter. Also, leave enough waste at the top for clamping.

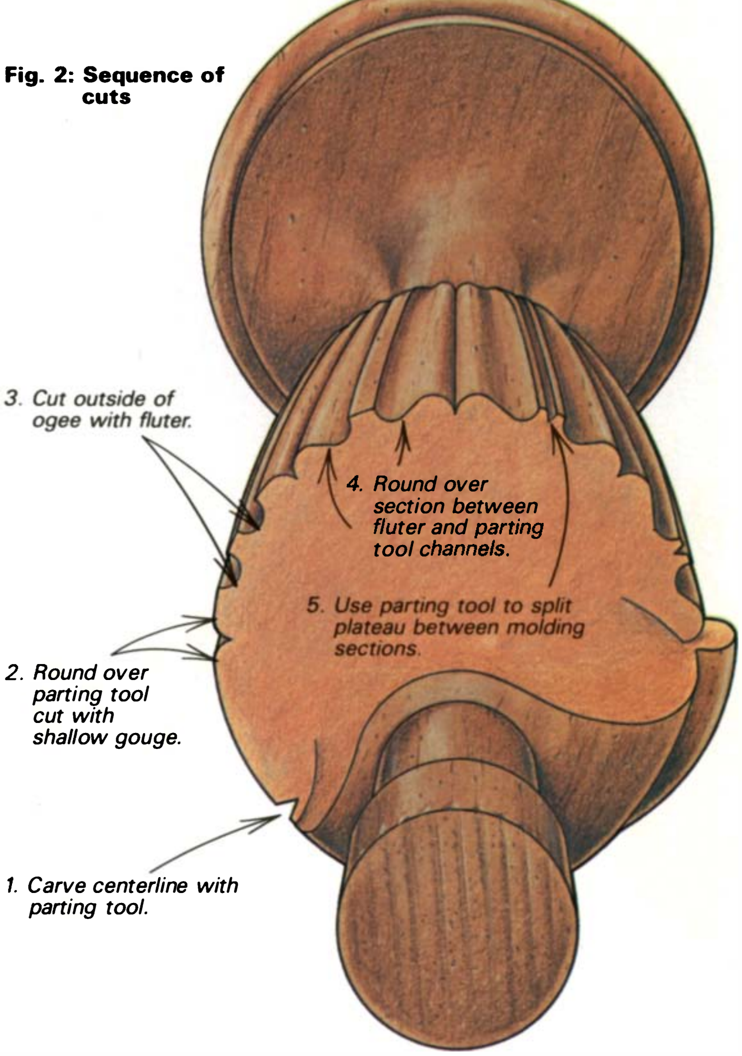
The pineapple is divided into three sections—the lower, molded half, the middle band, and the upper leaves. The molding consists of eight ogee moldings around the circumference, each segment itself divided in half. To lay out the molding, set dividers and mark the circumference on the middle band into eight equal sections. Each mark locates the centerline of one segment. Draw in the centerlines from the middle band down to the bottom of the finial, making sure that the gaps between the lines taper evenly as you draw down the globe-shaped turning. Begin carving on these centerlines by running a 3mm V-shaped parting tool down each line to make a series of 2mm-deep channels, as shown at top right. Note how the finial is clamped to the bench between pairs of bandsawn softwood supports. Clamping is mandatory. Most carving techniques require both hands on the tool. Generally, one hand is the power hand, supplying most of the force of the tool to the handle (or, wielding the mallet for heavier work), and the other hand is the controlling hand, the fingers spread over the metal, guiding the cutting edge. If the work is clamped securely, all the force will be transmitted through the tool to the wood, rather than into launching the work across the room. It's also impossible to cut your hands if both of them are behind the cutting edge. Be cautious—a 30mm gouge slicing across your wrists or fingers can do as much damage as a tablesaw.

You should be able to carve three or four of the centerlines before unclamping and rotating the piece. Repeating your cuts this way is the fastest way to carve, because you spend less time hunting for and picking up different tools than you would if you carved each section individually. After you've cut all the centerlines, take a #2 3mm gouge to round over both sharp edges left by the parting tool, as shown in carving sequence in figure 2, leaving two soft curves that will form the ridges of the ogee.

Again working from the centerline, use dividers to mark the two bands that will delineate the outer edges of each segment. The bands fall either side of the dividing line between segments, which is midway between the carved centerlines, as shown in figure 2. After these straight lines are drawn, use U-shaped fluters to carve a hollow down each band line. Begin with a #7 4mm, but switch to progressively smaller fluters as the molding tapers. Here I would use a #9 3mm, followed by a #8 2mm. The edge of the hollow forms the side of the band, so be sure to make smooth, even cuts, keeping the outside of the tools (the side away from the centerline) just on the line you've drawn. Once this is done, and all your lines are neat and even, take a small gouge (#2 or #3, 2mm and 3mm spade tools, described on the following page, work well for maneuvering in these tight spots), and round over the inside sharp edge of the cut, as shown at center right, leaving

Carve a 2mm-deep channel down each centerline, top photo, with a V-shaped parting tool. The finial is clamped to the bench with wooden blocks, bandsawn from softwood so they won't dent the carving. To complete the molding, use small gouge, above, to round over the sharp inside edge of the fluter cut.

Fig. 2: Sequence of cuts



Photos: Robert Aberman; drawings: David Dann.

the sharp outside edge. Now, repeat the entire carving sequence on the middle band. Make sure your cuts are crisp and that you have no rough tool marks or torn wood fibers where the band meets the molding or the pineapple.

The moldings are now complete, but need to be separated. Take the parting tool and run it down between the bands, splitting them into two distinct and equal parts, as shown at top left. Then take ¼-in. and ⅜-in. chisels (I used cabinetmakers' bevel-edge chisels) and deepen the V cuts, leaving a very sharp, straight division between the moldings.

The next step is to carve the leaves on the top. First, saw off the excess wood at the top and carve the top with a #5 20mm gouge to the shape shown in figure 1. Then, to make sure that all the pineapple leaves on each level are the same size, draw bands of diminishing width around the finial, corresponding to the tips of the pineapple leaves. Next draw in the individual leaves, as shown in the plan, making sure that they diminish in size as they reach the top of the finial.

Clamp the finial dowel to the bench between bandsawn blocks, with a softwood support block directly beneath the pineapple. The first cut is with a 6mm parting tool between the leaves. Then, using #2 and #3 3mm spade tools and 8mm fishtail gouges, round over the four sides of each leaf, leaving the center proud, as shown in the photo at left. Sand the leaves, if

After separating each ogee molding into two parts by running a parting tool down between the bands, above, use ¼-in. and ⅜-in. bevel-edge chisels to deepen the V-shaped parting-tool cuts. Next, outline the pineapple leaves with a parting tool, then round over the four sides of each leaf with a shallow gouge, left, leaving the center of each leaf proud. Finally, sand the leaves.

Spade tool from a fishtail

Less is better for spade tools. Upper shaft indicates how much fishtail is reground.

A good spade tool is, without doubt, the most useful tool a carver owns. It has a very thin shaft, usually no more than 3mm to 5mm square, a flared cutting edge, and can be maneuvered into tight spots where no other tools can go. The thin shaft is less likely to contact delicately carved elements than that of a heavier tool, and, therefore, causes far less damage, while giving the cutting edge maximum movement when you cut behind, under and around forms, such as the foliage work on picture frames or on the drawer fronts of some lowboys and chests-on-chest.

Although spade tools are great for maneuverability, their design does have some inherent problems. The thin shaft makes the tools weak, especially in relation to the force that such a broad cutting edge transmits. This makes the tools unsuitable for heavy or mallet work. The flared end is usually never more than ¾ in. long, so a frequently sharpened tool has a very short working life. These reasons may be why the tools are no longer manufactured.

Since you can't buy new spade tools, and it's becoming increasingly difficult to find old ones, your only alternative is to make them yourself or to convert them from other tools. The easiest method is to adapt them from commercially available fishtail gouges, which are much heavier than spades. A true spade looks like a triangle on a stick. Carefully grind away the excess metal from about 1 in. behind the cutting edge to about 3 in. Then grind away directly behind the cutting edge to make the tool flare from the shaft at a greater angle. Some tools have an angle as great as 60°, but I think 75° to 80° is sufficient. As with all adaptations, the end product is not ideal. Removing metal directly behind the cutting edge will often cut into the inner shape of the tool, distorting the interior grind and ultimately altering the actual shape of the tool's cutting edge.

You can avoid these problems by making your own tools from scratch. Annealed bar stock steel is ideal for very fine spades with a 5mm to 6mm cutting edge, like those shown at left. In the days when umbrellas were engineering marvels of bone, ivory and rosewood, the interior framing was steel the ideal thickness for spade tools. Grinding the tool out of bar stock steel is a lot more work. If you want a tool with a 6mm-wide cutting edge, you have to buy 6mm-wide steel and grind about 1.5mm off each of the four sides to get a 6mm cutting edge and a 3mm shaft. Once you get the outside shape you want, grind the cutting edge to the desired radius. Most spade tools are in the #2 to #7 range, but you can make any curve you want. As with all cutting tools, you want to make the cutting edge as thin as possible, while maintaining a strong edge. Harden and temper the tool (*FWW* #44, pp. 51,52), then form a tang by grinding the back of the tool to a point, like an awl. Clamp the tool in a vise with wooden sides, tang side up, and tap a handle onto the tang with a few gentle blows from your mallet.

Though it takes time and effort to form a precise, thin cutting edge, you will be rewarded by the number of times the tool helps you solve carving problems. You'll use and sharpen it so much, you'll notice that the cutting edge will get shorter and shorter, until it merges with the shaft. Like a wine from a vintage year, you'll enjoy returning to it again and again, and all too soon you'll find your favorite tool will be gone. —*B.B.*

necessary, then run down the groove between the leaves again with the parting tool, to make sure that the leaves are distinct. The finial is now complete, ready to be mounted.

The Goddard flame is carved in much the same way as the pineapple. Start with the leaves, evenly marking out the 16 tips with dividers and drawing centerlines down the leaves. You want to carve each centerline so it is lower than the leaf's edge. Run a 6mm parting tool down the centerline to make a 5mm-deep V-channel, shown below, top left, then round over the sides toward the center with shallow gouges (#3 8mm, #3 12mm, #2 3mm, #2 5mm). For a crisp, gently rounded cut, hold your gouge upside down with its bevel up, as shown in the photo below, right. Note that the definition between two leaves comes from the sharp spine created at their juncture as you round each edge toward its centerline. To be effective this line must be sharp, straight and even, so take care when rounding over. No wood is removed from the actual spine, so it remains at the same level as the original turned profile. Once the definition between the leaves is good, give the leaves a strong, straight centerline by running the parting tool down the center, straightening the line and removing any bumps or ridges.

The tops of the leaves are distinct from one another and curve slightly away from the ball. Carving this type of decoration requires two steps, traditionally called "relieving" and "setting in." In relieving, you remove as much waste wood as possible between the leaf tips with a parting tool, carving straight into the wood, removing a V-shaped wedge that corresponds to the flaring away of the leaf tips. "Setting in" is the process of removing small amounts of wood to refine the desired shape and achieve a sharp edge. Once the waste is removed by relieving, you have enough room to manipulate your tools for these delicate finishing cuts, which are very similar to the fine paring cuts used by cabinetmakers to fit joints.

Once you've removed the waste with parting-tool relief cuts, take gouges that fit the shape of the leaf tips (#2 or #3 gouges, 5mm, 8mm), and set in the tips, bottom left, undercutting them slightly so that the leaf edges don't appear thick and clumsy. The same gouges are good for refining the surface between the tips to make the curve of the top section flow smoothly between and under the leaf tips. Don't make your setting-in cuts too deep, or you'll leave unsightly tool marks in the finished surface that are impossible to remove unless you recarve the surface.

Saw the tip of the finial off, carefully reshape the top, and draw the flame, which is composed of four ridges and four hollows. First, draw one spiraling line freehand on the flame blank until the flow of the line is smooth and regular. Then add two concentric bands to divide the blank into three equal horizontal seg-

Cut a deep channel down the center of each leaf with a parting tool, top left, so that the midsection is lower than the edges. Next, round over the sides of the leaf with bevel-up gouge, above. There's no hard division between leaves, just a sharp spine created as you round each edge toward its centerline. Finally, undercut each edge with a gouge matching the leaf-tip shape, left, so it won't look heavy.

The wood between the ridges of the flame is removed with a sharp fluter or 5mm gouge, top photo. If wood begins to tear out, reverse the cutting direction by moving your hands, as above, rather than wasting time by walking around the bench.

ments. With the dividers, separate each band into four equal parts, beginning where the spiraling line crosses the band. It's simple to then join these reference points to make four evenly spaced spiraling lines.

The greatest problem in carving the flame is keeping the sharp ridge between the hollows from breaking out. Because you're carving a spiral tapering at both ends, the grain direction changes constantly. In some places you'll be carving long grain; in others you'll be carving across the grain. Use sharp tools—a large fluter or 5mm #9 gouge—to remove the wood from the hollows, leaving the 3mm-thick ridge, top left. Keep a keen eye for wood breaking off ahead of the tool. When this happens, reverse the direction of your cut, as shown at left. For speed and efficiency, most good carvers work ambidextrously, allowing them to easily reach any part of the work without maneuvering their bodies. Achieving this type of skill, however, requires a year or two of practice. Then, use the same tools to achieve a thin, sharply defined peak, running in a smooth spiral from top to bottom, without waver or wobble. It is vital not to carve the very top of the ridge, if you do you'll distort the outline of the flame, introducing dips and irregularities where you should have a clean, spiraling line that conforms exactly to the shape of the original turning. Once you've worked all the ridges, sand the hollow of the flame, using 120- to 180-grit paper. Recut where necessary to refine the sharpness of the ridge, then you should be done.

I hope the finials give you a habit-forming taste of carving. After carving these finials, you should be ready to research and develop your own forms. More than anything, carving is a matter of practice, and more practice, to acquire the drawing and tool-handling skills that distinguish an accomplished craftsman. □

Ben Bacon is an American carver now working in London. He wrote about the traditional carving methods he learned during his five-year apprenticeship in FWW *#50, pp. 60-63.*

The final touch

Woodcarvers generally create one of four distinct surface textures when they complete a carving—they either leave the tool marks showing, sand the surface, file everything smooth, or decorate the surface using metal punches. The choice of technique depends largely on your skill, what's being carved (flat relief, foliage, deeply carved foliage, figures, chair work, or architectural ornament), and how the work is to be finished (polished with some type of oil or covered with gold leaf, for example).

A straight-from-the-tools finish gives clearly defined details and great visual clarity, but requires a great deal of skill to do it right. You must use your tools accurately and cleanly to produce a crisp surface free of distracting facets and torn wood fibers. Some workers also object to the slight irregularities of the cut surface.

Sandpaper is most often used where you want smooth, regular surfaces, but don't need great definition. Sanding is usually necessary when you plan to use a glossy, clear finish that would highlight the inevitable small facets and marks left by tools.

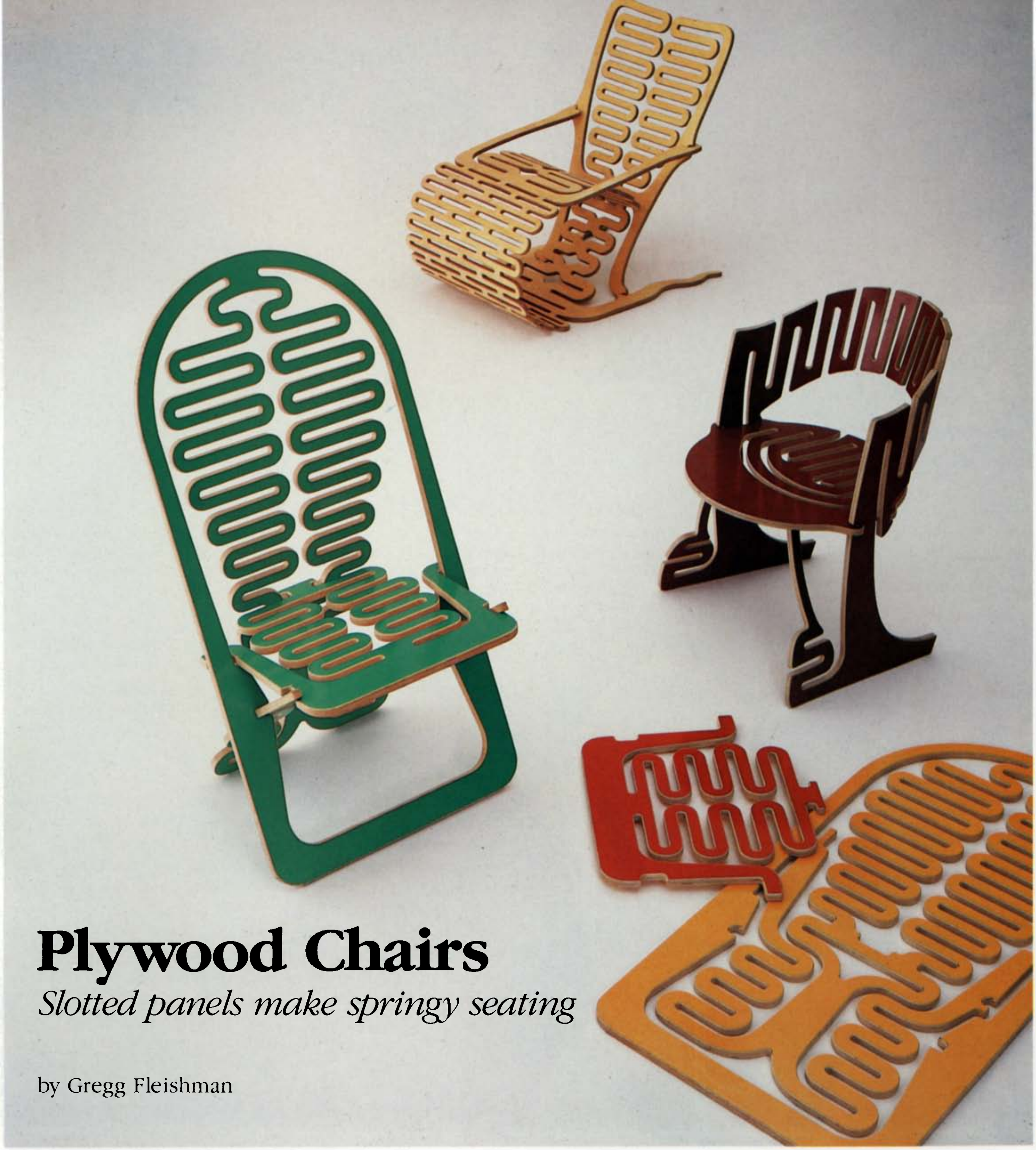
Figure carvers prefer rifflers, small shaped files, because they feel the filed surface has a great subtlety and fineness of finish that cannot be achieved with tool or paper.

For backgrounds in relief work, a variety of different shaped metal punches (circles, double circles, stars, points, diamonds, for example) are used to literally punch the wood, creating a decorated surface that disguises the general unevenness of the surface.

The tool-mark texture and sandpaper are the only relevant methods for beginning carvers, so I will concentrate on these. Many books advise carvers to reject sandpaper altogether and rely solely on tools for the finish texture, but I think this is a misconception based on a failure to understand that sandpaper and carving tools are both instruments for removing wood. Carving tools remove wood quickly and accurately, with sharp definition. Sandpaper removes wood relatively slowly, but leaves a uniform, smooth surface that lacks sharp definition. Once you understand this difference, you can analyze what kind of surface you want, and then decide which of the two methods will best achieve this surface.

Carving tools are the only medium when your goals are sharpness and crispness. In foliage work, flat relief work, and most carved decoration on carved and gilt furniture, where crispness is paramount, sandpaper should never be used, and care should be taken to achieve a fine, clean finish with the tools alone. Sanded foliage looks muddy and clumsy. But, if you're going to carve a surface that will be highly polished, one where the small facets that tools leave would mar the look and flow of the carving, then sanding is not only acceptable, but advisable. On the flame finials, for example, sanding the broad flutes between the ridges on the flame is the fastest way of achieving a smooth, regular, mark-free surface. It could be done with tools, but it would take far longer and probably look worse. But, if you sand the fine divisions between the ogee bands on the pineapple finial, you will end up with an indistinct mess.

In short, don't compensate for clumsiness with carving tools by using paper, but don't be afraid to use sandpaper where it is needed. As in all woodworking, suit the tools to the job at hand. *—B.B.*



Plywood Chairs

Slotted panels make springy seating

by Gregg Fleishman

Ten years ago I started designing chairs. I began working with plywood because I was familiar with the material, having used it in designing interfitting panels for concrete forms, and for building modular play structures and plywood-skin domes.

Most comfortable plywood chairs, such as those by Charles Eames or Alvar Aalto, are laminated—thin veneers are glued up on curved forms with vacuum or hydraulic presses—but I didn't want to get involved with such highly specialized techniques. I wanted a light, comfortable chair with few parts and no fasteners. And, I wanted a chair that could be easily built in multiples with a minimum of machinery and operations. In the beginning, I cut slots in the plywood to connect the pieces together. By the time I was finished, I discovered that if you cut certain patterns of slots you end up, amazingly, with a plywood spring that can be bent around the human body to support it in a dynamic, lively way.

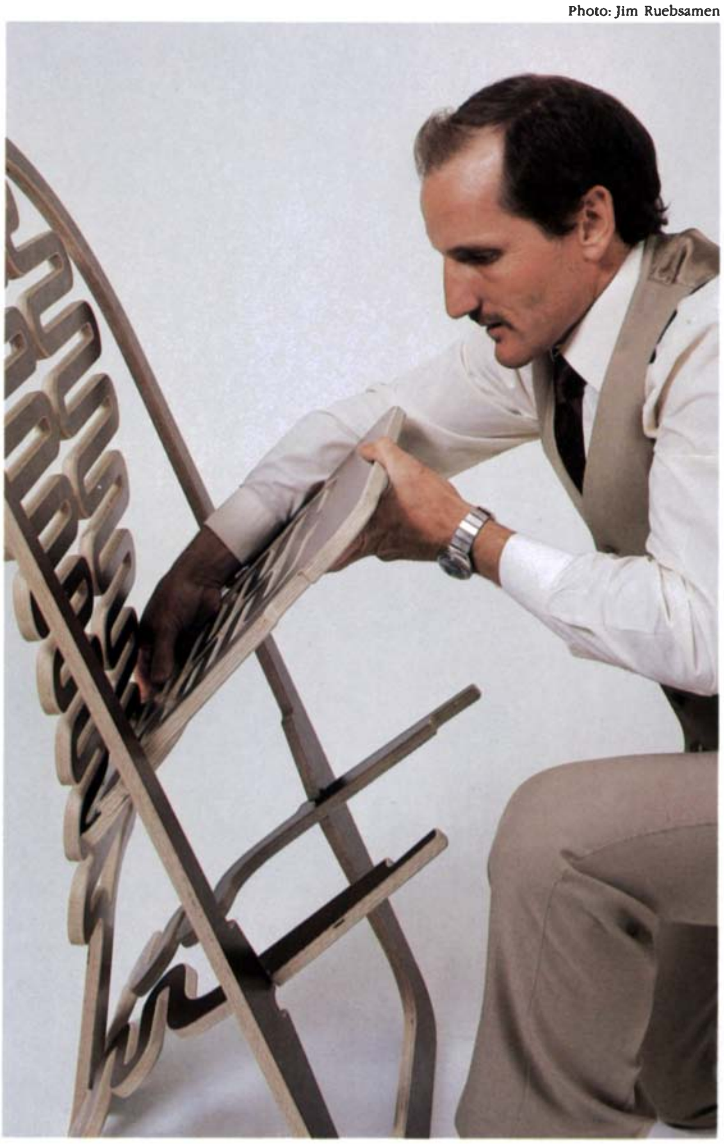
Discovering the right slot patterns, however, was a long process. It took me $4\frac{1}{2}$ years and 34 different prototypes before I was somewhat satisfied with the design of the green chair, above, which I call the Lumbarest. The chair not only is interesting looking, but its flat, serpentine loops add flexibility. This makes the chair comfortable, and reduces the number of pieces needed to build it. Made with $\frac{5}{8}$-in. plywood, it can support a 700-lb. static load. The Rock 'N' Roll chair in the photo's background can support more than 800 lb. when built with $\frac{3}{4}$-in. plywood. And each chair can be disassembled and stored, or

Photo: Ken Sabatini

Chair #1 has a cantilevered back that looks somewhat like the tines of a fork. The pattern for this four-piece chair is shown at right. Two pieces cut to match the middle pattern crisscross and lock together under the seat.

Fleishman's second chair was radically different from the first. Because of the vertical slots, he was able to bend the outer part of the back forward to become the front legs, reducing the number of panels needed from four to two.

Photo: Jim Ruebsamen



Gregg Fleishman fits slots together to assemble the two-piece "Lumbarest" chair, which is the result of 4½ years of experiments with slotted plywood panels.

shipped flat in a relatively small carton. Strength wasn't that much of a factor in my early experiments. My first test was to assemble the chair and sit on it—hoping it wouldn't break.

My first chair, top left, was built from four plywood panels and has a back that resembles a fork with its tines extending upward through the seat. The cantilevered tines make the back rigid at the bottom for lumbar support and the top somewhat more flexible for shoulder and arm freedom. The flexibility of the back encouraged me to experiment more with the slots on the second chair, top right. This is a two-piece chair—its vertical slots let me bend the outer part of the back forward to become front legs, eliminating the need for a third or fourth panel. However, I lost the comfort of the first chair—the back is too straight and the top too firm. In the third chair, I cut large loops to create a more flexible back, and pulled it forward to increase the slope. It was too flexible, actually, so I began experimenting with other slot patterns on the fourth and fifth chairs, and so on.

I developed all of the chairs with this seat-of-the-pants (pardon the pun), empirical methodology. I made sketches on paper, then drew the pattern full-size on the plywood. I cut all the slots by hand, drilling out the ends first with a 3/16-in. bit, then cutting between the holes with a saber saw. A router with a 3/16-in.-diameter roundover bit and a bearing guide running in the sawn slot finished the edges. Sometimes, when interlocking notches would miss each other, I would glue scrap into the slots and recut.

I built the first chair with ⅝-in.-thick fir plywood, but when I began bending the chairs, I switched to ½-in.- or ⅝-in.-thick Finland birch voidless hardwood plywood. (Baltic birch will work as well). Now, I use ⅝-in. plywood for extra strength on chairs for adults, and ½-in. plywood on children's chairs, which are about 60% the size of the adult models. I also make chairs with Finn-Form, a special plywood covered with a brown or red phenolic film that acts as a release agent when the plywood is used for concrete forms. This thin film is attractive, durable, and strengthens the chair slightly. The other plywood chairs are finished with clear or colored polyurethane.

As I developed new designs, I preserved the basic form of a traditional side chair. In chair #6, facing page, left, a central ver-

The seat on chair #6 locks into the front and rear legs. Pressure of the slightly angled seat stresses the legs, making them more rigid and stable. To make a comfortable and flexible back, Fleishman stopped the central back loop short of the seat.

Chair #22 introduced a new way to build in additional support for the seat front. The rear legs bend forward and cross the front legs, interlocking with them. Then, they continue forward to support the seat.

tical loop system forms the back and rear seat support, and an outer portion comes forward to form the front legs. For flexibility and a comfortable back angle, the back loop stops just short of the seat, where the center portion splits and each side returns upward to support the shoulders before going back down to form the rear legs. The front legs also return upward to form the front seat support.

The next 11 chairs all contain these basic features, although I did experiment with variations of shapes, sizes, and detailing. The shapes and sizes define the way each chair works and the detailing defines the piece's personality. By the time I had finished chair #16, my designs had stabilized into compact two-piece assemblies so I decided to switch from the saber saw to a router and see if I could produce chairs economically, as I had originally planned. I used a double-fluted ½-in. carbide bit and template guide with a 2½-HP router, cutting through the sheet in two passes. I made a series of templates to guide the router and keep the plywood rigid as the slots were cut. Generally, one template was used to cut the slots inside of the outer edges. Then a second template, which has projections that fit into the previously cut slots to locate the template, was used to complete the slotting. To finish, I repeated the process on each side with a roundover bit.

My production techniques worked well enough (about ½-hour cutting time per chair back), but I was still dissatisfied with the shape of the seat. I experimented with the design, and discovered a loop size and shape relationship that worked so well I decided to apply it to the other portions of the chair as well.

In chair #22, above right, I solved the final major problem in this two-piece chair project—how to increase the support for the seat front. As you see, I extended the rear leg stabilizer upward and bent it forward so it would cross over and interlock with the front legs before continuing forward to support the front of the seat. In the next few designs, I continued the back loop system down below the seat and bent a stiff brace arm forward. In later chairs, I changed to a stiff leg below the seat and added loops to the lower part of the brace arm. Generally, I varied the loop size and thickness, and thus adjusted the chair's flexibility, varied its height and back slope to improve its comfort.

I concluded the basic design process in the final six chairs, beginning with chair #29. It has the first stiff central rear leg that is part of a stable structural frame supporting the flexible seat and back areas, a feature I incorporated in the Lumbarest. Although it was workable, I continued modifying the rear seat support, the details of the loops, even tried more radical back loop configurations. I gradually realized that I had reached a point of diminishing returns in these experiments. The major difference between chair #29 and the Lumbarest is that chair #29 is lower with a split at the top of the back. The Lumbarest is made from 12 sq. ft. of ⅝-in. Finland Birch and weighs 17 lb.

The chairs are now produced from templates on a pin router. A blank is clamped to the top of a template that has a pattern that is an exact duplicate of the chair design. As the pattern is pushed along the pin protruding up from the table, a router cuts slots in the blank from above. I cut to a depth about 1/16 in. less than the plywood thickness, leaving the remaining ply to hold the internal loops stable under the router's cutting action. After separating the blank from the pin-router template, I cut the final ply with a roundover bit and bearing guide in a hand router.

After finishing this chair design, I continued experimenting with other shapes using the same methodology as for the first series. The Rock 'N' Roll is made from a 2 ft. by 8 ft. piece of plywood. The Surround, the burgundy chair on p. 41, comes from a single 3-ft. square. These designs are covered by patents in the United States and Canada.

At the present time, I'm still working on refining my production techniques and developing my market. Right now the Lumbarest retails for $325 to $575, depending on how it is finished. As I find that a lot of my time and expense involves hand sanding the slots and edges, I've been investigating various types of bits and CNC (computer-driven) routers. With continued development and a higher volume production, these eminently functional and elegant chairs will soon be produced more economically from plywood and other readily available materials. □

Gregg Fleishman is an architect in Los Angeles. His shop and showroom is at 2742 South La Cienega Blvd., Los Angeles, 90034.

Photos by author, except where noted

Shopmade Lathes

Low-Cost Wooden Longbed

by Carlyle Lynch

I designed and built this lathe to turn everything from chessmen and chair rungs to tall bedposts. The materials cost $179.25 including $30 for a used ½-HP motor, but not including some scraps of plywood and oak left over from other jobs. The spindles are made from machine steel tubing, which I threaded and reamed to a #2 Morse taper so standard Delta lathe accessories will fit.

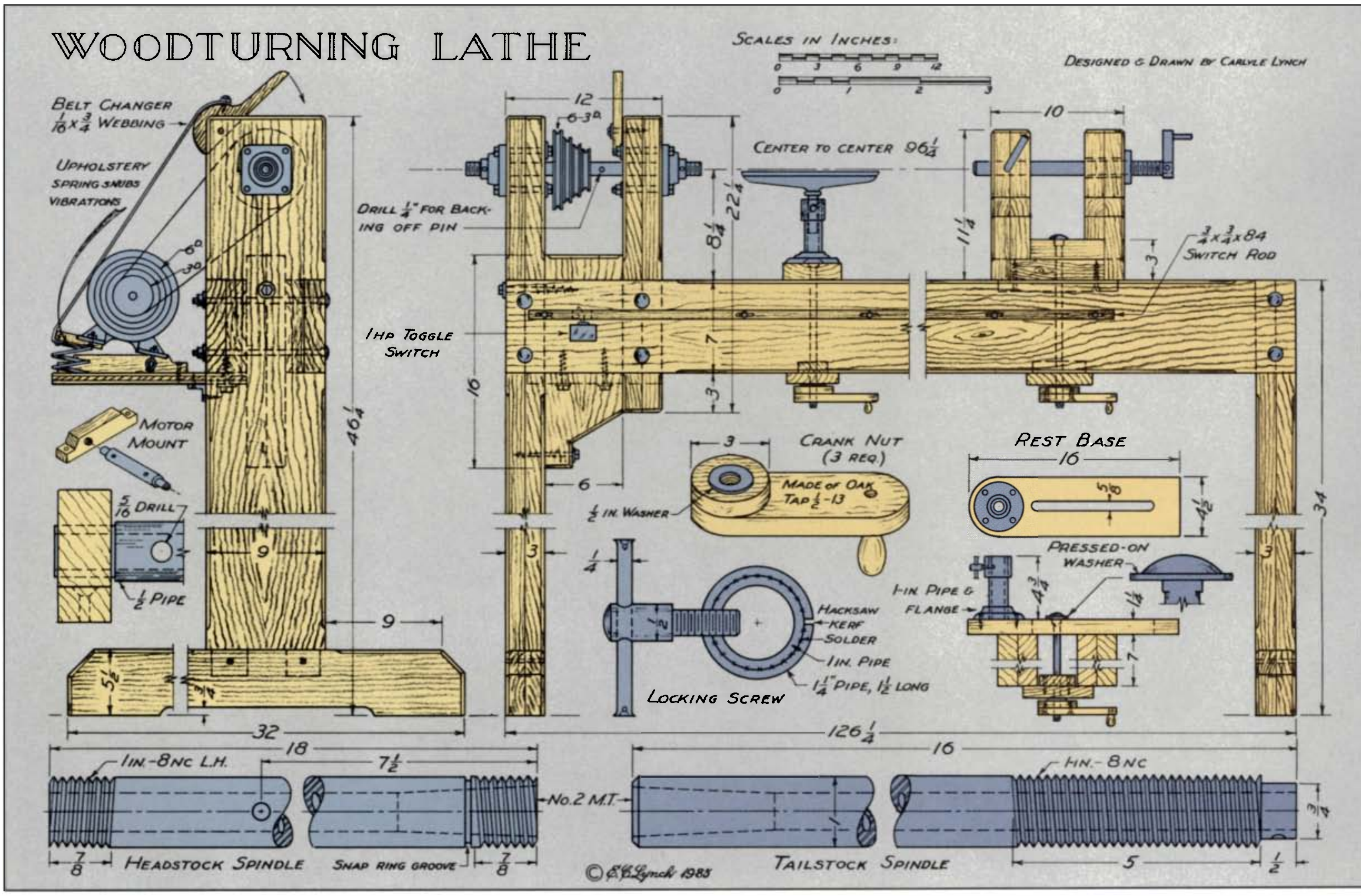
Sources for heavy timbers are so uncertain that I decided to glue up the 3-in.-thick wooden members from kiln-dried southern yellow pine framing lumber; two 2x10s, four 2x8s, and one 2x6, each 12 ft. long. My local building supply dealer let me flip through his stacks to find pieces with straight grain and few knots. Besides the ready availability of standard "2 by" lumber, laminating had other advantages over heavy timbers. Until final glueup, most of my work was easier because I was hefting just half of each member at a time. The laminated members are also stronger and more dimensionally stable than heavy timbers.

Each of the ways is made from two pieces of 2x8 (1½ in. by 7 in. after dimensioning), as shown in the drawing below. After temporarily screwing the ways together, I clamped the uprights to each way in turn, and made sure that the ways were square to the uprights. I drilled the carriage-bolt holes in the ways with a long electricians' auger bit guided through the dadoed bolt holes in the uprights. Then I glued, screwed and clamped the ways together.

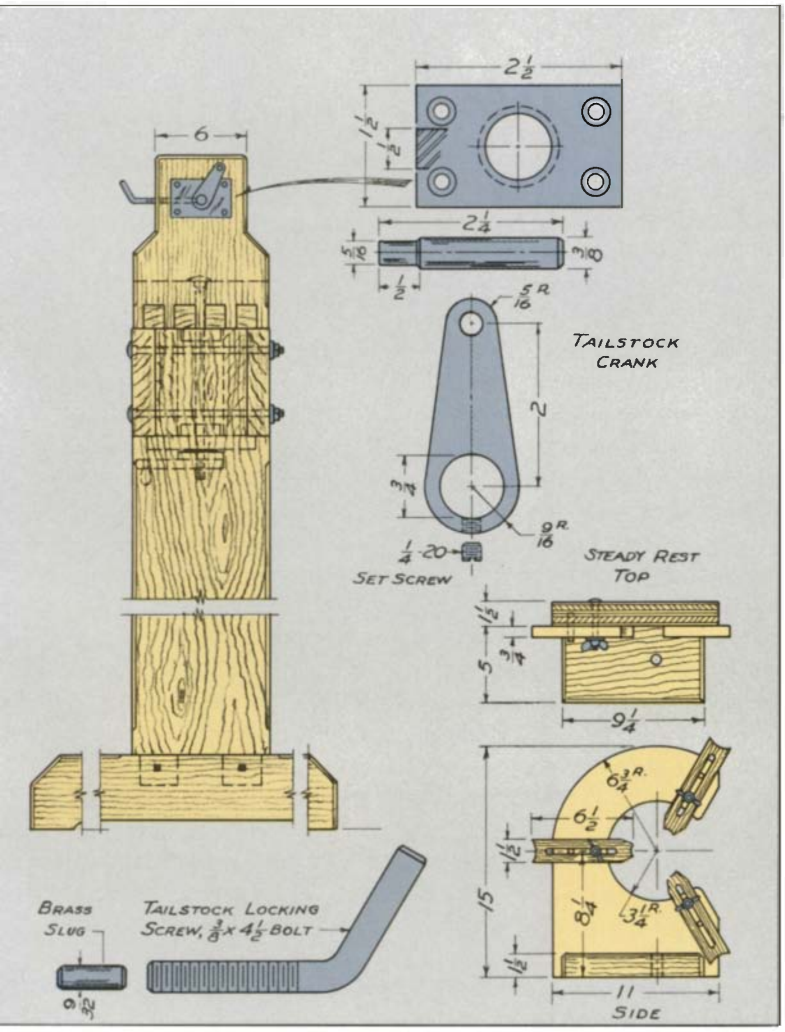
The headstock brace was made a snug fit between the headstock uprights and the ways and fastened to the headstock leg with two ½-in. by 5-in. lag screws and washers.

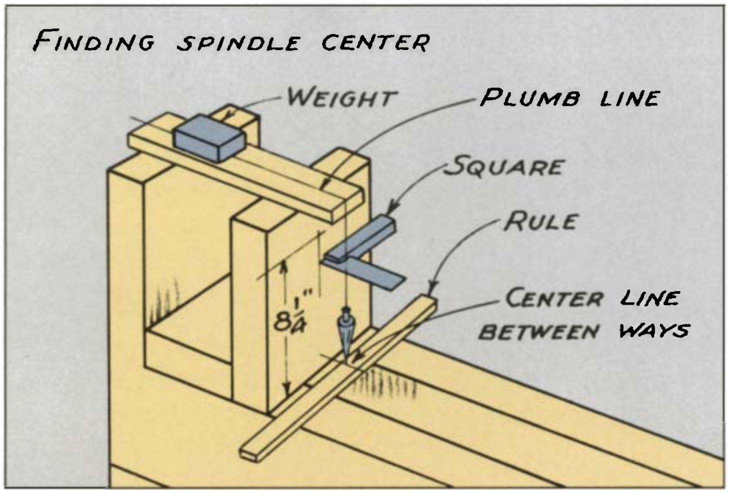
Each foot is made of two pieces of 2x6 (now 1½ in. by 5½ in.). I outlined blind mortises for the leg tenons, unscrewed the pieces and cut the mortises in each half. The foot halves were then glued, screwed and clamped together, then bandsawn to shape when dry.

The tailstock is made of two uprights joined to a base with dovetails. I cut 10° tails on the base with the bandsaw. I cut the



Glued up from yellow pine framing lumber, Lynch's wooden lathe cost less than $200 in materials. With its 10½-ft. bed, it can handle up to 8-ft. work. A strip of wood, screwed to the bed through slotted holes, activates the on/off switch from anywhere on the bed.





Hardware specifications:

2—One 1-in. bore, 4-groove cone step pulley, 3, 4, 5, and 6 in. dia., and one to fit motor shaft (Made by Browning Mfg., Emerson Electric Co., P.O. Box 687, Maysville, Ky. 41056)

2—1-in.-bore flange block bearings (Fafnir RCJ, made by Fafnir Bearing Div. of Textron Inc., 37 Booth St., New Britain, CT 06050)

1—12-in. toolrest (Delta part no. 46-692; Delta lathe parts are available from local Delta dealers or may be ordered by phone from Delta International, 1-800-223-7278.)

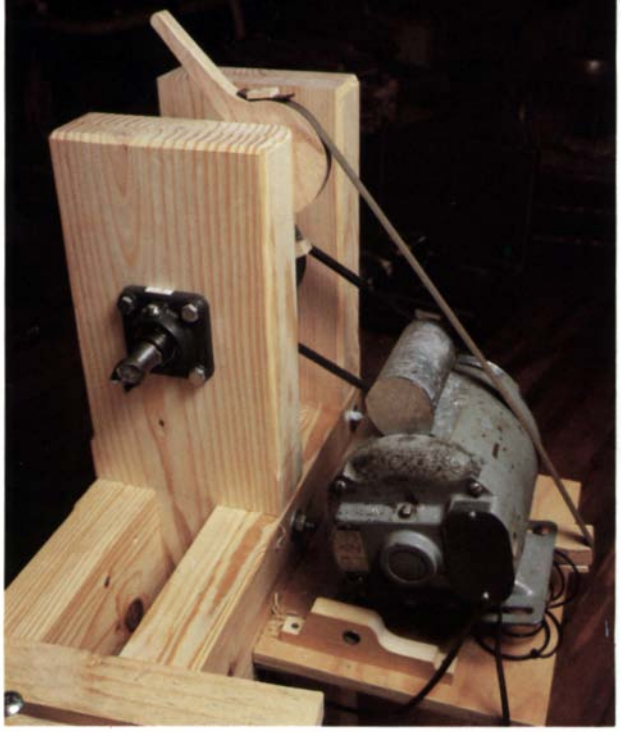
1—6-in. faceplate, 1-in. -8 thread (Delta part no. 46-937)

1—Spur drive center #2 M.T. (Delta part no. 46-933)

1—Cup center #2 M.T. (Delta part no. 46-439)

1—Headstock spindle; 16 in. by 1-in.-OD machine steel tubing

1—Tailstock spindle; 15 in. by 1-in.-OD machine steel tubing



The headstock spindle turns in flange-block bearings bolted to the headstock uprights. The weight of the ½-HP motor keeps tension on the belt. Pulling forward on the lever pulls a strip of ¾-in. webbing to lift the motor forward and take the weight off the belt for changing speeds. The upholstery spring under the motor damps vibration. A birch-plywood indexing ring (above) screws on the inside of the inboard headstock upright. With the belt removed from the motor pulley, a pointer fits around the headstock spindle so that an 8d nail can slide through a hole in one of five concentric rows. A bar on the pointer passes through a hole in the spindle.

matching pins on the tablesaw by setting the miter gauge at 80° and standing the board on end. The other three tailstock pieces shown in the drawing are glued to these three parts. On the underside of the base, I screwed an oak guide block exactly as wide as the gap between the ways, so the tailstock moves smoothly on the ways without any side play.

To locate the headstock spindle hole on the inboard headstock upright, I assembled the lathe and leveled the bed in both planes by shimming the feet. I laid a rule across the ways and dropped a plumb line over the upright to the center point between the ways, as shown in the drawing on the previous page, then marked the center. I disassembled the lathe and drilled the spindle holes on the drill press—1⅛ in. dia. on the inboard upright and 1¼ in. dia. on the outboard leg.

To mount the spindle, I clamped one of the flange block bearings to the inboard upright, inserted the spindle, and clamped on the outboard bearing. I stuck a spur center in the inboard end of the spindle, and with plumb line, ruler, and a short spirit level on the spindle, I maneuvered the inboard flange block until the spindle was level and centered in the headstock upright. When it was, I clamped the inboard flange block in place. A strip of wood clamped under the flange block provided additional support while I drilled through one of the four mounting holes in the bearing for a bolt hole. With that corner bolted, I drilled and installed a bolt in the corner diagonally opposite. I moved the spur center to the outboard end and centered and bolted the outboard bearing in place. Once the headstock spindle was in place, I tightened the locking collars (supplied with the bearings) that hold the spindle in the bearings.

To mark the center for the tailstock spindle, I placed a spur center in the headstock spindle and slid the tailstock along the bed until it bumped into the spur center. Using this dent as center, I drilled a 1-in. hole through the inboard tailstock upright and a 1¼-in. hole in the outboard tailstock upright on the drill press. I spun the threaded steel plate onto the tailstock spindle threads and inserted the spindle through the holes in the tailstock. With a center in the tailstock spindle, I slid the tailstock up to the headstock to align the points. When the tailstock spindle was aligned and level, I clamped the steel plate in place and drove two No. 8 screws in diagonally opposite ¹¹⁄₆₄-in. holes in the plate, checked again for alignment and installed the other two screws. Then, two at a time, I removed the screws, drilled out the holes to ¼ in., and replaced the screws with ¼-in. by 4-in. machine bolts. I made the tailstock spindle handle from a piece of flat steel bar, but a handwheel would be better.

The ½-HP motor rests on a plywood platform held to the back of the lathe bed by a piece of angle iron and a wood brace. The weight of the motor furnishes the belt tension. A piece of ¾-in.-wide webbing and an eccentric lever take the weight off the belt to make changing speeds easy, as shown in the photo, above left. An upholstery spring under the motor acts as a snubber to take out slight motor vibration. A 20-amp, single-pole, single-throw toggle switch is mounted on the front side of the bed. Slots cut in a ¾-in.-square 84-in. pine strip allow control of the switch from anywhere along the bed.

The drawing shows a wooden toolrest base with a pipe flange and short length of pipe that holds standard Delta toolrests. A 30-in.-long wooden rest can also be made for long work.

Tall bedposts and the legs of Sheraton tables are often reeded, fluted or carved, necessitating an indexing ring, not shown in the drawing. The ¾-in. birch-plywood ring is fastened to the left side of the inboard upright, as shown in the photo, above right. With the belt removed from the motor pulley so the lathe can't be accidentally started, a pointer is fastened on the headstock spindle so that an 8d nail can slide through any one of five holes in the pointer to engage one of five concentric circles of holes in the ring. Working in from the outer circle, the number of holes in each circle are: 60, 11, 9, 7, and 8. The circles were scratched by holding the nail against the plywood ring and revolving the spindle. A pair of dividers found the correct spacing by trial and error.

Long spindles must be kept from "whipping" while being turned, so I made a steady rest, as shown in the drawing. I carefully and slowly turn long pieces to a smooth cylinder for a couple of inches in the middle before turning the whole piece. Then, I set the hickory jaws of the steady rest against that smooth surface, turn the lathe on and touch on paraffin to lubricate the friction spot.

I finished the lathe with shellac, about the only finish that will prevent sappy grain and knots bleeding through. The lathe is bolted to the floor with angle irons, to keep vibration down. □

Carlyle Lynch is a retired teacher, cabinetmaker and designer in Broadway, Va.

Heavyweight Lathes

by Jerry Blanchard

About five years ago, I looked around for a lathe that would swing 24 in. over the bed. Big patternmakers' lathes had the capacity I wanted, but they cost a fortune and take up half the shop. Instead of buying one, I designed and built the lathe I had in mind—heavy, versatile, and bull strong.

My lathe is fabricated almost entirely of structural steel members. I machined everything myself on a 10-in. Delta metalcutting lathe. If you aren't up to basic machining, or don't have access to a metal lathe, a local machine shop can probably do the machining for you, working from the drawings.

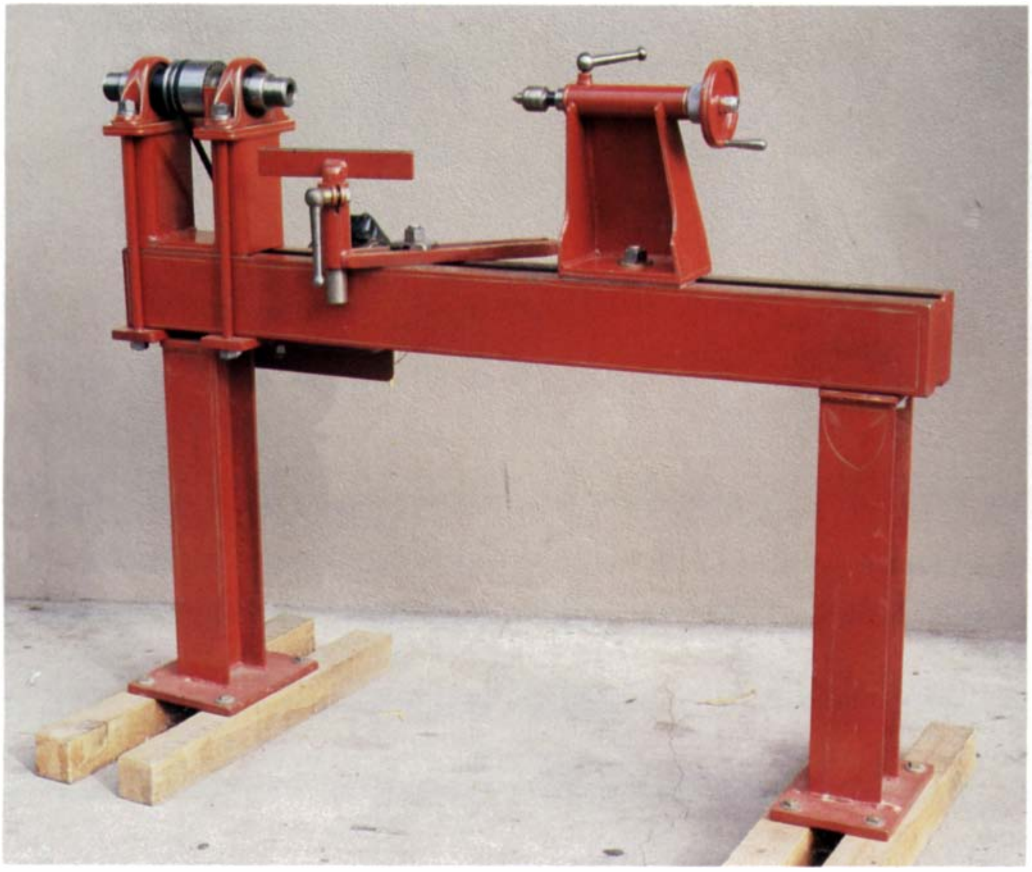
I designed the lathe in sections that bolt together so I could move it piece by piece; alone, if I had to (three times so far). It would be simpler to weld things together if you don't care about portability. With a little scrounging, you can pick up most of the steel at a low price, as I did. The legs are made from 5-in. by 5-in. H-beams, and the bed is made from two lengths of heavy 6-in. channel iron spaced 1¾ in. apart. My lathe is 6 ft. long, but you could make the bed longer or shorter.

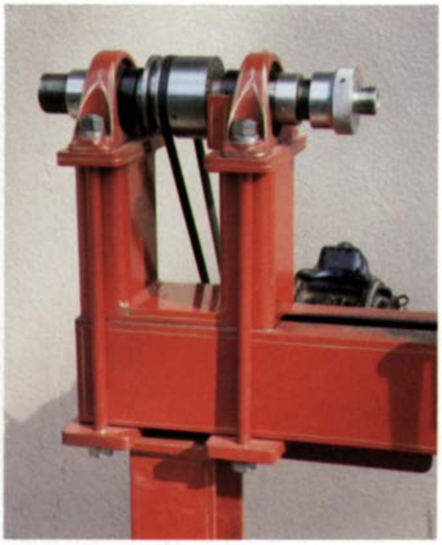
The headstock uprights are made from 3-in. by 6-in. mechanical tubing with a ⅜-in. wall thickness. The flat plates that make up the tailstock assembly, and other parts here and there, are mild steel. I cut the plates to shape with an oxyacetylene cutting torch and a hacksaw, ground the edges clean with a hand-held disc grinder, and arc welded the parts together with low-hydrogen welding rods (E7016 or E7018).

I made the headstock spindle from a 16-in. piece of 2⅝-in.-dia., seamless mechanical tubing with an inside diameter of ⅞ in. The ends are turned down to 2³⁄₁₆-in. diameter, as shown in the drawing on the following page. This massive spindle may seem like overkill compared to store-bought lathes, but I like to overbuild. I reamed a #3 Morse taper in each end to hold centers, and cut the threads on the Delta lathe. I could have mounted a step pulley on the spindle, but I planned to use a variable-speed motor so I didn't need a step pulley to change speeds. I wanted an indexing device so I combined functions and machined a heavy, one-piece pulley/indexing head that slips over the spindle. To drill the twenty-four ¼-in. indexing holes, I scored a centerline around the face of the pulley using the Delta lathe, spaced off the holes, and drilled them on a drill press. The pulley/indexing head is a press fit on the spindle, held in place with a key. As an extra touch, I crowned the surface of the pulley/indexing head slightly, just in case I ever felt like running the lathe with a flat belt off a lineshaft.

The headstock bearings are Fafnir self-aligning 2³⁄₁₆-in. ball-bearing pillow blocks (available from bearing-supply companies in major cities). These compensate automatically for twist or other misalignment of the headstock so precision machining of mounting surfaces isn't needed. Pillow blocks come in various strengths, types, and sizes. Commonly-used sizes are cheaper than others, so it pays to buy pillow blocks that your dealer has in stock and make your spindle to fit. Fafnir pillow blocks come with eccentric locking rings that lock the spindle tightly to the bearings. I supplemented these with threaded rings at each end of the spindle to take heavy thrust loads applied from the ends. One-inch-diameter threaded rods bolt the headstock to the bed.

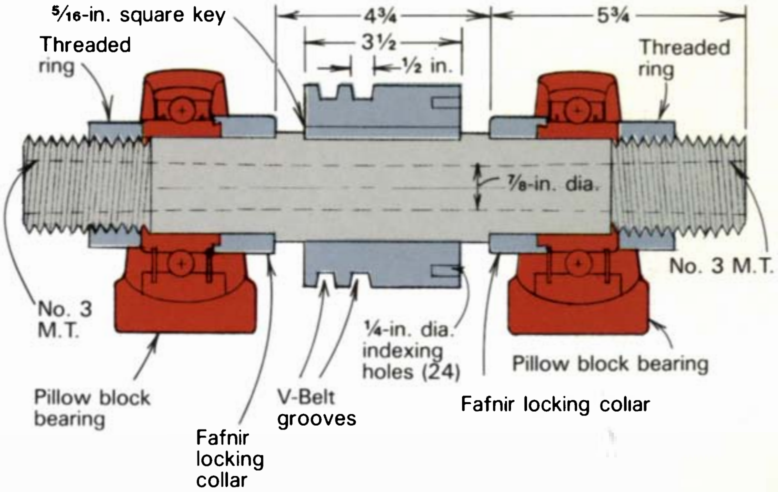
The tailstock assembly shown in the drawing works just like the tailstock on most store-bought lathes. The thrust bearing is not essential, but it makes it easy to really tighten up the spindle





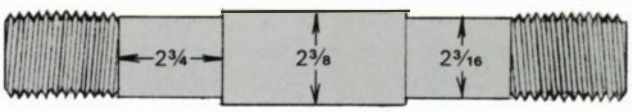
This scarlet behemoth swings 24 in. over the bed, weighs about 500 lb., and knocks down for portability. The body of the lathe is welded and bolted from stock structural steel shapes. The headstock spindle turns in pillow-block bearings bolted to the headstock and bed. A variable-speed motor eliminates the need for a step pulley. An adapter (shown above on inboard end of spindle) permits use of standard size faceplates and chucks.

Headstock spindle section

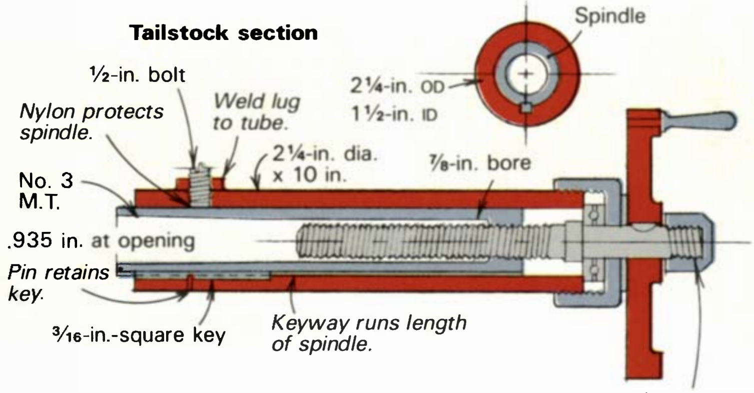


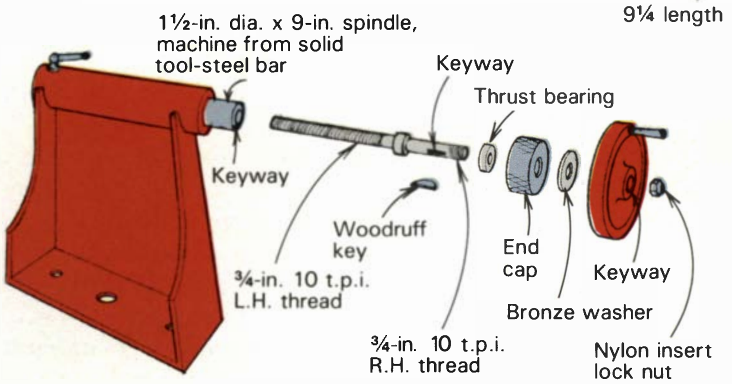
Note: Locking collars alone will secure bearings to spindle. Threaded rings increase resistance to end thrust.

Spindle detail



Tailstock section





Josephus Daniels

Blanchard poses with the super bowl lathe (newly pinstriped) that he made for bowl turner Neil Weston. The lathe swings 8 ft. with the toolrest removed, and 36 in. with the rest in place. The top is a 21 in. square of ¾-in. steel plate welded to 3-in. by 3-in. angle-iron legs. Two non-syncromesh G.M. transmissions from the 1940s—a 4-speed truck and a 3-speed—provide 13 forward speeds from 33 RPM to 856 RPM, and some in reverse for final sanding. Power comes from a 2-HP, 220-volt single-phase Baldor motor, mounted on the floor to isolate vibration. The spindle is a length of 2½-in.-dia. heat-treated shafting. The clamp on the toolrest post is made from Powermatic lathe toolrest clamp parts ordered from the Powermatic parts catalog.

without too much effort on the handwheel. I made a lot of attachments for my lathe: centers, faceplates, steady rest, a sanding disc and a metal-spinning toolrest. Most useful, so far, is an adapter that allows me to mount standard lathe faceplates and chucks on the big spindle.

The motor on my lathe is an ancient G.E. variable-speed reversing model that works by mechanically shifting the brushes with a lever. It's underpowered, but the brushes spark and it smells wonderfully of ozone, and it pleases me to use it.

I spent some time sanding everything smooth and painting it shiny red with gold pinstriping. The lathe was a lot of work, but I enjoyed making it and it does what I wanted it to do. □

Jerry Blanchard, engraver, machinist, woodworker, and gunsmith, lives in Pebble Beach, Calif., and teaches woodworking at nearby Monterey High School.

Safety warning

A lathe is a dangerous machine. A block of wood that is carelessly secured can fly off and hit you in the face with enough force to maim or even kill. You can't make a lathe completely safe, but you can eliminate this danger by turning large-diameter bowls and out-of-balance blocks at the slowest speed setting on your lathe. Be sure your wood is securely mounted. Double-check your speed setting and rotate the stock by hand to make sure that it clears the toolrest before you turn on the lathe. As you throw the switch, stand to one side, just to be sure.

Before turning, take off ties, loose clothing and jewelry. If your hair is long, tie it back. Long hair can wrap around the spinning wood and pull your face into the lathe with frightening speed and force. Above all, ***never turn wood without wearing a Plexiglas face shield.*** Safety glasses and goggles don't protect your face.

Kentucky Quilt Cabinet

A cabinetmaker tackles two-board construction

by Warren A. May

A custom cabinetmaker has to be ready to make pieces of furniture that the general marketplace doesn't provide. At the same time, a craftsman is better off doing work that he feels a sympathy for. I had the chance to satisfy both requirements recently when some customers complained that they couldn't find furniture roomy enough to store quilts and other bulky items. Quilting is a popular hobby and home-industry in this part of Kentucky, and even if the quilters themselves didn't need a storage cabinet, I was sure the quilt collectors would.

The design is taken from the two-board hutches made by rural handymen all over this country. It's called two-board construction because of the sides—one long board on each side runs from floor to top to support the upper shelves and doors. A second, shorter board is attached on each side to support the counter and the lower shelves and doors. My adaptation, instead of shelves and doors at the bottom, has a pair of deep drawers. With some minor changes in the plans, this piece would be very easy to adapt to make a gun cabinet, a hi-fi center, a kitchen cabinet, or even a tool cabinet.

I have seen a lot of the old hutches, and I'd say the old joinery standards were, well, quick. Typical construction was a simple nailed butt joint reinforced with a nailed cleat on the inside. Shelves were laid atop nailed cleats as well. The two side boards often were not even glued along their length—the lower shelf cleats held them together. Lumber thickness varied randomly within any one piece, and so did cleat widths. It's as if whoever built these pieces was in a great hurry to get on to more important work, such as pulling stumps or cutting firewood.

These hutches served as storage and display pieces; sometimes the top doors were glazed so the contents would show, perhaps an imitation of the high-style city furniture, where china and porcelain figurines might have been kept visible yet out of harm's way. Ironically, all the glazed hutches I've seen had curtains inside so that the contents *wouldn't* show.

Hutches might be found in any room of the house, but most of them seemed to end up in the kitchen, storing canned goods and other non-perishable items. Inevitably, the doors sagged in time and rubbed a groove in the counter (I raised the doors in mine to prevent this). Some pieces were repaired with as much abandon as they had been made in the first place, and most have accumulated six or eight coats of paint, with apparently never the same color twice in a row. I love these old hutches because of the story they tell about past times. I remember one day seeing an old cabin that had sagged down a couple of feet on one side as the earth beneath it gradually eroded away. On the front porch was a two-board hutch that had managed to keep together and keep its balance all the while—it was about 20° out of square when I saw it, but it hadn't given up. In fact, I managed to purchase it, straighten it up again, and give it a second chance. It has a place of honor in the gallery my wife, Frankye, and I run. Country crafts look just right in it, something you can't say about display cases made of glass and stainless steel.

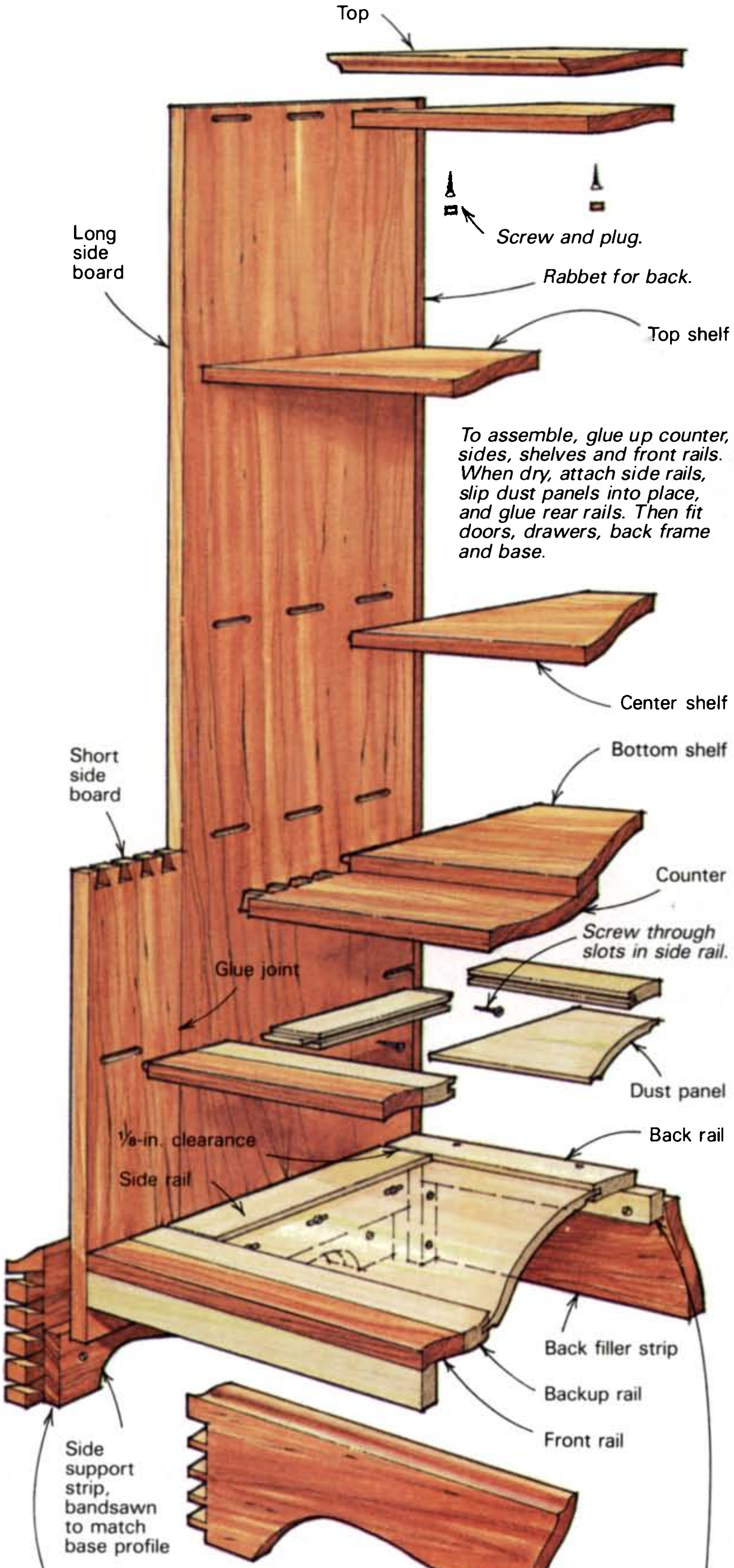
So, when it came to making a cabinet for traditional quilts, I was predisposed to a two-board design. I felt that I could avoid the design's construction flaws without losing its character.

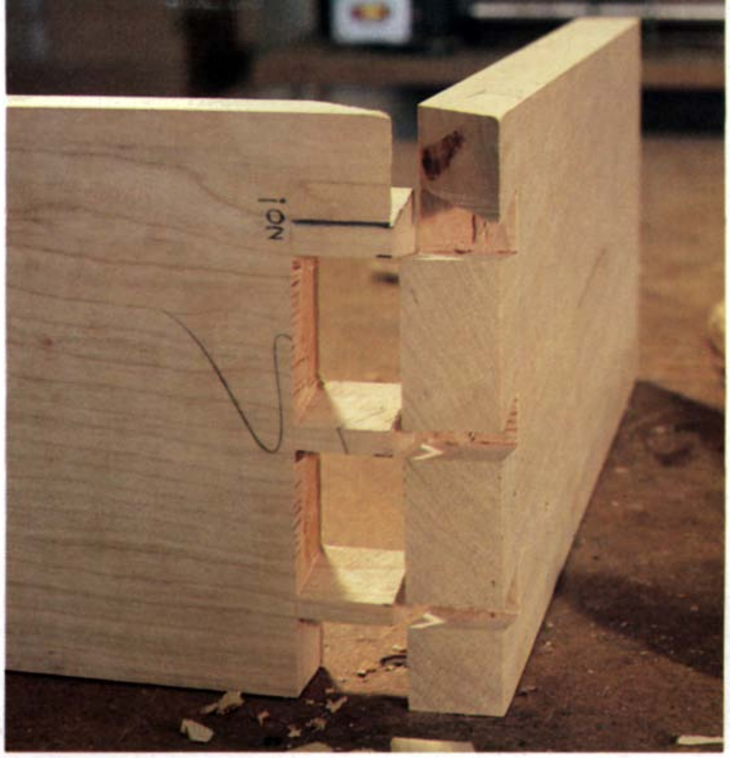
I like to run my shop, which is in a corner location down the

The quilt cabinet owes its lines to traditional hutches, but the joinery and detailing have come a long way from the originals.

Photos: Brunner Studio

Carcase construction





A mitered through dovetail is made the same as a regular dovetail, except that the top corners are tablesawn at a 45° angle before the rest of the joint is cut. Notice the author's reminder to himself not to cut the top layout line for the first pin.

street from the gallery, so that most operations can be done by one man. My helper and I are likely to get customers stopping by at any hour of the day, and this way one of us can get on with the job while the other goes to talk. Over the years, I've worked out a router-joinery method that's clear enough so that either one of us can take up where the other leaves off, and which even allows one-man glueup when necessary.

If you consider the construction of the quilt cabinet, you'll get the idea. The sides are solid wood, and the crossmembers (whether shelves or front and rear drawer rails) fit into routed mortises, which are easily made with a straight bit and a right-angle fence clamped to the work. For a stock thickness of ¾ in. or ⅞ in., I have found that a ⅜-in.-thick tenon works best, with a length of 7/16 in. Mortises are ½ in. deep, to allow some end clearance, and can be routed in one pass in most woods.

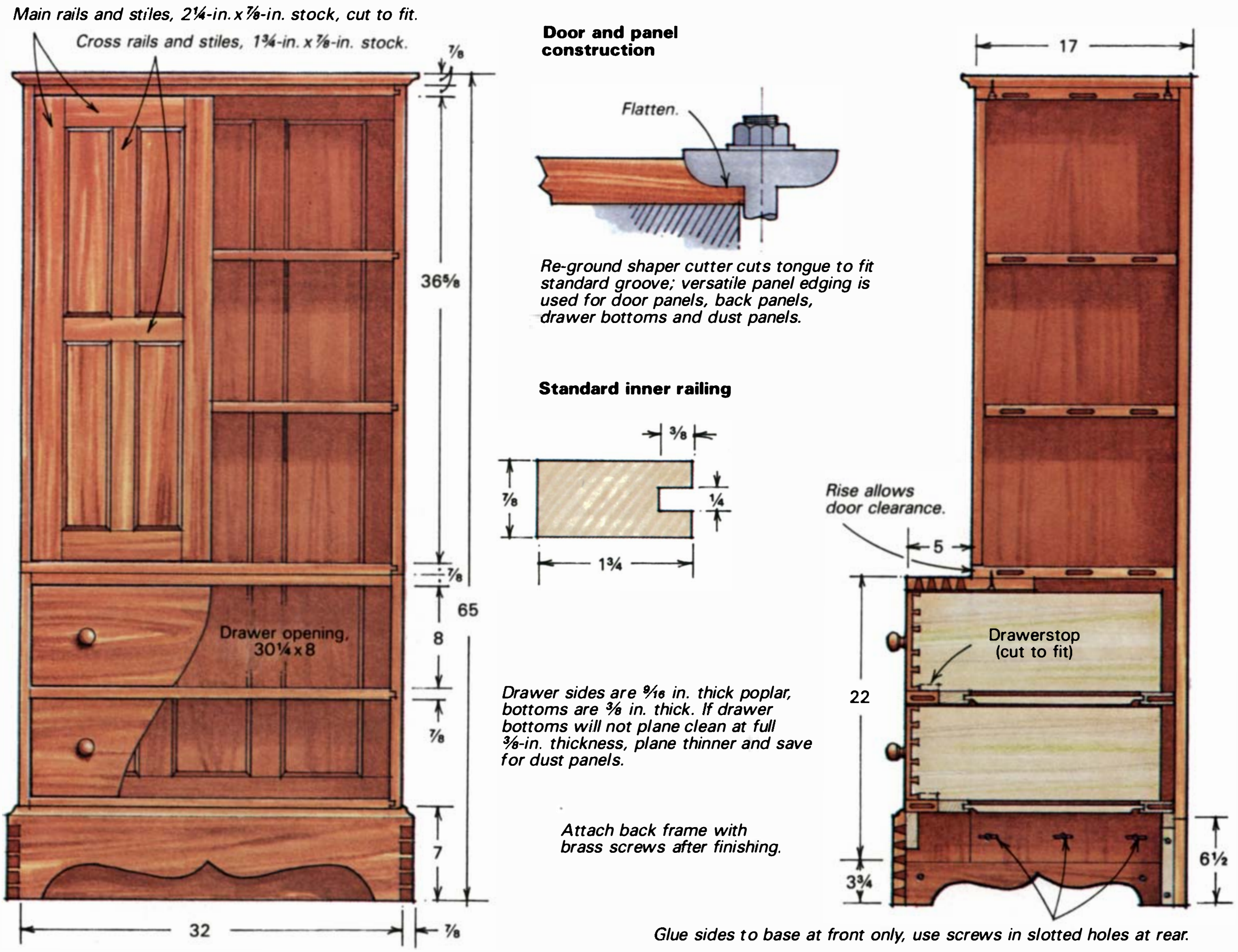
I use several short mortises along the width of shelves rather than a long dado for two reasons. First, it is easier to fit the parts; second, the sides are stronger. At the top and bottom corners of my cases, I offset the tenons toward the inside of the cabinet, as shown in the plans, so as to leave more wood and help prevent end-grain breakout. I make tenons with a dado blade on the tablesaw, then clear the waste between them with bandsaw and chisel. The back of the case fits into a rabbet and is secured with brass screws. This allows the back to be removed for finishing the piece, which makes for a much cleaner job.

The top part of the quilt cabinet shows how such a construction would work for a simple bookcase. Just rout mortises for as many shelves as you would like, assemble by working the shelves in one at a time, then screw on the back. I like a solid top applied afterward, with a molded edge. The bottom can be similar to the top if the bookcase is hung on the wall; if it stands, you can apply a base and filler strip, as at the bottom of the quilt cabinet. I like the idea of a filler strip instead of carrying the sides all the way down, because it keeps the end grain away from the floor, where it might pick up moisture.

When my helper and I make a chest of drawers—the bottom half of the quilt cabinet is an example—the router-joinery method is very straightforward and allows easy assembly. To begin

Drawings: Joel Katzowitz

Hutch plans



with, we make up a standard yellow-poplar drawer rail in large lots, then use it for interior rails in all pieces. This alone saves a lot of confusion. The same profile, in show-wood, can be used for rails and stiles for doors and back panels, so we usually run off some in cherry and walnut as well. To shape the edges of the panels themselves, I re-ground a standard shaper cutter as shown above, to raise the panel and cut the ¼-in. lip at the same time. We leave this cutter on the shaper most of the time, because in addition to door panels and back panels, the shape is handy to thin down the edges of both drawer bottoms and dust panels.

In making a chest with drawers, we cut the sides of the case to size first, then rout mortises for the front and back drawer rails. Front rails are routed to fit flush with the edge, back rails are set in to allow room for the back framing. The front rails are show-wood, of course, and on a wide drawer, we often back them up by gluing on a strip of the standard yellow-poplar rail to give extra strength and to minimize any chance of warping.

For a chest, the first stage of assembly consists of gluing the front rails into the sides and clamping things square. When the glue is dry, we add the front backup rails, if any, and side rails, securing them as shown in the drawings. Then we slip in the dust panels and attach the back rails. The top can then be screwed on from beneath and various forms of base moldings and feet can be added. Although it's nice to have company, all this can be a leisurely one-man job.

Of course, the quilt cabinet is more complicated than a simple chest of drawers. To build this piece, first dovetail the counter to the short side boards. Measure this to determine the shoulder-to-shoulder length of the shelves and drawer rails. Then disassemble the dovetail joint and glue the long side boards to the short ones. Proceed to rabbet the sides for the back framing, then rout the mortises for the shelves and rails. Next, measure all this to get the true sizes of the drawers and doors. Once the overall proportions are established, you can let the piece build itself to its own measurements as it goes along.

It will be necessary to dry fit the dovetails at the counter, but I'm not sure whether to recommend that you dry fit the whole thing. We have found that another advantage of using the same joinery from piece to piece is that you quickly learn what tolerances to allow so that joints practically weld themselves together. If you dry fit too often, the wood becomes overcompressed and some of this strength is lost. □

Warren May lives in Berea, Kentucky.

Dovetails for Case Work

Strength and durability from traditional joint

by Gene Schultz

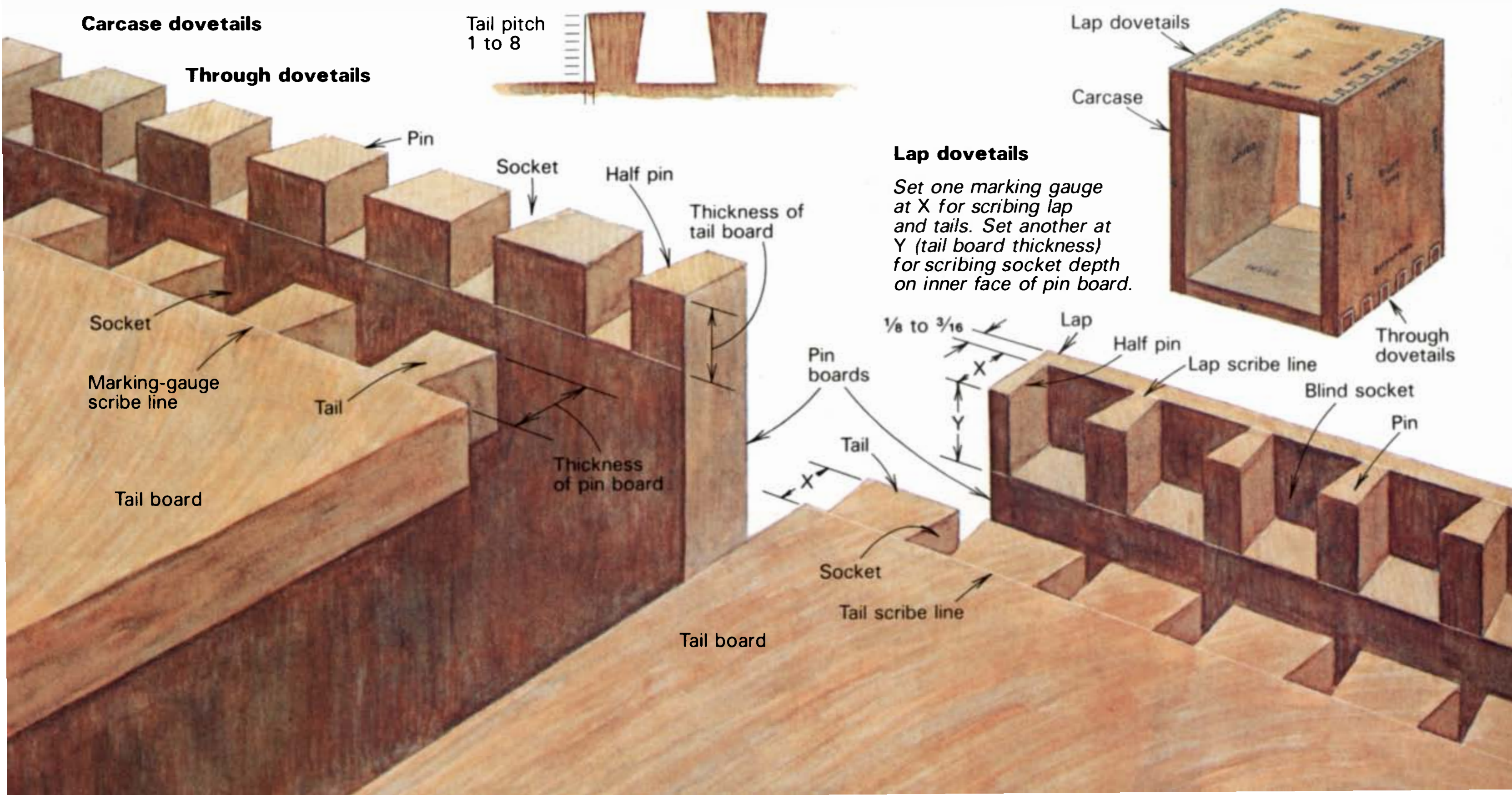
I cut my first set of carcase dovetails 12 years ago for a large toolbox. At the time, I was planning a career reproducing American furniture of the 18th and 19th century, a period in which dovetailed carcases were the norm for fine furniture. I've since expanded my business to include modern materials, methods and designs, which permit a wide variety of carcase joinery. But for unquestioned durability and strength in solid-wood construction, it's hard to beat dovetails, and I use them whenever the job warrants—and the customer will pay for them.

Traditionally, both through and lap (also called half-blind) dovetails were used for carcase work. In through dovetails, the joint is visible on the surface of both joined pieces. Lap dovetails are visible only on one surface and hidden behind a lap on the other. Through dovetails, which are faster to cut, were first choice when it didn't matter if the joint was visible; lap dovetails were selected when it did. Contemporary makers often choose through dovetails for their decorative quality, and use lap dovetails mainly for drawer work.

To illustrate the process of cutting both joints, I'll describe the making of the simple carcase shown in the drawing, lap dovetailed on top, through dovetailed on bottom. Before any joints are cut, the stock must be prepared. I usually rough cut the stock about 1 in. longer and 1 in. wider than finished dimension, then plane them to final thickness—I finish by taking light shavings with a sharp handplane to smooth the surfaces. Next, cut them to exact size on the tablesaw. I use an accurate framing square and a 12-in. combination square to check that the boards' ends are square to the edges, as well as the faces. If necessary, I handplane them square. The stock must be perfectly square and uniform in thickness for the dovetailed case to go together well, without wind or other difficult-to-correct distortions.

Next, mark each board so there is no doubt about its position in the carcase. I mark the outside and inside faces of the top, bottom, left side and right side; then on each of those pieces, I mark the front and back edges, and the top and bottom ends. This may seem redundant, but it saves a lot of time and mistakes later on.

I layout and cut the tails first, then mark the pins from the tails. Others do the reverse, but I find this sequence easier and faster. Set a marking gauge to the exact thickness of the stock and scribe a line on the faces and edges of the tail boards, and on the faces of the pin boards. If the boards are the same thickness, tails and pins of through dovetails will be the same length and all four boards can, therefore, be scribed with the same



marking-gauge setting. I sharpen the spur to a chisel point so it cuts rather than scratches across grain. Darken the scribed lines with a chisel-point pencil so they're easier to see.

Some craftsmen space the tails precisely and evenly, their pitch uniform. I prefer the handmade look of asymmetrical pitch and spacing. For added strength, the pins and tails should be about equal at their widest part, but there are no hard and fast rules regarding width, and pleasing appearance is certainly important.

I divide the board for the tail spacing by eye, rather than measurement. Start by marking the center, then mark a half pin in from each edge, just a bit wider than half an actual pin. Divide the spaces between the center and end pin marks in half, and continue to subdivide until the spacing looks good to you. You may want to sketch out a few tail/pin spacings on paper to find one pleasing to you, then divide the board to approximate the sketch.

Now, draw the tails using your dividing marks as centerlines. The pitch I prefer is about 1 to 8. A much higher ratio resembles a box joint; much lower and the short grain in the tails may weaken them. I draw the tails with a pencil and plastic draftsmans' square, gauging the pitch by eye. If other joints on the case are the same, use the first layout as a rough template for them. Square the pitch lines across the end with a square and knife, then darken them with a chisel-point pencil. Finally, mark an "X" on the waste between tails—a simple precaution that can save much grief.

I saw the tails with a 20-point dovetail saw or a bandsaw, cutting the layout lines in half, rather than sawing to either side of them. Handsawing is best done with the work held rigidly in a vise, the top end parallel to the floor, and at a comfortable height. The closer the end of the board is to the vise, the less chatter sawing will create. As this puts the end rather low, I prefer to sit on a stool while sawing. As you work along the end, you can switch the board from one side of the vise to the other to reduce chatter. Auxiliary clamps, fixing an unsecured edge to the bench, for example, may be useful, too.

Start the cut with the saw at about 45° to the board's face. Use your thumb as a guide as you pull backward with light downward pressure to establish a kerf. As the kerf deepens, be sure you're cutting square across the ends, following the knifed-in scribe lines. As you near the marking-gauge line, lower the saw to finish the cut at the gauge line on both faces. After sawing all the tails, remove the bulk of the waste between them with a fine-tooth coping saw, slipping it into the dovetail sawkerf and cutting about $\frac{1}{16}$ in. to $\frac{1}{8}$ in. proud of the marking-gauge lines.

I clear the rest of the waste in the sockets between the tails with a sharp $\frac{1}{4}$-in. to $\frac{1}{2}$-in. bevel-edge chisel and mallet. Lay the board flat on the benchtop and clamp it securely. Place the chisel in the gauge line between two tails and chop down about halfway through the board. Chop first in the center of the socket, then in each corner; bevel-edge chisels conform to the pitch of the tails. If the waste is too thick, reduce it by making a cut or two away from the line. Chop square to the board's face or undercut slightly—this makes for much less clean-up later. Chop halfway through all the sockets on one side, turn the board over and chop from the other side to clear the remainder of the waste. Check with a square, or by eye, to make sure the socket bottoms are flat or concave (undercut), not convex, and pare any high spots with a chisel.

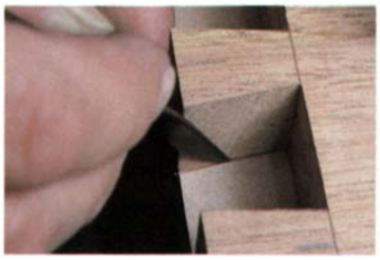
Dovetail saw cuts that aren't square to the board's face must be squared up before marking the pins. To do so, knife a square line on the end of the tail, then rest the chisel in the line to start a paring cut. Control the chisel by holding your arm and elbow

Determine the tail centerlines by eye, dividing the board in half, then quarters, and so on. You can freehand the tails' pitch with a straightedge as shown here, or use a sliding bevel for strictly uniform pitch.

Cut down the pitch lines for each tail. Start the cut against your thumb, the saw at an angle. Lower the saw to finish the cut at the scribed lines.

After clearing most of the waste from the sockets with a coping saw, chop to the scribe lines on both faces with a sharp chisel.

Drawing: Philip Harvey



A stable, accurately aligned setup is crucial when scribing the pins from the tails. Pull any bow out of the pin board (the vertical one) by clamping it to the bench, as shown above. Scribe carefully, keeping the knife blade flush with the tail, as shown at left.

tight to your body and use "body English" to push, while manipulating the chisel slightly from side to side to guide it. Keep the chisel flat throughout the entire slice.

Now you're ready to lay out the pins. Clamp one of the pin boards in the vise, with the board's top end parallel to and just slightly above the surface of the benchtop, its outside face toward you. Place scrap blocks under the bottom end of the board so that it won't move under downward pressure. Lay the tail board on the benchtop, aligning the appropriate end (check your marks) flush with the face and edges of the pin board. When the tail board is positioned exactly, secure it to the benchtop with a hand-screw clamp to keep it from moving while you scribe around the tails.

A snug-fitting set of dovetails depends on precise positioning and scribing of the pins from the tails, as well as accurate sawing and chiseling. A board that has bowed slightly across its width—a common problem—needs to be straightened for accurate scribing. I use a series of handscrews and my vise to pull it flat, as shown at top left. I move the piece manually until the distortion is corrected, then improvise a clamping arrangement that duplicates my hand position.

I scribe with a jackknife, and one that doesn't have a super-sharp edge seems to work best. Place the blade tight against the tail and draw it toward you lightly. Then deepen the mark with a second pass under slightly more pressure—double scribing is less likely to follow the grain of the wood. When all the tails are scribed, remove the tail board and darken the knife lines with a chisel-point pencil. With a square and the knife, extend the scribe lines down to the marking-gauge lines on both faces. Darken these; and mark the waste between pins with an "X."

The procedure for sawing and chopping the pins is much the same as for the tails. Accurate sawing is especially important when cutting the pins. Try to split the knifed scribe line in half—that is, the sawkerf should fall entirely in the waste, leaving half the V of the scribe line on the pin. Removing the scribe line completely, or leaving it completely on, will make the joint either too tight or too loose. If you have difficulty controlling the dovetail saw, it is better to cut away from the line on the waste side and pare to the line with a sharp chisel. Clear the bulk of the socket waste with a coping saw, then lay the board flat on the bench and chop to the socket-bottom gauge lines, as for the tails.

Before test fitting the joint, inspect all the tails and pins for squareness and accuracy, and pare where necessary. Then, line up the tails and pins and tap them together evenly along the width of the boards with your fist, or a hammer and a scrapwood block. Keep the pieces square to each other to avoid damaging the joint. Don't force the joint together—you may break a tail or even split a board. Instead, note where the joint doesn't fit, pull the boards apart and trim where needed. I usually drive the tails all the way home on the test fit. When you knock them apart, be sure to keep the boards square to each other and tap evenly along the width.

Lap dovetails are laid out and cut in much the same way as through dovetails, the main difference being the blind sockets. When preparing the stock, remember that tail boards must be shorter than the overall width (or length) of the case by the combined thickness of the two laps on the pin boards.

When laying out lap dovetails, I find it convenient to use two marking gauges, which eliminates some confusion and possible error when resetting the gauge. Set the first gauge to the length of the tails—the thickness of pin-board stock minus the lap, usually $\frac{1}{8}$ in. to $\frac{3}{16}$ in. Set the second gauge to the thickness of the tail-board stock. With the first gauge, scribe the faces and edges of the tail board and the ends of the pin boards to establish the lap line. Scribe the inside faces of the pin boards with the second gauge for the socket depth.

I divide the board and lay out the pitch of the tails by eye, as for through dovetails. The pins of lap dovetails are customarily much smaller than those of through dovetails, though extremely slender pins reduce the joint's strength considerably. Saw and chisel the tails exactly as described for through dovetails.

When the tails are finished, scribe the pins using the previously described setup, positioning the end of the tail board exactly on the scribed lap line. After knifing around the tails, knife the pin lines square down the inside face, darken with a chisel-point pencil, and mark the waste. Split the knife lines with a fine dovetail saw, but this time, saw only to the lap line and the marking gauge line on the inside face.

Some craftsmen remove the bulk of the socket waste with a Forstner, or similar flat-bottomed drill bit or a mortising machine, others cut it out with a fine-tooth coping saw, as I do. I clamp the board flat on the benchtop for making the coping saw cuts, keeping well clear of the gauge lines on the end and face of the board. I complete the sockets with a chisel, chopping vertically and paring horizontally a little at a time ($\frac{1}{8}$ in. or less). Start the final cuts in the scribe lines and clean out the corners with a skew chisel. Undercutting slightly is okay. Take very thin slices with a very sharp chisel in difficult or reversing grain. Dry assemble the joint to check the fit.

Position the tails on the scribed lap line and carefully knife along them to layout the pins.

Now you're ready to glue up. With all you've invested in cutting the joints, take the time to prepare for assembly. I make a complete dry run to uncover any problems with the clamping procedure. Once you start spreading glue, you must work extremely fast to finish before the glue sets up. I usually use white glue, which allows about 10 minutes for assembly, but, if you're inexperienced, you might try a much slower setting glue such as liquid hide (for more on this glue, see p. 66). An assistant is a big help for spreading glue and handling the clamps.

For a carcase like this, I usually use three or four bar clamps across each case end, placing a 1x2 hardwood-scrap batten under the clamps to avoid denting the work. To put pressure on only the tails, I cut a shallow relief in the batten over each pin. A strip or two of masking tape prevents excess glue from sticking to the battens. Before spreading any glue, lay the carcase parts in the correct positions on the benchtop, preset the clamps to length and place them, the battens, and some damp rags for wiping excess glue conveniently near the case parts.

Spread glue evenly on all surfaces of the tail and pin sockets. Work quickly and methodically. It's usually best to first assemble two pin boards to one tail board, pushing them together as far as you can by hand pressure, then push on the remaining tail board just far enough to hold the case together. Position the battens (tape them in place if you don't have a pair of helping hands) and apply pressure uniformly with all clamps. Tighten the clamps slowly to allow the excess glue to squeeze out. If one part of the case isn't drawing down, reposition a clamp or add an extra clamp at that point and continue tightening all the clamps evenly.

When the joints are seated, put the case on a flat surface and check the squareness of the carcase by comparing diagonals across the front and, if possible, the back openings, with a tape measure or a pair of sticks. If the diagonals aren't equal, the case is out of square. Depending on the diagonal to be shortened, move the heads or heels of the clamps away from the carcase to pull it square. Once the glue has dried, plane the joints smooth—you'll be amazed at how crisp the joinery looks. At that point, all of your hard work will indeed be worth it. □

Gene Schultz is a partner in Boston Cabinet Making, a custom shop in Boston, Mass.

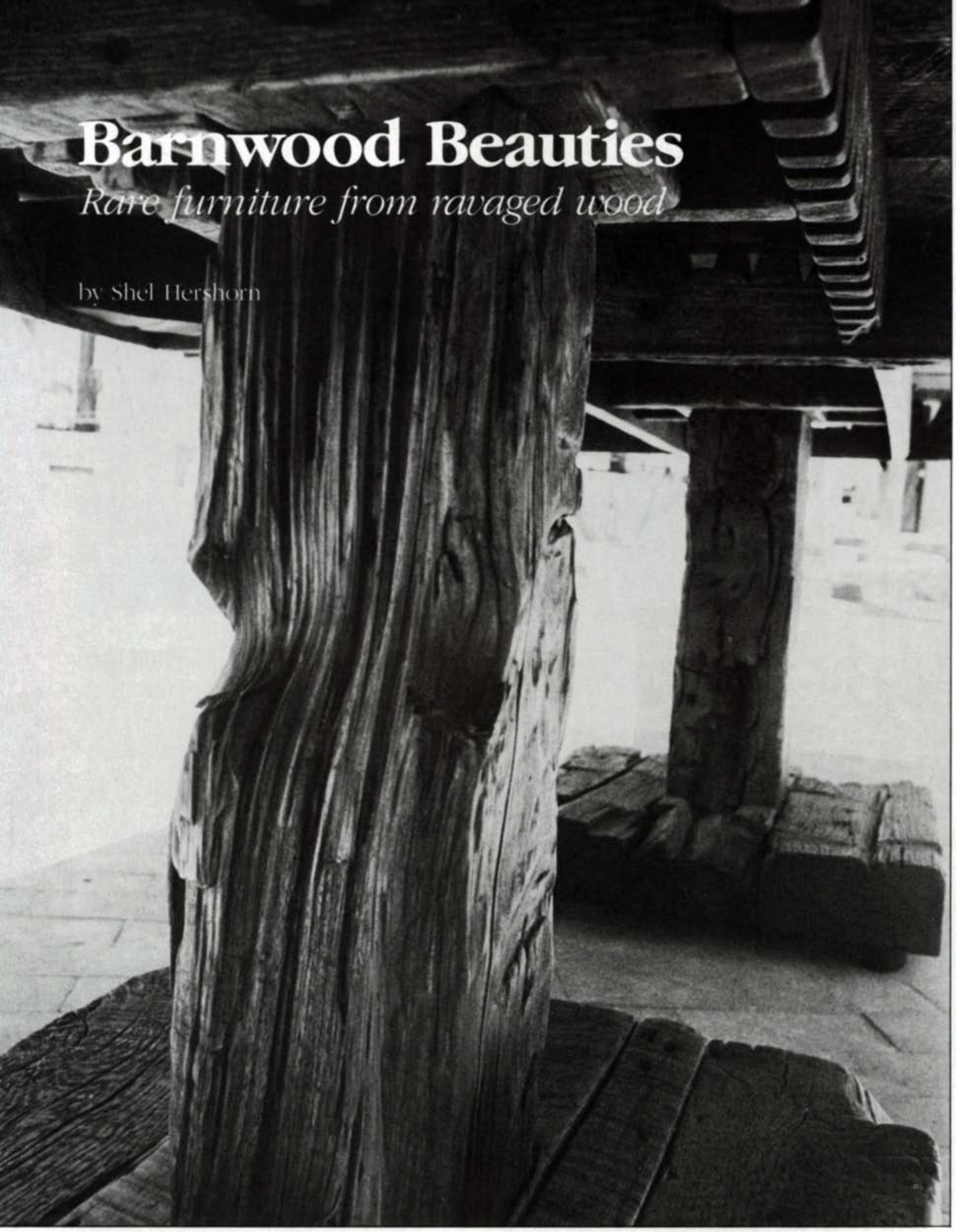
Clear waste from the sockets with a coping saw (top right), staying well short of the scribed line for the socket bottoms. Then chop the remainder of the waste, making the final paring cuts on the scribed lines (above).

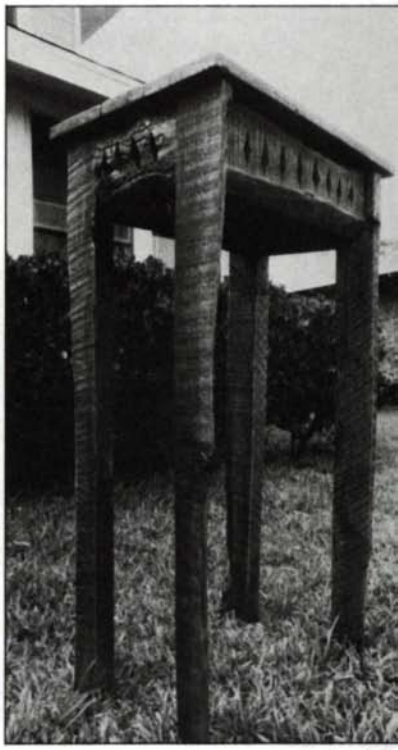
Using battens to protect the wood and distribute pressure, glue and clamp up the carcase. Work all the clamps down evenly to avoid straining the joints.

Barnwood Beauties

Rare furniture from ravaged wood

by Shel Hershorn





Julian Wood

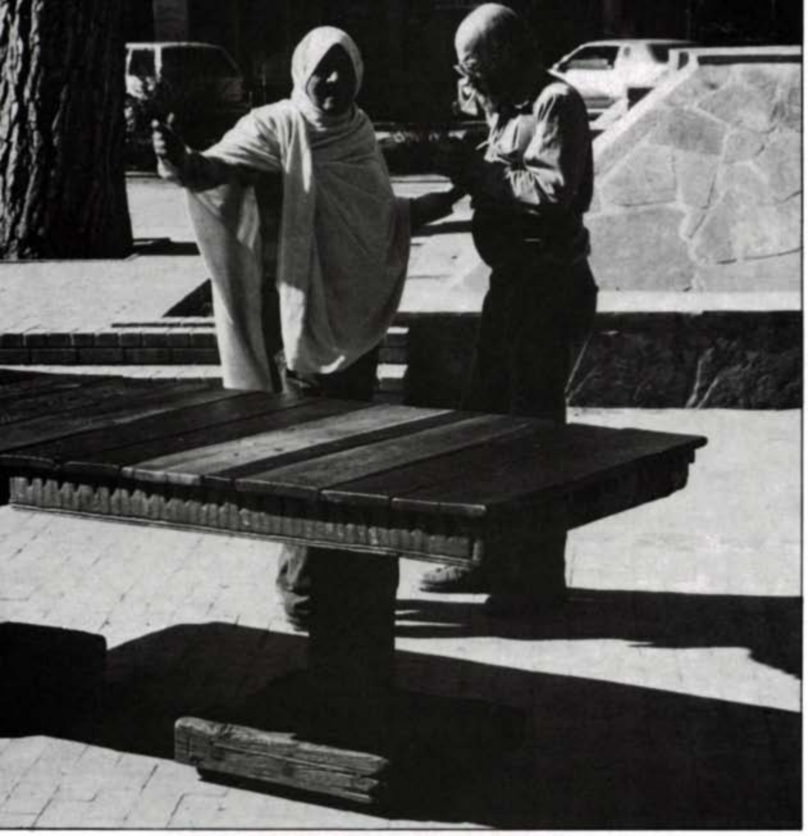
Author

In 1971, I escaped from my life and photography career in Texas. I hit the road in a state of mild hysteria. My truck broke down in Taos, New Mexico, and I looked around and decided to settle in and start the healing process. The predominant Indian and Spanish cultures in northern New Mexico seemed to be light-years removed from the mainstream of American life. In other words, I felt "safe."

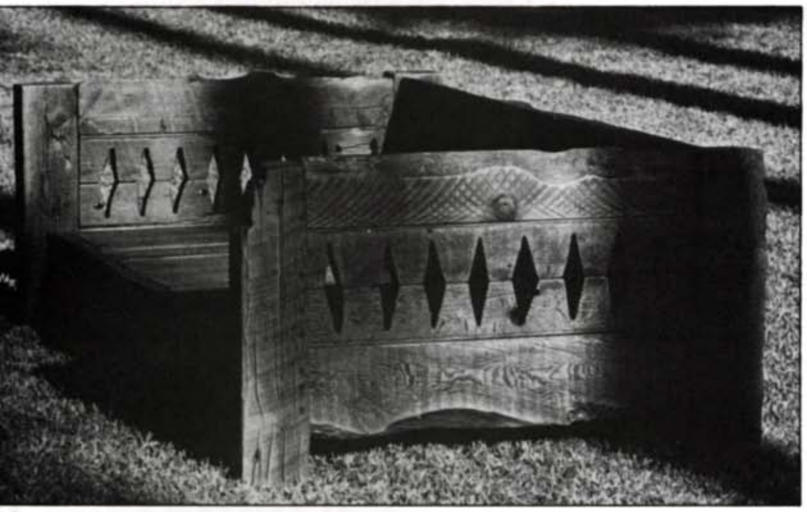
In the early years of that period, I worked as a handyman and as an aging, slow-moving "gofer" in the construction industry. I also built a few pieces of furniture for our house from miscellaneous scraps of wood from our yard. And it looked nice to me—and to my loyal wife, Sonja. In 1975 I told Sonja that I was bored with construction and intended to devote my time to furniture design and manufacture. She clenched her jaws somewhat, but, in fact, gave me "enough rope. . . ." Now, two years after moving to a farmstead near Gallina, New Mexico, Sonja has quit her teaching job and we build furniture together.

Looking back, it seems natural that I would eventually focus on the kind of work I do now. Living in a three-room adobe house, I found wood, in all its forms, became an integral part of our existence. Heating the house and the water, cooking—all required wood. As we got into growing our own food, including meat, the need for forest products of all description for sheds, maintenance, posts and fencing, became part of our daily life. We spend as much of our time outside as we can, and Carson National Forest has become our playground, as well as our resource.

In the beginning, my woodworking philosophy was predicated on "good glove, no bat," which in my case meant "good hands, low aptitude." Add to that a decent eye and a strong appreciation for the primitive furniture built in northern New Mexico during



Julian Wood



Author

Shel Hershorn (on the right in the top photo) discusses two of his tables in the Taos Plaza. Collaborating with nature, Hershorn builds with the dry-land equivalent of driftwood. At far left are the tables' center pedestals. Despite their rough appearance, every surface on Hershorn's pieces is smooth as silk, the result of hours of careful sanding and filing. On the table and sofa bed (bottom left and right), Hershorn's simple saw- and rasp-cut ornament blends nicely with that provided by long-forgotten saws and years of wind and sand.

the 1800s. Consciously, words like "symmetry," "plumb," "square," and "parallel" are not part of my operation. My work will always be primitive because I can't draw a straight line, let alone cut one with a precision machine! So, to all of that add a touch of whimsy, and lo and behold, my business, the Semi-Polite Furniture Co., emerges.

Company law dictates that all mistakes will be incorporated into the finished product and must remain as visible details. For example, a loose mortise-and-tenon joint might be made solid with a one-piece, L-shaped shim; infirmities in a coffee-table top might be bound with thongs of wet rawhide. Anything goes, as long as it looks right to me, and implies the promise of endurance. I've been told that in my ignorance I overbuild, compensating for the frailty of the wood. I hope so. I suffer enough anxiety building this stuff.

I look for, and buy, unused barns, sheds, houses, privies, and mining structures. All of this lumber is either rough or re-sawn mixed-conifer, mostly Ponderosa pine. The buildings I understand to be from 50 to 100 years old. We dismantle these buildings most carefully, trying to avoid breakage and surface damage. The lumber yard that adjoins our shop has everything graded and stacked according to thickness, width, length, and color. One pallet is reserved for weird, one-of-a-kind pieces. I have to admit to being obsessed with using the most aged, stressed and convoluted boards and posts imaginable, and to finish them as soft as I can, through 400-grit sandpaper. All of this while taking as little from the board's surface character as possible.

The final product is finished underneath as well as on the outside surfaces. Every saw cut, drilled hole, dowel or dowel cap is beveled, aged, antiqued. Each crack, split, nail hole, wormhole is softened—first with riffler files and then succeeding grades of sandpaper. There is, hopefully, nothing incongruous in the final appearance of the piece. No sign of machine tools having been used. The final look (such as it is) can't be faked. There are no shortcuts that I know of.

The boards I start with can be frail and vulnerable, both in appearance and in fact, as long as the areas of stress and/or joinery are solid. Dangerous splits are bored and joined with dowel rods driven with a four-pound sledge. If the suspect board survives that treatment, it has passed a major test.

Most of my pieces are constructed with mortise-and-tenon joints and drywall screws. I cut my tenons with a dado on a radial-arm saw. The boards are always warped and/or twisted and/or cupped. Using wedges under the boards and a level, I get reasonably rectangular tenons. After cutting the joints, I bevel all edges with a rasp, then work the surfaces with 100-grit paper on a finishing sander. I use knife and riffler files to dig out rot and big splinters, mending and gluing as I move along. After more sanding come the riffler files, beveling all the cracks, splits, and aberrations in the surface, minimally taking off the hard edges.

Folding and refolding 2-in. by 2½-in. squares of 150-grit through 360-grit sandpaper, I sand every inch of the surfaces, including the interior surfaces of knotholes, shotgun blasts, and the like. This process is like "Painting-by-Numbers," where the grain, texture, and color of the board is the pattern to be revealed by the ongoing finishing procedures. Vinegar in which nails have soaked grays out the whiteness of fresh cuts in the wood.

I finish with a mixture of Watco natural, dark walnut and black walnut, and sometimes add a dab of Minwax golden oak and mahogany to enhance the natural reds and yellows that show in Ponderosa pine. One thing I remember from my photography days is the reflection of light and contrast. I enhance these features in the wood, wherever I can, with spot staining and the like. The end result is that the furniture resembles a lot of my photographs that used to give editors migraines—backlit, grainy and venerable. One last coat of natural, applied by hand with 400-grit wet/dry sandpaper, finishes the piece. Down and dirty is the final appearance. But, soft as the proverbial baby's bottom.

The way I have intended for my work to go has pretty much happened. For the last three years, I've been working on advance commissions and essentially building the stuff to suit myself. If I like it, then the client should like it. If they are not bent like me, then it's unlikely they would be with me in the first place. So far, only one person has shied and bolted at first viewing. □

Shel Hershorn makes furniture near Gallina, New Mexico.

Making a Wooden Clockworks

Part two: Getting things ticking

by Wayne Westphale

In part 1 we discussed the theory of how a clock works. Now is the time to make one. There are a variety of ways to cut gear teeth, methods that cover a broad range of accuracy, speed and expense. The method you choose will depend on your goal, your shop equipment, and your budget.

As an example of how low-tech clockmaking can be, for my first clock I turned the arbors on a lathe setup that consisted of an electric drill (as a headstock) clamped to a 2x4 (the lathe bed). A piece of angle iron, drilled and tapped to carry a pointed bolt, became a tailstock. A chisel served as a lathe tool and a piece of scrap as a tool rest. My first tooth cutters were reground spade bits, as shown in the bottom right photo on the facing page. Needless to say, this was doing it the hard way.

I've always tried to surpass each clock I've built with a better one, and along the way I've invested in some pretty sophisticated equipment—machines more often found in a metalworking shop. These are not essential to building a good clock, but they allow me, as a matter of routine, to achieve repeatable accuracy with little fuss. Expect this clock to tax your ingenuity in getting the necessary precision from your own machines and tools. There are ways around every problem as long as you understand the features in a clock that are critical to its operation.

Horologists don't speak of gears, but of wheels and pinions. Wheels, the large gears, have teeth; pinions, the small gears, have leaves. I cut teeth and leaves on two different machines, but the process is basically the same—I use a set of reground router bits to cut the gullets between the teeth.

The preparatory step, laminating plywood gear blanks, was described in part 1. The photos on the facing page show some of the actual cutting, including my jig for bandsawing circles. To cut the wheel teeth, I mount a stack of gear blanks on a mandrel and mount the mandrel on an old metal lathe, which I also use to turn clock arbors. The tool-bit holder on the lathe's cross-slide and compound has been adapted to carry a router, with the router bit perpendicular to the lathe centerline. By cranking one of the lathe's control wheels, the router bit can be positioned closer to or farther from the work, then locked in position to give a cut at a set depth. By means of another control wheel the router can be moved precisely along the length of the work.

The first step in cutting the teeth is to turn the lathe on at slow speed, then use an end mill or hinge-mortising bit in the router to trim the blanks to true round, sizing them to the correct diameter at the same time. This ensures that the arbor hole will be exactly centered.

The lathe is then turned off, and the blanks are indexed by a pin and a shopmade plate. The router roughs out the gullets one by one by traversing horizontally along the stack. I crank the router from the tailstock end up to the headstock end to cut a tooth gullet. Then I crank the router back to the tailstock end, turn the stack of wheel blanks to the next index location and repeat the process. (The escape wheel is a special case. It has three very critical surfaces on each tooth, and I make these as shown in figure 3, on p. 62.)

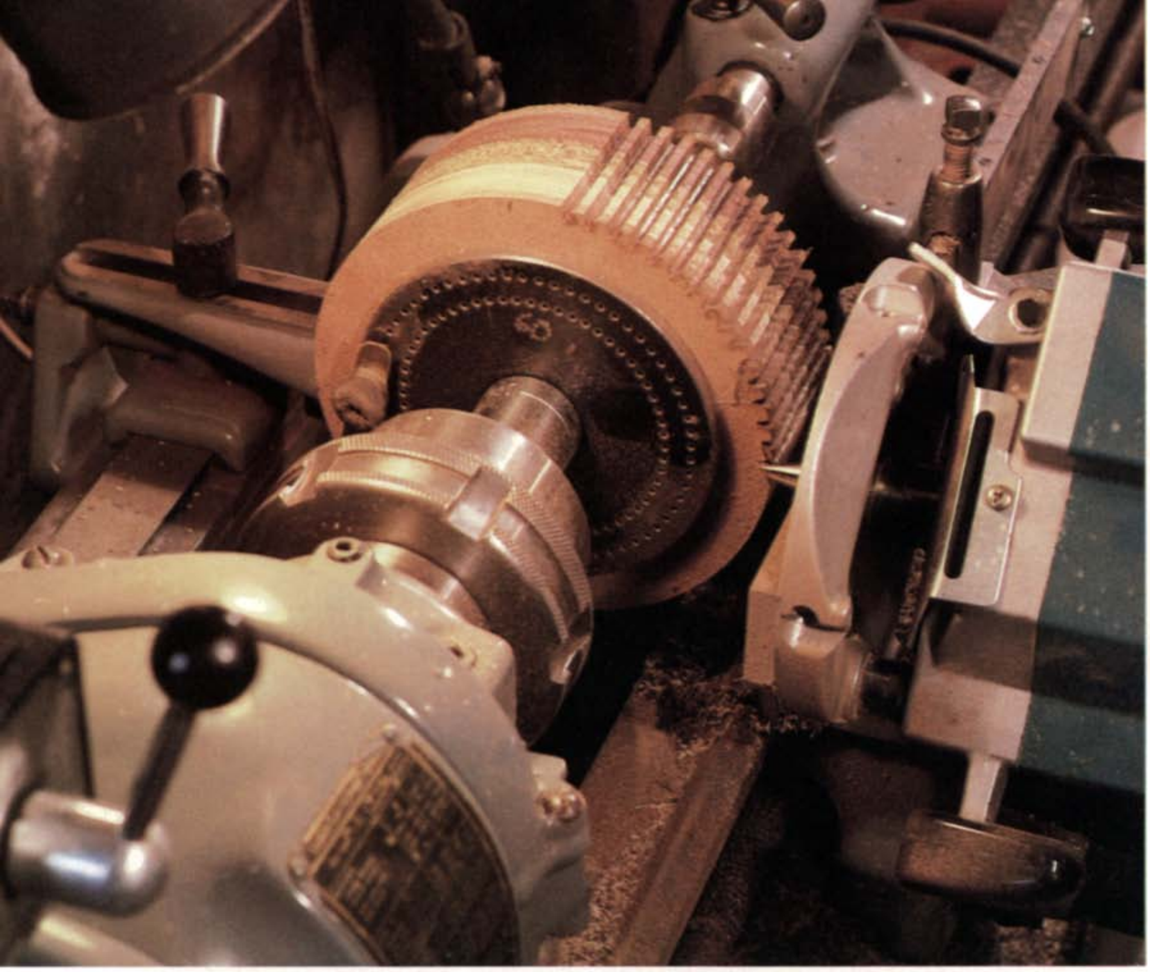
To minimize chipping—and maximize cutter life—I make several passes, each with a different cutter. The first cutter, as shown in figure 1, has straight faces, is easy to sharpen, and has an included angle of about 32°. It is a wasting cutter. I set it to about 80% of full depth. The next cutter profiles the tooth face and cuts to final depth. The last cutter eases over the tooth tip. The relief angle of this cutter is only 2° to 3°—the desired effect is to round over and burnish the tooth tip in one pass. Next, I lightly sand with 400-grit paper over a soft block to remove the burr left at the tips of the teeth.

This produces a stack of identical chip-free wheels. The method suits itself both to small-scale production or, if you are making just one clock, to making any identical wheels that may be in it (there are two identical pairs in my grandfather clock). Pinions are cut in a similar way on a milling machine, as shown in center photo. The same operation could be accomplished with a drill press fitted with a compound table (available from Sears for under $80 and from time to time in various bulk-mail catalogs for even less) and a properly contoured cutter.

I profiled my cutters in a series of steps, as shown in figure 1. I began with a full-size drawing of each of the gear-tooth profiles. Figure 2, on p. 61, shows the exact profiles of the teeth and leaves in my grandfather clock. To achieve the necessary variety with the fewest number of cutters, I taper my cutters slightly at the tip, so that the tooth size, the width at the pitch circle, can be controlled by depthing the cutter as required. Pitch circle and other technical terms are explained in part 1.

Arbors and bearings—I turn arbors in the metal lathe—it is fast and sure and will maintain 0.001-in. tolerances (exact sizes are shown in figure 2). I strive for a snug fit of wheel to arbor. A metal lathe is not absolutely necessary, though I would not recommend using dowels straight from the hardware store either. You'll find that commercial dowels are only approximately sized and only approximately round.

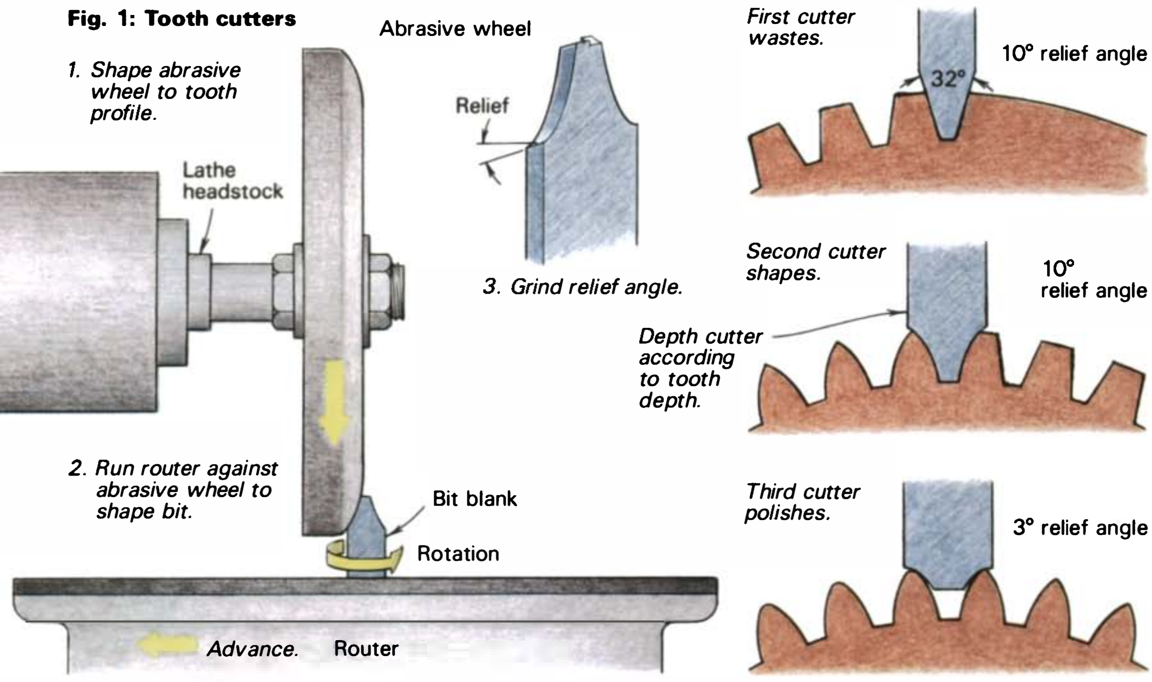
I recommend a piece of tool steel or $\frac{1}{16}$-in. drill rod be pressed into the arbor to serve as a pivot. Wood-on-wood is too inefficient at this point from the standpoint of friction as well as durability. The pivot must be accurately centered. If your lathe has a



At left, large gears are cut by a router mounted on the cross-slide and compound of a South Bend metal lathe, which the author bought used for $4,000. The blanks are indexed by the pin opposite the router bit. Above, Westphale cranks the router along a stack of six wheel blanks, backed up at each end by a hardboard blank to prevent tearout.

Left, a milling machine is the metalworker's precision version of a drill press, equipped with a table that can be moved horizontally on X and Y axes by hand cranks. The stack of pinion blanks is indexed by a dividing head, which calculates angles by means of perforated plates and a gearbox. It takes forty turns of the crank handle to rotate the output shaft one full turn. Far left, an efficient circle-cutting jig: The board has a runner on the bottom that rides in the bandsaw's miter-gauge slot, and a number of axle holes to suit the various gear sizes.

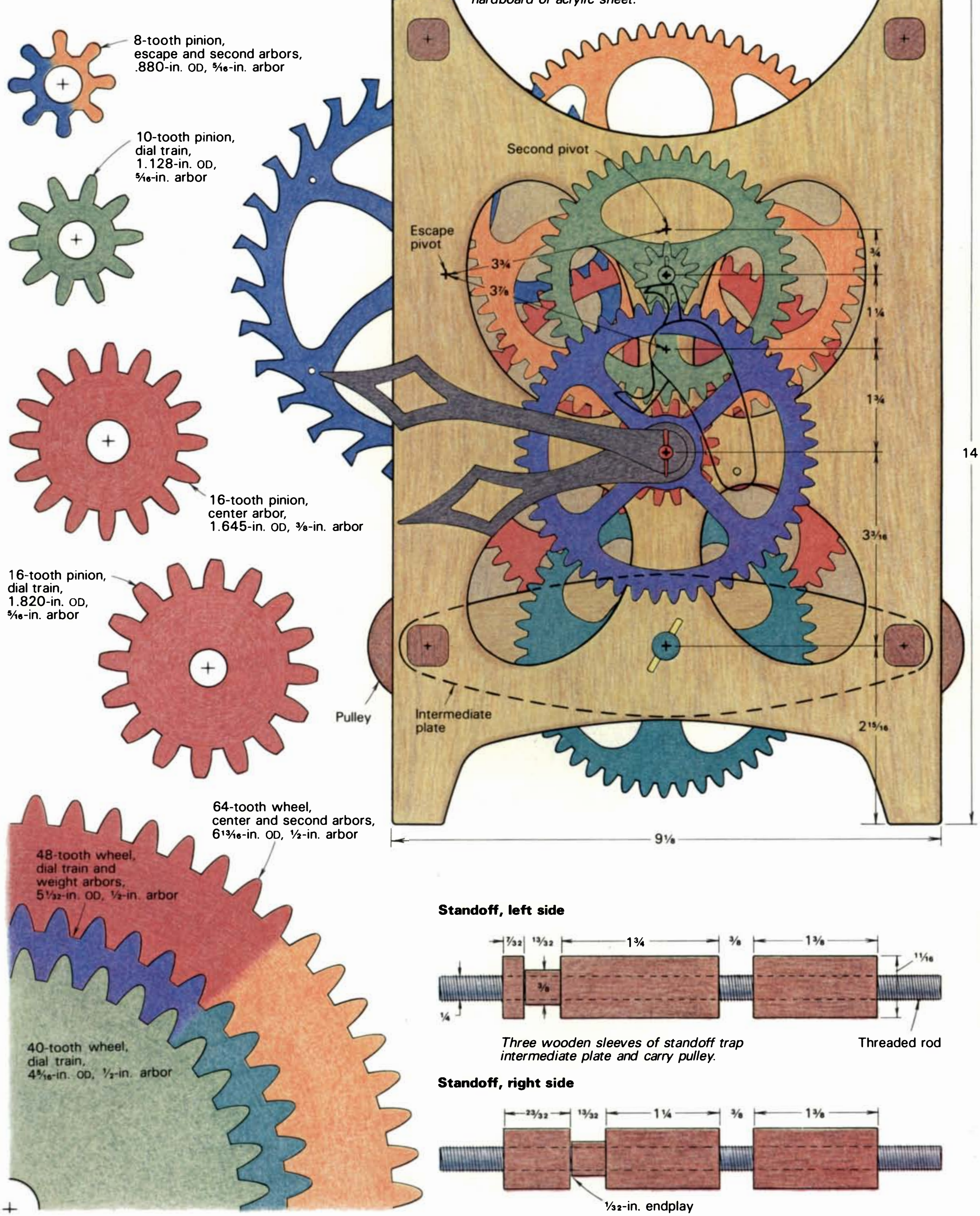
Fig. 1: Tooth cutters

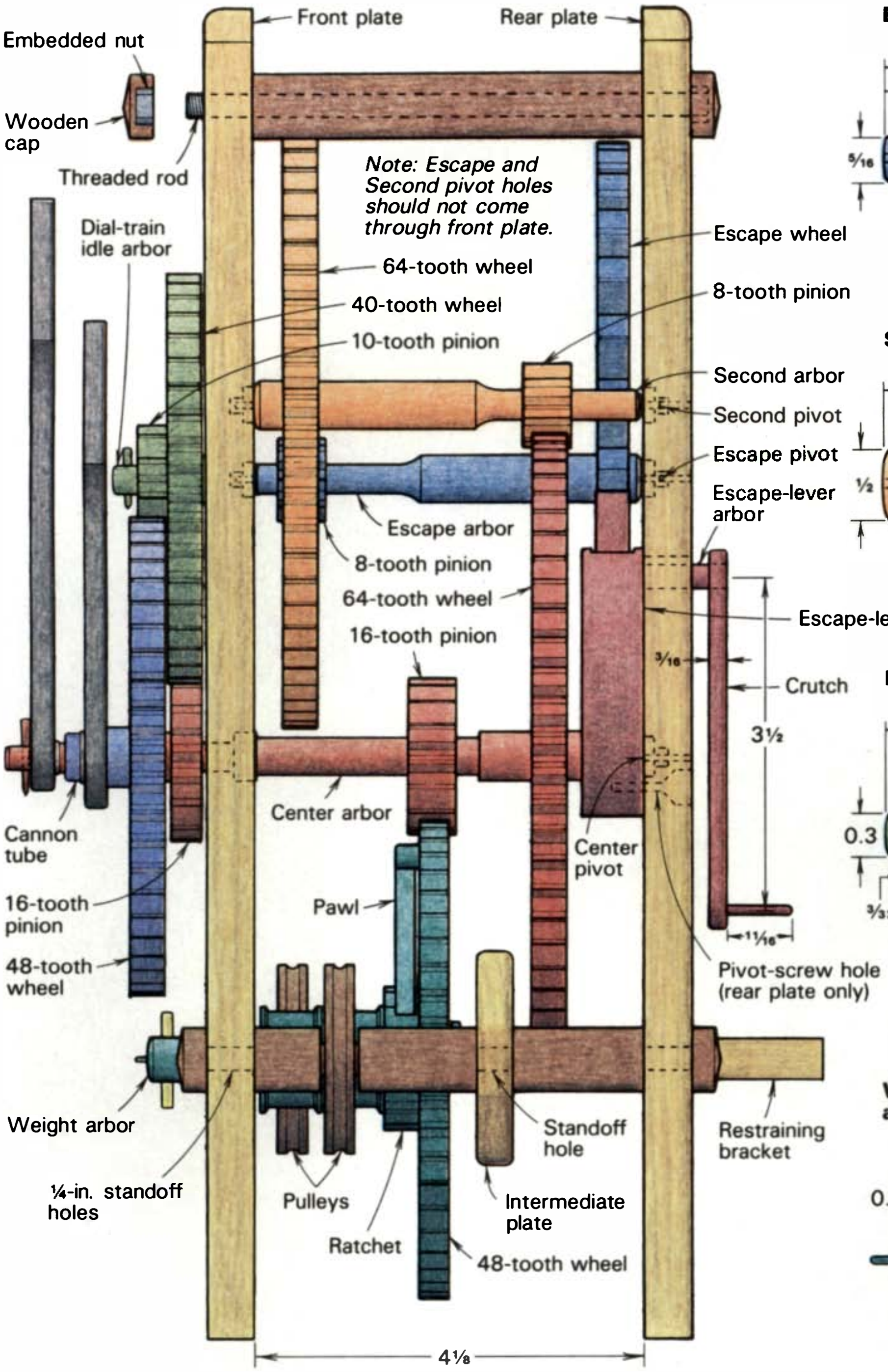


Cutters are reshaped as shown in the drawing at left. Tooling need not be high-tech. Westphale shows two of his early gear cutters, reground spade bits, alongside the highly evolved ones he uses today.

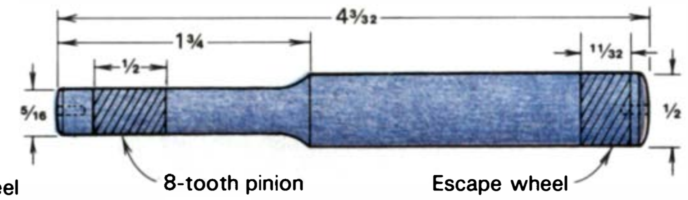
Drawings: Lee Hov

Fig. 2: Wheels, pinions and arbors

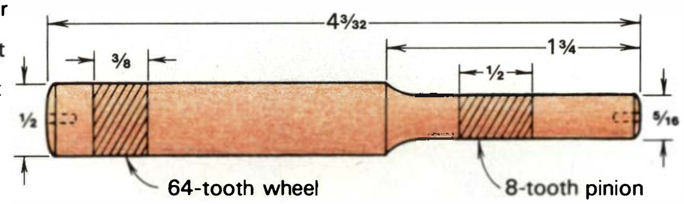




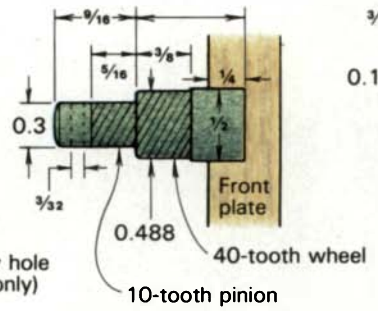
Escape arbor



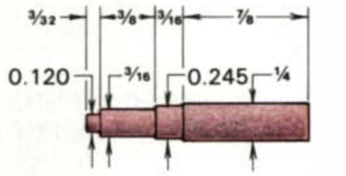
Second arbor



Dial-train arbor

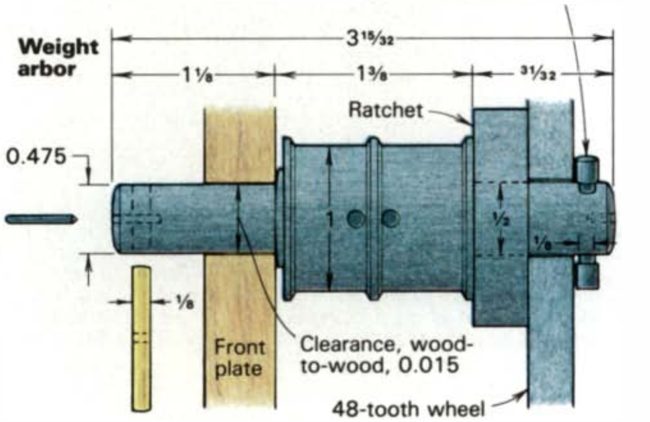


Escape-lever arbor

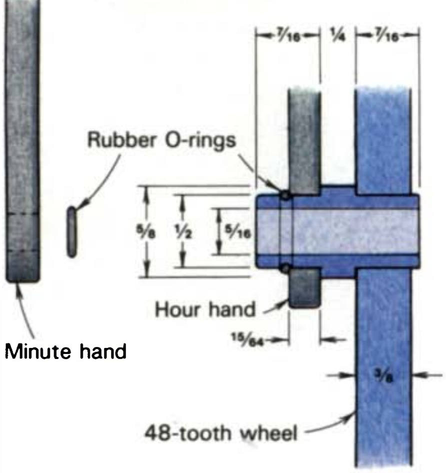


Three pins hold wheel on arbor.

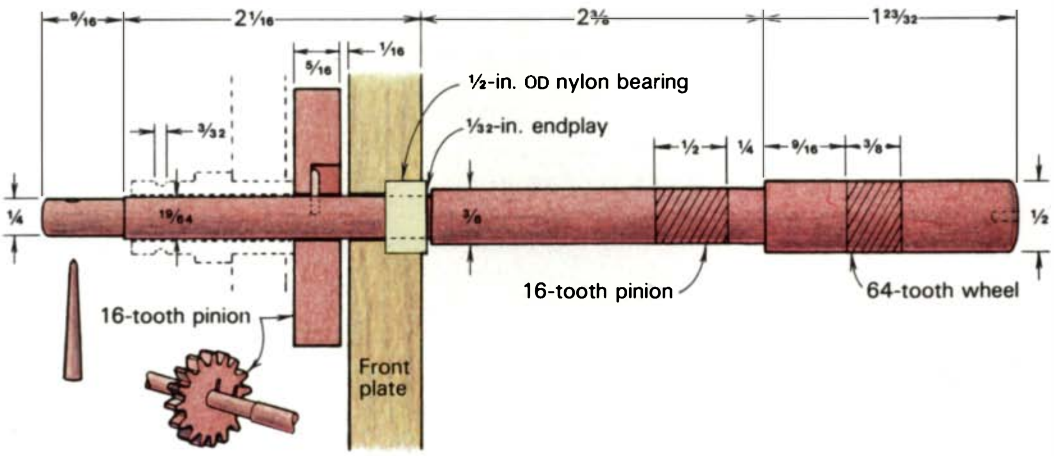
Weight arbor

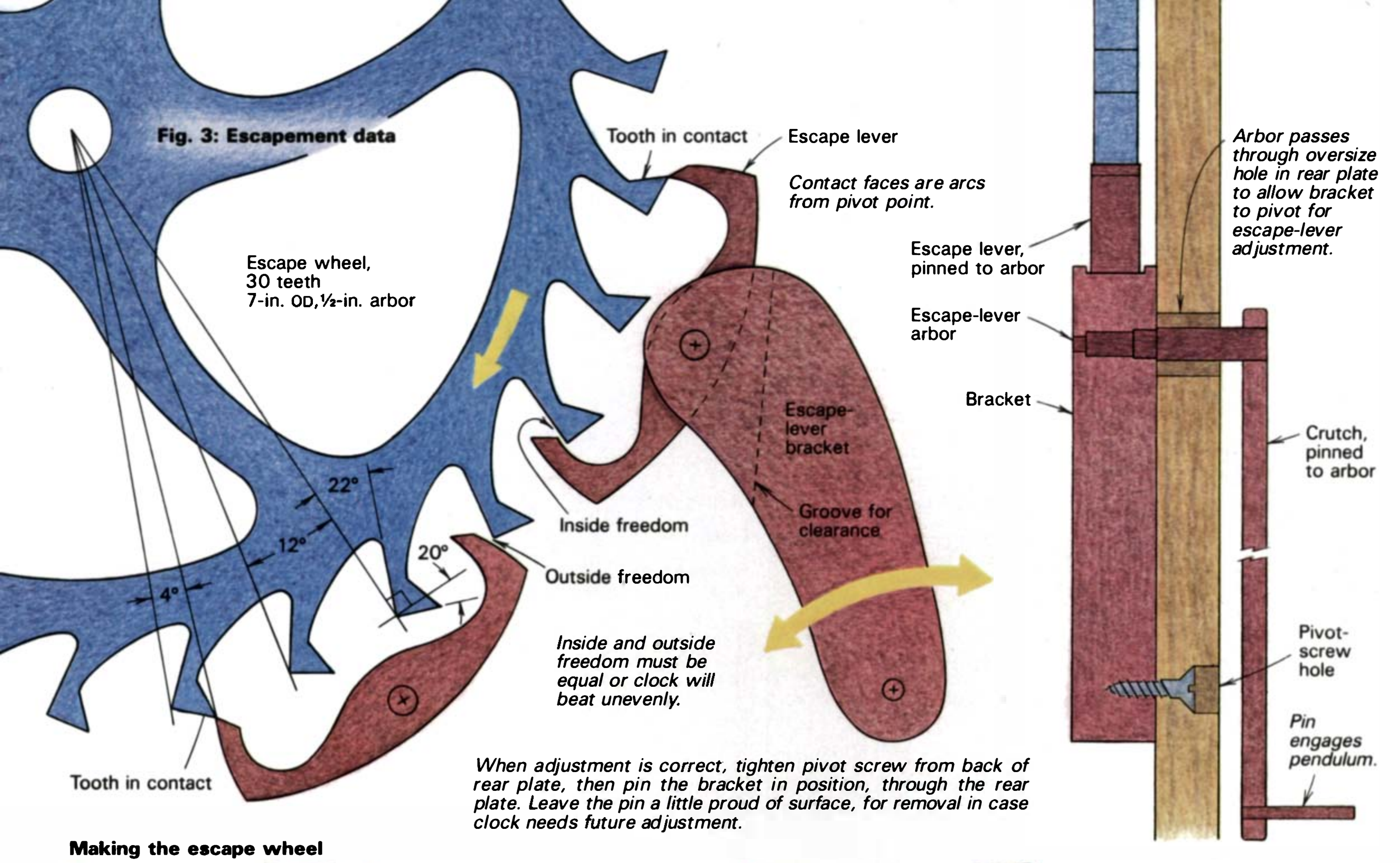


Cannon tube

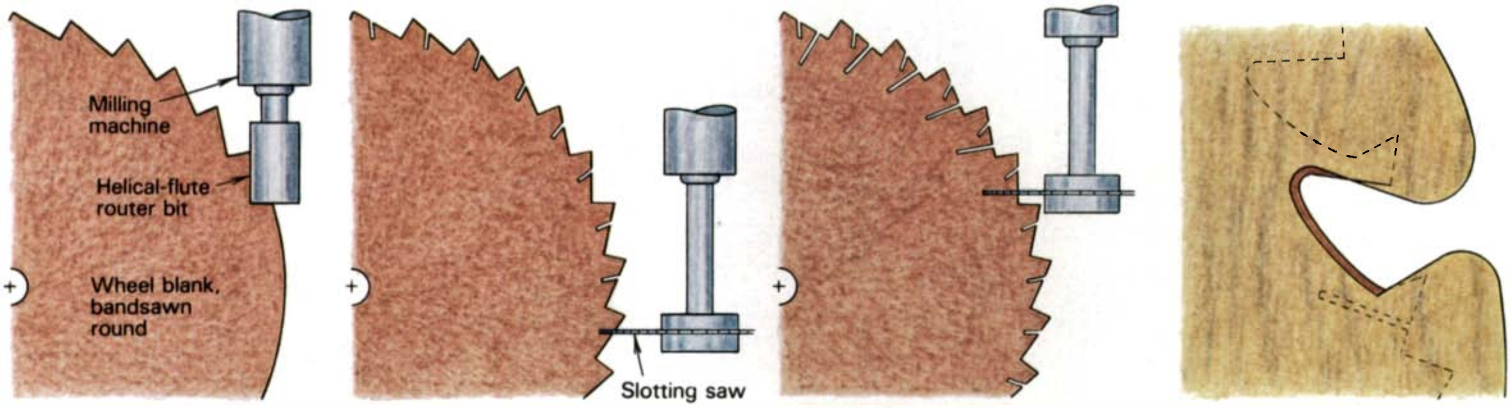


Center arbor





Making the escape wheel



Westphale makes the teeth on his escape wheels with a series of straight cuts, as shown above, then routs out the curved shape of the gullets using a template and guide bushing (far right). The escape-wheel blank (or a stack of blanks) is mounted on a mandrel through the arbor hole, and the mandrel is fixed to a dividing head. The dividing head rotates and locks the wheel blank a fixed amount for each cut, ensuring even tooth spacing. Cutters are held in the chuck of a milling machine, the metalworking equivalent of a drill press. The milling machine adjusts precisely in three planes to locate the cutter relative to the work. The dividing head is attached to a sliding table, worked by hand cranks, that moves the work horizontally past the cutter and back again for the next cut. When routing the gullets, the work is indexed under the template by the dividing head. Spokes are routed the same way (photo, facing page) then rounded over on a router table.

hollow headstock you can drill the pivot holes as I do, with a bit in the tailstock. If not, I'd suggest clamping a piece of scrap to your drill-press table and drilling a hole the diameter of your arbor through the scrap just off the edge of the table. Maintain the setup but change the drill to a size a few thousandths smaller than your pivot material; I find that a #53 drill bit works well. Insert the arbor from the bottom and drill carefully into the end. As the arbors are different diameters on each end, at least two different setups will be required.

Bearings, which I make from nylon rod, can be drilled with a similar setup. In this case, just drill part way through the scrap. For instance, if you use ⅜-in.-dia. bearing stock, drill a ⅜-in. hole ⅛ in. deep with a Forstner bit into the clamped scrap. Then drill a ¼-in. hole all the way through. Cut your bearing stock into ⅛-in.-thick wafers. Insert the wafer, drill the appropriate size pivot hole, then push out the completed bearing from below.

Engagement testing—Test wheel-and-pinion engagement patterns at various center distances. In a scrap of plywood, drill a hole for a pin that will represent the wheel arbor. Around it, draw a series of pinion-arbor holes, one at the nominal distance from center, the others at $\frac{1}{32}$-in. increments from the ideal. Mount the pinion on a pin in various holes, revolve the gears, and note how the teeth mesh. Part 1 explains what to look for. Choose the distance that gives the smoothest action. There is some latitude, but many times, while working out the tooth profiles of the grandfather clock, I had to refine the contour of one cutter or the other, and sometimes both. You don't have to go with the exact tooth profiles and distances I've worked out, but they work well and I recommend that you try to match them.

Once the teeth have been cut, the wheels can be lightened with any number of spoke configurations. Spoke shapes are limited only by what is practical and aesthetically pleasing. My

The escape wheel nearing completion. The acrylic template remains stationary, with its far end clamped to a block on the workshop wall. To rout successive spoke holes, the work is turned by the dividing head, which has been set in position to hold the wheel horizontal. Spoke-hole patterns for some of the other wheels in the clock are also visible in the photo.

spoke template is shown in the photo above. I use a router and guide bushing with a ⅛-in. veining bit. Some of my spoke patterns are a series of round holes of various sizes, which can be cut with a drill or a circle cutter as size dictates.

Next the spokes can be rounded over on a router table, using a regular piloted roundover bit. After that, I seal the wood with a mixture of tung oil, polyurethane and mineral spirits, equal parts of each. I soak the wheel for a few minutes, then wipe off all the surplus. At the teeth surfaces, I use high-pressure air to blow away all external traces of the sealer—all I want left is what has soaked into the wood. After drying, I repeat the sealing step a couple of times until there is enough finish on the wheel to be buffed and polished. The final step is to wax the surface and buff it, but take care not to wax the tooth surfaces—they must run dry.

After finishing, the escape wheel gets a little extra treatment with 400-grit paper to polish the contact surfaces of the teeth.

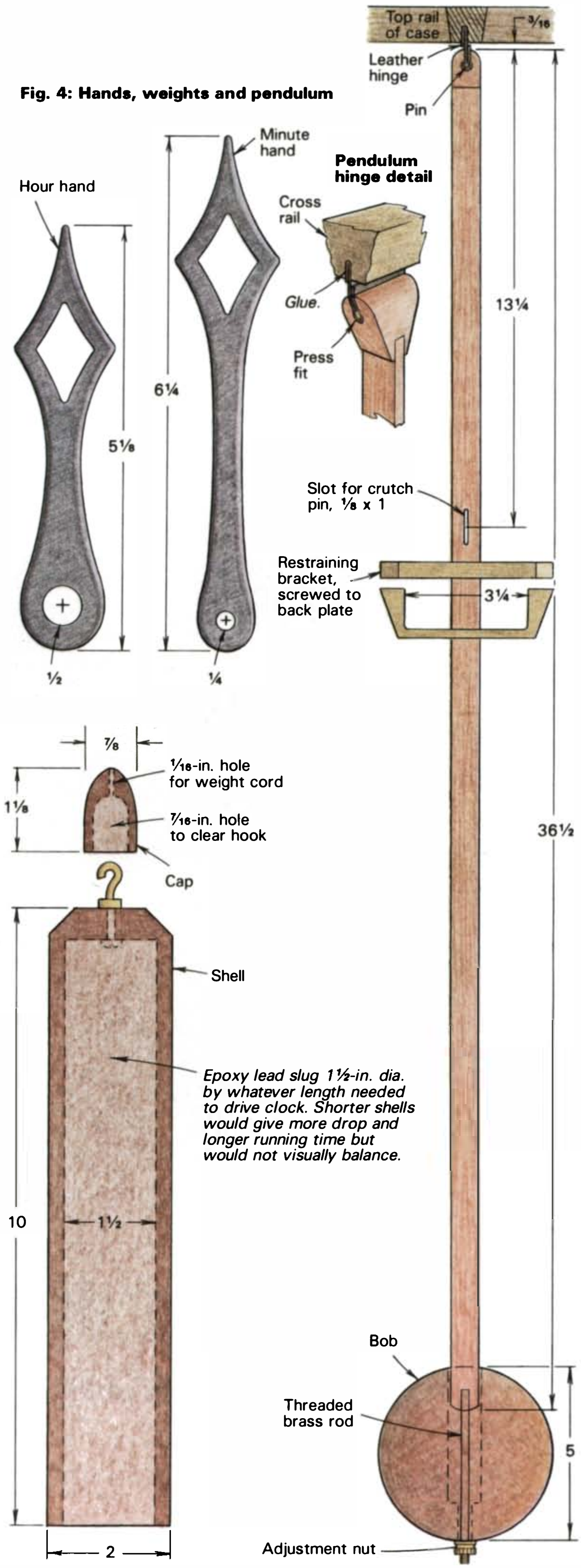
The wheels can now be balanced. Do this after the wheel and pinion are secured to the arbor (I use both glue and brass pins, driven at an angle). Wood density varies and sometimes wheels that you would reasonably expect to be balanced are not. To test them, I rest the pivots on the open jaws of a machinists' vise. The heavy side of the wheel will stop at the bottom. Rotate the wheel one-quarter turn and release. If the wheel stops in the same position, it needs balancing; if it doesn't turn, or the stopping position is random, it doesn't require balancing. Usually it will.

Mark the light side of the back of the wheel near the perimeter and drill a hole about halfway through the wheel. Insert a small lead plug or piece of lead shot and test again. Add more weight if required until the stopping pattern becomes random, then use a small nailset or punch to expand the lead in the hole. You can plug if you wish—I usually leave the hole open as evidence the wheel was balanced.

Setting up—The clockworks are supported by two outside plates. An intermediate plate carries the back end of the weight arbor. My template for the plates is shown in figure 2. Distances between pivots are critical, and should be adjusted in your clock according to how each wheel/pinion pair functions in the engagement testing described earlier.

My clock case is an open frame that is 76 in. high, 18 in. wide, and 11 in. deep. The clock plates are attached to the frame's crosspieces with screws from beneath. A photo of my finished clock was shown in part 1, and you are welcome to copy my case design as closely as you care to, but feel equally free to design

Fig. 4: Hands, weights and pendulum



Rout-a-clock

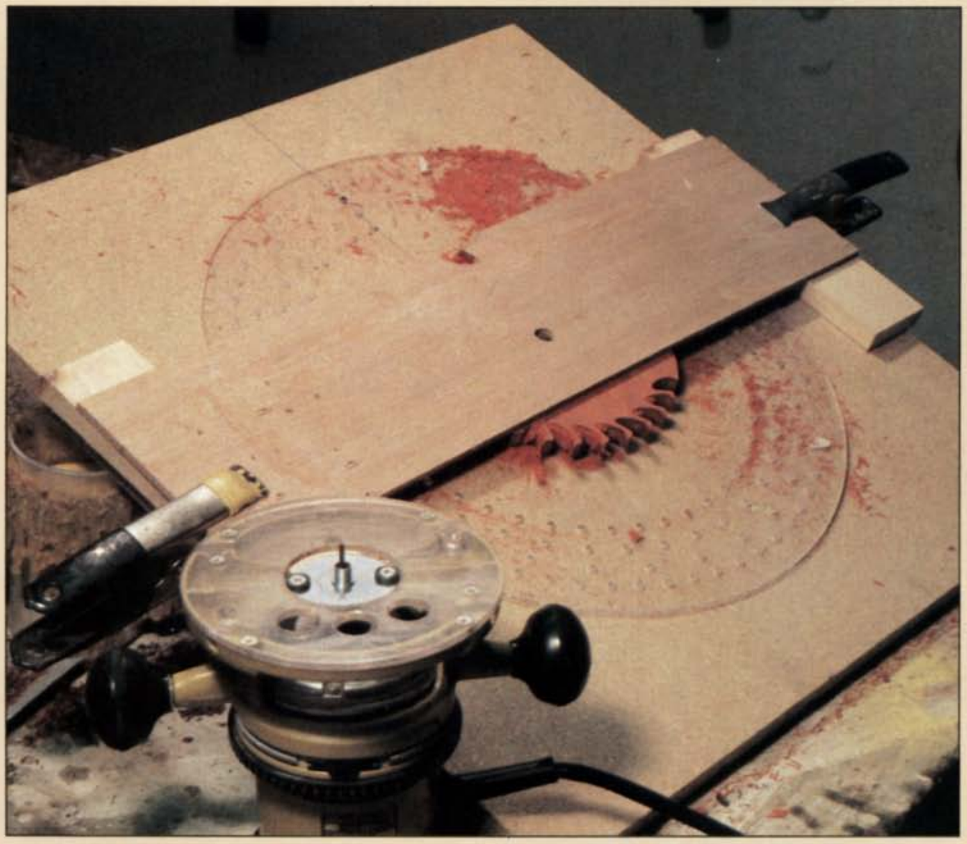
by Jim Cummins

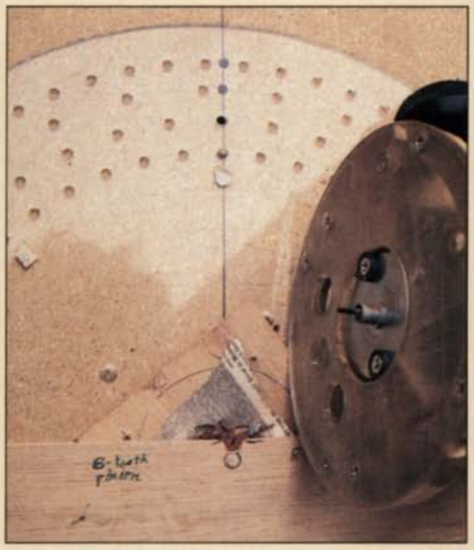
While editing Wayne Westphale's article, I had occasion to visit him in Colorado and watch him at work. He relies on precision metalworking equipment, which most woodworkers don't have, so I began trying to think of other ways to make a clockworks, using tools that might be found in any shop.

The various options seemed: to rig up a carriage on the drill press in imitation of Westphale's dividing head and milling machine, to rig up my lathe with a traveling router, or to focus on the indexing setup. I chose the last course and devised the router-template jig shown in the photos. Here are the basics:

The index wheel turns on a ½-in.-dia. pin that sticks up through a particleboard base. My index wheel is acrylic plastic (though it could be hardboard, etc.) with four concentric circles drilled for 64, 48, 40, and 30 holes (various increments of these give all the necessary divisions in Westphale's design).

Mark what will be the centerpoint on the wheel, then use a compass to lay out the four index circles. I worked out the spacing for the holes by using the circle division table that appears in *FWW on Proven Shop Tips* (or Methods of Work, *FWW* #38, p. 12). For those who don't have access to the table, here's how it works: Measure the exact diameter of the circle in inches, then multiply by one of the following factors: for 64 holes, 0.0491; for 48, 0.0654; for 40, 0.0785; and for 30, 0.1045. Work things out to as many decimal places as your calculator will allow. Set sharp dividers to the figure (you can measure with a machinists' rule in hundredths, or convert things to sixty-fourths as I did) and step off around





At left, routing an escape wheel on the indexing jig. The rough shape of the teeth can be cut using the template as shown. A second template is then needed to square off the tops of the teeth. Minor tearout can be patched with epoxy and sawdust. Pinion blanks (above) are too small to be screwed to the index wheel, but they can be glued to an oversize spacer for routing. The newspaper allows the finished pinion to be split free.

one of your own. Just be sure your design will accommodate the pendulum pivot as shown in figure 4.

Mount the plate assembly on the clock frame and hook up the pendulum and weights, shown in figure 4. My standard weights are three pounds each, but you may find that your clock will run on less (mine do, but I allow a 50% safety margin for customers).

The clock should be set level, and the escape lever must be adjusted so that it performs as shown in the tick-tock sequence in part 1. Let the clock run for a while, as a test to see whether it is fast or slow, then adjust the pendulum bob a little to correct it. If the clock is running slow, shorten the pendulum, and vice versa. Keep a record of how often you make adjustments and of how many turns of the adjustment nut you make each time.

You will probably have to make many adjustments to get the clock just right. Clocks don't really run at a steady rate, but speed up and slow down minutely according to the weather and which particular teeth are engaged at any one time. But these slight irregularities average out. My grandfather clock is accurate to a few seconds per day. For the final bob adjustments you may have to let it run a week or more before you can tell whether it is gaining or losing time.

If your clock has problems, a careful rereading of part 1 should allow you to understand what they are. Clocks are fascinating and magical, but they follow physical rules. The important checkpoints are summed up here: The perimeter of wheels and pinions must be concentric with the arbor and the pivots must be the circumference to show the location of the holes. If it doesn't come out exactly right, adjust the dividers minutely and try again until it does.

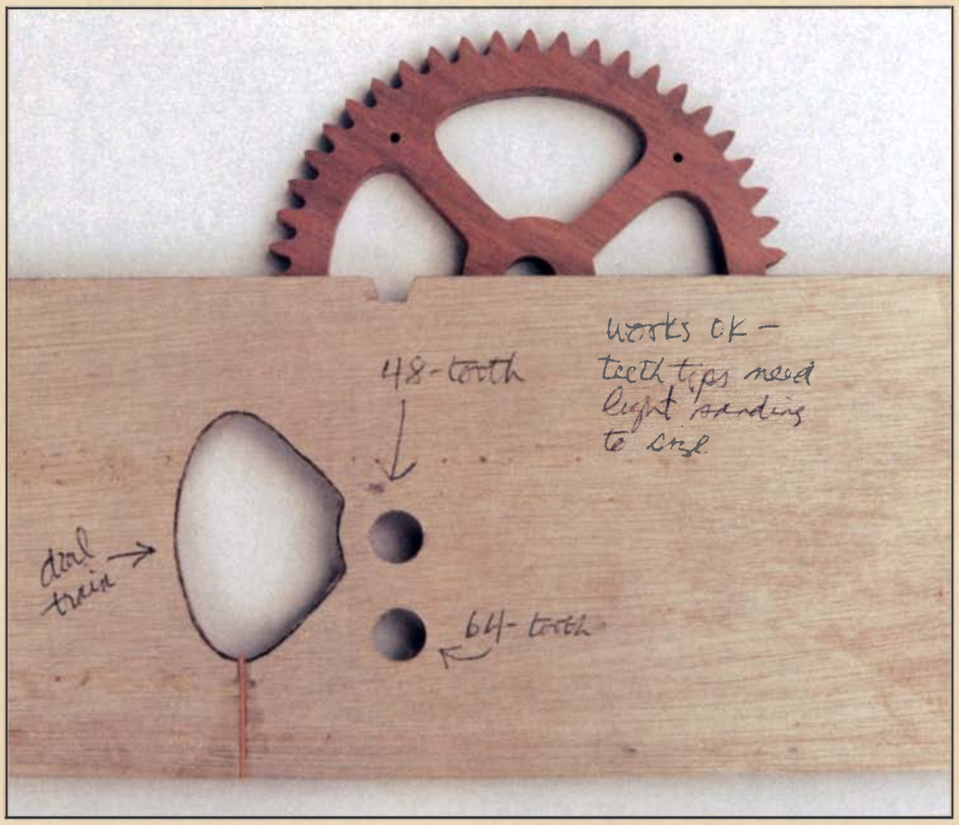
When the hole locations are scribed, drill the center hole. Next mount the wheel on its pin through the base, clamp the base to the drill-press table, and pivot the wheel around to drill the series of holes in each circle. I used a 3/16-in. twist drill (the plastic will ruin a brad-point).

Next, fit your router with a 5/16-in. guide bushing and a 1/8-in. straight bit with at least a 3/8-in.-long cutting flute. Shopping locally, I found that Black and Decker bits were longer than Master Mechanic bits, so I bought a half-dozen at $2.49 (I'm going to need at least that many more before I'm done). A router bit will give you a round bottom to the gullet, not as nice looking as Westphale's square corners, but perfectly functional.

Screw the wheel blank to the index wheel from beneath, with the screw holes where the spokes will eventually be. Use a spacer between (I used lauan plywood scraps) so the router bit doesn't chew up the index wheel. For the small gears, the pinions, I had to make two stepped-down center pins for the jig, one for a 3/8-in. arbor hole and another for a 5/16-in. arbor hole. The smallest pinions don't have enough wood in them for anchor screws, so I glued them to an oversize spacer with paper in the joint, as shown in the photo on the facing page.

Make templates that will rout the shapes of the gullets shown on p. 61. To use the jig, rout a gullet, turn the wheel a notch and rout the next, continuing until done. One critical point is to keep a sharp bit and to rout against the rotation, a technique called climb cutting. This helps prevent tear out.

My lauan plywood templates took me several tries each before I was satisfied, but each practice run of a few teeth will show you exactly what modifications are needed to come down to the correct shape. The template should be indexed by riding on the center pin—this ensures that the final wheels will be the same diameters as the practice pieces—and can be clamped as shown in the photo.



The teeth and spokes of this 48-tooth dial-train wheel were routed using the plywood template shown. To make the spoke template, the author bandsawed the spoke hole pattern, closed the entrance kerf by gluing a strip of veneer in it, then trued the shape with a rasp. Next step will be to round over the spokes with a piloted router bit.

Spokes are routed similarly. Make a template for one spoke hole, then use the index wheel to rotate the wheel the correct amount to space them equally. The spoke edges can be rounded over using a piloted bit in a router table, if you have one (I just clamped my router upside down in a vise).

All this has taken me about five weekends so far, with a good part of the time just spent musing about the myriad little decisions to be made at each step. I remember that it took me the best part of an evening to realize that I couldn't rout a tooth, but had to rout a gullet. Things like that.

In all, it's been as much of a challenge as Westphale promised and I've enjoyed the project thoroughly. My clock won't be ticking for at least a few more weekends, but the results so far are very promising, and I think I'm on the way. □

Jim Cummins, who putters weekends away at his frame shop in Woodstock, N.Y., is an associate editor at FWW.

at dead center of the arbor. Pivots must be straight, not bent (set the complete arbor, with wheel and pinion mounted, on the open jaws of a vise, then rotate the shaft briskly to check for wobble, warping, etc.). Allow 1/32-in. endplay between the arbors and the clock plates (even so, if the plates warp the arbors may bind). Check for teeth jamming (bottoming or tips butting). Remove the escape lever assembly to check whether the rest of the gear train spins freely. Test pinion leaves for uniform spacing with a micrometer. Never use oil.

I've found that the most likely problem is eccentric wheels, pinions or arbors. One diagnostic trick, which I hope you will never need to use, may pinpoint an intermittent fault. If your clock regularly stops for no apparent reason, mark each pair of engaged teeth with small dots of masking tape. Then start the clock again. The next time it stops, look with suspicion at any taped pairs of teeth that are engaged as they were before. If it's not the teeth, the same test may pinpoint two gears that are slightly out-of-round, and that bind only when their long axes are aligned. A little work with a file may be all that's needed to put everything right. □

Wayne Westphale designs and builds clocks at his shop, Contemporary Time, in Steamboat Springs, Colo. His grandfather clock took two years to develop, and is copyrighted. Westphale extends to individuals the right to make a copy of his clock for their own use, but not for commercial purposes.

Visit to a Glue Factory

Versatile hide glue still holds its own

by Jim Cummins

The world's largest hide-glue factory, the Peter Cooper Corps., is located on the western shore of Lake Michigan about twenty minutes south of Milwaukee. Each day they produce 20 tons of granulated dry glue. Until recently I'd thought that the PVA glues had dealt hot glue a knockout punch. But hide glue is a long way from obsolete. In fact, after reading this article you may decide there's a place for it in your own woodworking. One of its features, for example, gives it a decided advantage over the PVAs—you can stain over hide glue residues without getting those ugly blotches. Also, you don't need a $90 glue pot these days—a $5 baby bottle warmer will do the job.

My visit to the glue factory began about a year before, when I received a letter from Larry Broadmoore of San Fernando, Calif., who excitedly passed on the following information:

"After 18 years of struggling with setting glue—which I use to repair automatic musical instruments—I finally found out that the setting time of hot animal hide glue can be extended by the addition of small amounts of urea, a gel depressant. The time can be extended by seconds or minutes—if enough is added you will have cold liquid hide glue. This in no way lessens the strength of the glue. To the contrary, you will find that joints are stronger, as the glue does not skin over prior to closing of the joint. This simple trick multiplies the usefulness of hot hide glue many times. . . . There are dozens of grades and types of animal glue, and many additives that can make it flexible, water-resistant, etc. Ask Mr. George DeBoth at the Peter Cooper Glue Co."

This was news to me. I called up DeBoth and quickly found out that almost everything I knew about hide glue was wrong.

PVAs are stronger, right? No, hide glue won't creep the way PVA will, will stand dry temperatures of up to 400°F, and a good hide-glue joint is one of the strongest possible with any adhesive. Even the weakest grades of hide glue make joints that are stronger than the wood itself. Hide glue is so tough that it can be used as a mask for sandblasting; it's so strong that a film of it applied to a pane of glass will dry, shrink and chip the surface away. There's a whole craft, called glass chipping, based on the process. Of the various grades of glue (more about them later) the preferred one for glass chipping is one of the "weakest," the stronger ones are too fierce, taking giant chips with them as they dry. That took care of myth number one.

But hide glue doesn't last very well, does it? I remember as a kid that whenever furniture around the house fell apart, it was because the hide glue in the joints had broken down into crusty, granular stuff. Re-gluing with hide glue, the only stuff I knew of other than DuCo cement, never helped much. DeBoth handled that one easily: "If you find that much dried glue in a joint, it means that there was never any good wood-to-wood contact. The problem was the joinery, not the glue. You never saw an old tabletop fall apart that way, did you? They're hide glue. In fact, joints in some Egyptian furniture found in the tombs are still sound after 3,000 years." There went myth number two.

I told DeBoth that as far as I knew nobody much used hide glue but period furniture diehards and musical instrument makers. He responded by mentioning Kittinger and Steinway. That spelled the end to myth number three—companies like that were not using hide glue out of stick-in-the-mud conservatism. There must be something to the stuff.

So I flew to Milwaukee and drove south to Oak Creek, a mostly suburban area of 17,000 population that harbors some huge industrial sites shouldered side by side against the lake. Peter Cooper was *big.* DeBoth turned out to be a genial man with hair two shades grayer than mine and an arthritic knee a few years older than my own. John Eberhardy, glue-blending manager, joined us and we spent the next half-hour over lunch at a nearby diner. Talk turned immediately to woodworking. DeBoth has his own small shop, inherited from his father. Eberhardy, an athletic, rangy man in his late-thirties, is restoring a turn-of-the-century house, building furniture to fill it as he goes along.

Apropos the lunch, I learned that there's an edible grade of hide glue—called gelatin—used in pill capsules and in various common foods such as dessert concoctions and marshmallows. Gelatin is made at Peter Cooper in an entirely separate plant that refines the product to pure food standards. In a sort of carefree research project, company executives had been vying to see who could produce the sneakiest version of *ambrosia,* a delectable gelatine dessert enhanced by a little fruit and alcohol. DeBoth had won the last round, but Eberhardy was experimenting with a recipe that promised to make nitroglycerine seem tame.

"That reminds me," said DeBoth. "Glycerine is a widely used glue additive. It makes the glue film flexible. Normally, hide glue dries with a harder film and a higher tensile strength than PVAs—that's another of its advantages—it doesn't clog sandpaper. But if you need a flexible joint, such as for a roll-top desk or a leather hinge, mix from 10% to 20% glycerine with the glue, based on the dry weight of the glue, and reduce the amount of water by the amount of glycerine you've added. The glycerine will slow the tack speed, lengthen the setting time, and leave you with a flexible film. I wouldn't recommend using glycerine-glue for stressed-wood joints, though—it might creep."

I turned the discussion to lemon juice, which I'd heard was a way to slow tack time. DeBoth said that any acid, including garlic, will slow hot glue's tack time because it chemically attacks the glue, breaking up the long chains of molecules that interlock to give the glue strength. But acids weaken the final bond. Hide glue is a complex natural combination of protein chains. When hide glue sets, it does so in two ways. The first set depends on the particular grade of glue and the temperature. As the glue cools, the protein chains form a matrix something like a Velcro fastener, hooking into each other. This initial set occurs within a critical time period—with some grades of glue, those beyond the top of the chart on p. 69, the glue will set, or gel, within seconds, much too quickly to have any woodworking uses, but essential in industries such as papermaking.

The second set occurs when the water in the glue is absorbed by the surrounding wood. This takes about 24 hours, though clamps can safely be removed after two hours as long as the joints aren't stressed until they fully cure. The glue remains water soluble, allowing a piece to be taken apart for repair, but other solvents, oils and even gasoline, won't affect it. "You can dis-

Photo: Clair J. Wilson Photographers, Inc.

The recipe for glue begins with a mountain of hides, best shifted with a front-end loader (photo, facing page). Above, George DeBoth pauses at what must be the world's largest glue pot, a holding tank midway down the line. The photo at right shows gelled hide glue near the end of the process. The spaghetti-like extrusions will be dried crisp in ovens, then granulated.

Photo left: Clair J. Wilson Photographers, Inc.

assemble a hide-glue joint with plain hot water," said DeBoth. "But this takes so long that the wood becomes saturated too, so most people use steam. If that's not practical, you can break down the glue protein with a meat tenderizer, such as Adolph's. Before re-gluing, neutralize the wood with peroxide."

Glue used in woodworking mustn't set too fast or it will skin over before a piece can be assembled. Depending on the job, a woodworker might want a setting time of a few minutes—for hammer-veneering, inlay work or rubbing glue blocks—or as much as a half-hour, for assembling a complicated case piece. A glue's setting time depends, first of all, on its grade. Glue is made by heating hides that have been soaked in lime, which dissolves unwanted proteins and chemically effects the collagens so the glue can be extracted. A batch of hides (about 20 tons at a time) is heated gently at first to extract the palest and fastest-gelling glue. Then it is heated three times more, which yields gradually darker and slower-gelling glues. These are graded according to an industry-wide set of standards that was formulated in the Peter Cooper lab in 1827. Broadly speaking, jelly strength values range from about 30 grams (very weak jelly) to 500 grams (exceptionally strong jelly). The glue Larry Broadmoore extolled in his letter as being the finest he'd ever used was 150-gram strength; glass-chipping glue is 80-gram strength.

Setting time next depends on temperature. In a cold shop, working with cold materials, glue will gel faster than usual, and vice versa. One veneering technique calls for applying the glue then heating the work to reliquify the glue film at the time of pressing—you can use a heated veneer press or even, for curved work, hot bags of sand. Modifying the amount of water in the glue mixture will also affect setting time—the more water, the slower the set. Recommended proportions for various grades of glue are shown in the chart, and DeBoth cautioned that deviations shouldn't be extreme. "If there's too much water in the glue film it will squeeze too freely from the joint. If there's too little water, the dried film will be too thick. Hide glue is not a gap-filling glue. Adhesion depends on the chemical bonding of glue and wood. The glue does not have to penetrate into the pores of the wood, that's another myth—consider that porous endgrain doesn't yield good glue joints, but glue will adhere very well to a non-absorbent surface like glass. You'll get the best joints from chemically clean, fresh wood surfaces that mate tightly. Furniture factories aim for about 150 pounds of clamping pressure per square inch and apply only enough glue to give them a thin bead of squeeze out along the full joint length. It's best to apply enough glue to one surface so that it can transfer to the other surface during the closed assembly time, when the edges are in contact but not yet clamped. If you apply a thin coat to both surfaces, the glue may cool and gel prematurely."

DeBoth explained proper mixing procedures. "Glue has to be of the right consistency. Proper concentration depends on assembly time, the temperature of the room and the wood, the temperature of the glue, and the clamping pressure. The higher grades of glue are more viscous, slower flowing, than the lower grades, so the amount of water varies according to the grade of glue. Following careful measurements by weight, add the dry glue granules to cool, clean water, stirring thoroughly until the granules are evenly wetted. Soak the glue for half an hour, then heat at up to 145°F until the glue melts. Temperatures higher than 145°F will cook the glue, breaking down the protein chains and weakening the bond. You can use a commercial glue pot with a built-in thermostat or a double boiler and a candy thermometer. For small amounts, a baby bottle warmer will work, and a thermometer is a good idea there too. As soon as the glue stirs out into a smooth mixture, it's ready to use.

"Glue granules have an indefinite shelf life and will last for years if kept dry. We recommend making up hot glue day by day. It will easily last 8 to 10 hours if you keep it covered to prevent too much evaporation. The next day, make a fresh batch. The glue is the least expensive part of any woodworking project; it's better to throw leftovers away at day's end than to take a risk with a reheated batch. Commercial liquid hide glue has a shelf life of about a year, because the manufacturers add preservatives. If you extend gelling time to make your own liquid glue, I wouldn't keep it more than a week.

"In the case of prolonged assembly times, or if the shop temperature is low, you can add small amounts of urea to retard gelling. High-grade urea is available from your local drugstore for about $10 per pound, but for the same amount of money you can get 50 pounds at garden supply stores such as Agway—it's used as a fertilizer."

Back at the factory, DeBoth introduced me to Victor Apps, chief of production, who conducted us all on a tour. The first stop was a short distance from the office, in a tall corridor where a swinging, steamshovel-type bucket was biting into a knee-high pile of fresh leavings from a slaughterhouse. "There's an ear," said Apps, reaching into the pile and pulling one out. "These are trimmings from hides, the parts not worth turning into leather."

Apps led us around the corner to a vast, dimly lit building. Five or six rows of 12-ft.-dia. wooden tubs stretched 700 ft. away into the murky depths. In the tubs, hides were being sloshed around by slatted wooden agitators on rotating arms, while debris was washed away by an endless supply of water—the factory draws about 10 million gallons from Lake Michigan every day. Midway down the left side was a pile of crushed lime as large as a two-car garage. At the far end, a mountain of dusty-blue leather scraps (the color comes from the chrome) dwarfed what looked like a three-times-larger-than-usual backhoe.

"Hides are washed and soaked in lime for three months," Apps told me, walking briskly. "Then they go to another building where they're heated to extract the glue."

The extraction tubs, which looked like half-size railway boxcars, were on the second story of the building next door. They were just finishing a first heating, and as the thin glue floated to the top it was piped off through a huge strainer, a 10-ft.-high barrel filled with excelsior, resembling a giant wooden Brillo pad. The strainer removed loose hair and bits of hide to yield a golden, watery outflow.

From there, the water was gradually extracted by heating it in a series of steps that took us to what has to be the world's biggest glue pot. Apps' tour pace was whirlwind. He flitted like a bird ahead of us all. We, maintaining a straight line of travel, were hard-pressed to keep up with him, yet he constantly made his own diversions from one side of each building to the other, now checking a gauge on the wall, now pausing to chat with a worker while the rest of us caught up. Finally we all arrived at the penultimate station, where the molten glue was chilled to congeal it into a spaghetti-like jelly, then extruded onto a conveyor belt that would carry it through an oven to dry it hard.

I had lost all track of where I was, but suspected that we'd walked at least a mile—up, down, inside and out in a maze-like pattern that led from slippery raw hide to crispy sheets of glue. We'd trod hundred-year-old wooden stairways whose handrails were polished hard by use, and whose posts were capped by turned balls that had long ago been worn down to ovals. Midway

Recipes

The chart shows properties of various glue grades and the recommended amount of water to mix with them for general purposes. There are higher and lower special-purpose gram strengths not recommended for woodworking. The high-gram-strength glues on the chart have more shock resistance, and are best for hard, dense woods. The low-gram-strength glues are less expensive, still stronger than wood, and good for jobs with long assembly times. A glue such as 1XM would be a good choice for all-purpose work.

The amount of water in the table can be reduced by 20% to shorten gel time; this thicker glue is best for porous woods. The water can be increased by 20% to lengthen gel time; thinner glue is best for dense, non-porous woods. Hide glue is quite forgiving, but mixtures too far from standard can cause problems—too heavy concentrations will not penetrate and wet the wood enough; too thin concentrations will penetrate too much, bleed-in, and produce a starved joint.

Modifying gel time: Urea, a common chemical available from pharmacies and garden supply stores, slows the gel time of hot hide glue without affecting the strength of the bond. Compute the percentage of urea in relation to the weight of dry glue. At 140°F, addition of 15% urea will extend the open assembly time of 1XM glue from about 1½ minutes to about 5 minutes (30% will extend it to 14 minutes). If the modified glue is at a lower temperature, open assembly time will be even longer, because the water in the glue won't evaporate so fast.

At 140°F, 30% urea will change the viscosity of the standard water/glue mixture from a honey consistency to that of milk. As the mixture cools, it will thicken. You can add up to 20% water to produce a glue that will be usable at room temperature. Results in the shop will vary according to grade of glue, concentration, humidity, temperature of the work and glue-film thickness. Adapt the basic recipe to your own needs.

Strength: The tensile strength of the glues listed is in excess of 10,000 PSI for all grades. Shear-strength tests of joints, made with 315-gram glue on some West Coast woods, produced the following results: California laurel sheared at 2,929 PSI with 50% wood failure; chinquapin sheared at 1,749 PSI with 92% wood failure; tanoak sheared at 3,042 PSI with 74% wood failure; madrone sheared at 2,675 PSI with 84% wood failure.

Increasing moisture resistance: Dissolve 8 ounces of borax in 9 pints of water, then add 1 pint of commercial formaldehyde (40% Formalin). Brush or sponge the mixture on one face of the joint and allow it to sink in. Apply glue to the other face of the joint and clamp as usual overnight. Full moisture resistance, enough to withstand conditions of very high humidity, develops in 5 to 7 days.

Better wetting: Animal glues can be modified at the factory in various other ways for special purposes: For hard-to-glue oily woods, the surface tension of the glue can be reduced by the addition of sulphonated oils. If foaming is a problem, the factory can add fat emulsions.

Hide glue is renowned for its versatility. The same glues used for woodworking are essential for products ranging from coated abrasives and polishing wheels to match-heads and gummed tape. Hide glues have a place in electrolytic refining, gasket making, textile sizing and, of course, papermaking. Without hide glue, in fact, this magazine page would fall apart. *—J.C.*

This low-tech glue lab requires only a scale, a bottle warmer and a thermometer. Various grades of dry glue are shown, along with a packet of urea, a white powder that extends gel time for making cold hide glue.

Glue mixtures

	Peter Cooper Grade	Gram strength	Water-glue ratio
Extremely fast gel	A extra 1 extra	379 347	2¾:1 2½:1
Fast gel for rapid assembly work such as edge gluing	1 extra special #1 1XM 1X 1¼	315 283 251 222 192	2½:1 2⅛:1 2:1 1¾:1 1⅝:1
Slow gel time for prolonged assembly work	1⅜ 1½	164 135	1½:1 1¼:1

in the tour we passed through ghostly wooden-floored expanses like low gymnasiums, where hundreds of workers used to dry glue in sheets on chicken-wire racks. It's all automatic now—although there are 125 people working at the factory, I never saw more than one or two at a time except in the offices.

All through the tour, surfaces got stickier and stickier. The black patina on the wooden handrail wasn't paint—it was glue deposited in minute layers year after year by thousands of hands. The yellow railings at the end of the line, where the glue was fresh, did not feel sticky to the touch, but my hands had picked up so much glue that when I pressed my palms together I could hear the sound as they came apart. The sensation was nothing like PVA, which pulls at the hairs on the backs of your hands and forms irritating crusts on your fingertips. This was entirely different—complex chains of golden protein that were warmed by my own body heat and ready to go to work. Tage Frid's test for hide glue is to put a drop between his finger and thumb, press for a moment, then pull apart. My whole hands could take Frid's test and pass. This was a good batch of glue. □

Jim Cummins is an associate editor at FWW. *Dry hide glue costs from $4 to $6 per pound in most mail-order woodworking catalogs. Peter Cooper sells primarily to industry. Their minimum order is $100, which will get you about 100 lbs. of glue.*

Router Joinery

Jigs expand the repertoire

by Bernie Maas

When I bought my first router in the mid-1960s, I thought that it might be useful for putting fancy edges on things. My attempts to do something more with it, like dado or rabbet, usually came to grief when the machine kicked out and gashed the piece. I kept at it though, and over the years, with the addition of a variety of sub-bases, jigs and templates, the limitless possibilities of the router became apparent to me. Today, I believe that the router is one of the more significant innovations in our craft in this century, particularly since the recent introduction of plunge routers.

The router is relatively safe, and it promises surety of performance without a lengthy apprenticeship—ideal qualities for the students in the shop that I run at a small Pennsylvania university. Shapers are expensive and they can be dangerous; I have neither the budget nor the inclination to buy one for our shop. The router can do much of what a shaper can do, and much that a shaper can't. The new generation of heavy-duty plunge routers can accept ½-in.-shank bits with the size and mass of some shaper cutters. Our 3-HP Hitachi TR12 plunge router, for example, comes with collets for ¼-in., ⅜-in. and ½-in. bits; it lists at about $300, although it can be found for half that price. Bits vary in price from a few dollars to over $100 apiece. Most of the jigs and fixtures I'll discuss here can also be used with much less expensive light-duty or medium-duty routers, and inexpensive cutters.

Perhaps the simplest router fixtures are auxiliary sub-bases. We commonly make two sub-bases for new routers, as shown at left and center in figure 1. We prefer to use ¼-in. Masonite or void-free plywood (such as Baltic birch), both of which are hard, slide easily, and wear well.

The first sub-base is similar to the router's original base, but we cut the center hole just large enough for the biggest bit we use to pass through. This reduces the chances of dipping or sniping when routing around corners or working small sections. Additional holes make it easier to see the cut in progress. The second base has a long, straight edge (12 in. or more) to guide the router against a fence for dadoing, rabbeting, or cutting grooves. The straight edge helps prevent loss of control when exiting a cut. The third sub-base shown in the drawing, which extends 6 in. either side of the router, is useful for spanning large templates. Make it as thick as possible while allowing the router's template guide to protrude.

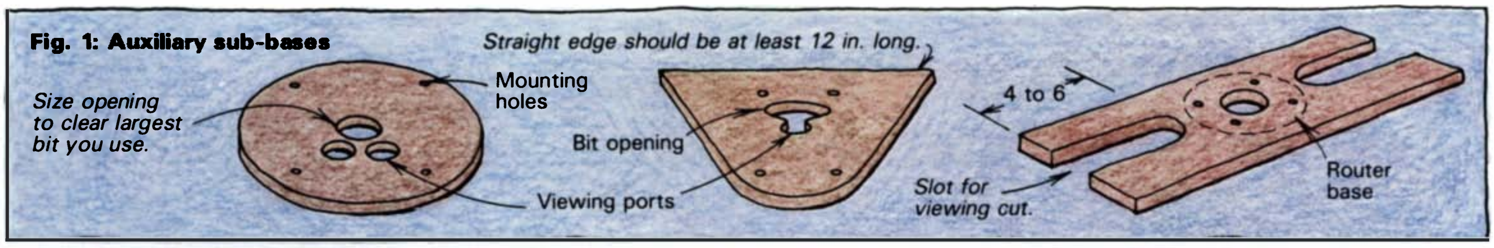
An excellent partner for the straightedge sub-base is the shop-made T-square fence shown in figure 2. The blade is 30 in. to 36 in. long, and extends 6 in. to 8 in. beyond the head, to steady the router as it exits the cut. We make our fences from stable, defect-free hardwood scrap. Usually one clamp is enough to secure the fence to the work. Clamp the fence on the side of the dado, groove or mortise that will be most visible. This limits wander or run-out to the "no show" side.

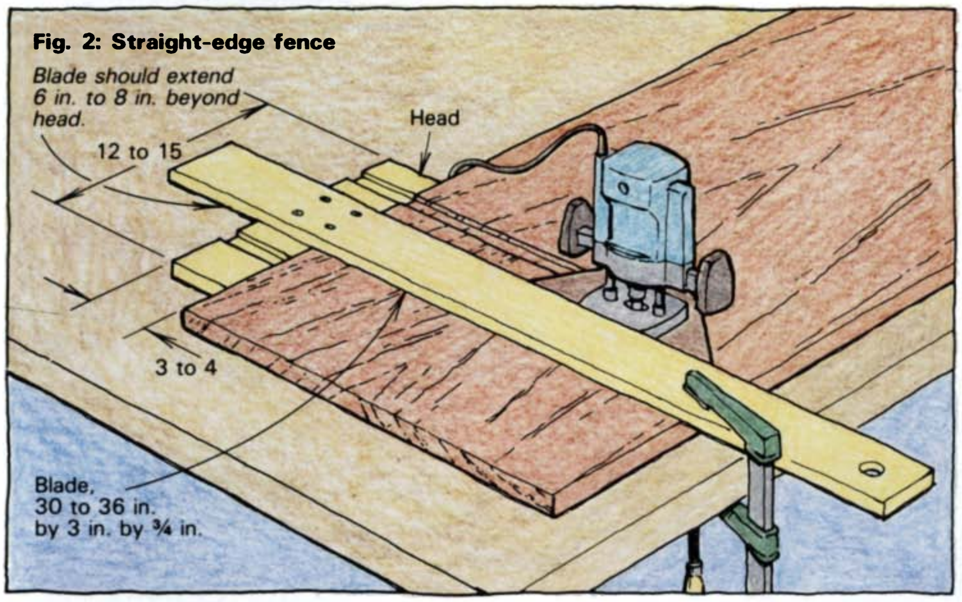
Trimming the ends of a wide panel square, smooth and true can be a stumbling block. A 40-in.-wide, 2-in.-thick tabletop can be a bear to wrestle through a tablesaw, a radial-arm saw doesn't have sufficient reach, and portable power saws leave rough surfaces at best. A router fitted with the straightedge sub-base will trim the ends dead square and glass smooth. We use a Freud 12-130 bit, a ½-in.-dia. straight, double-fluted carbide bit with 2½-in. working length, or a Freud 12-158, a similar ¾-in. bit with 2-in. working length. (Double-flute bits seem to cut cleaner than single-flute bits.) Both bits have ½-in. shanks.

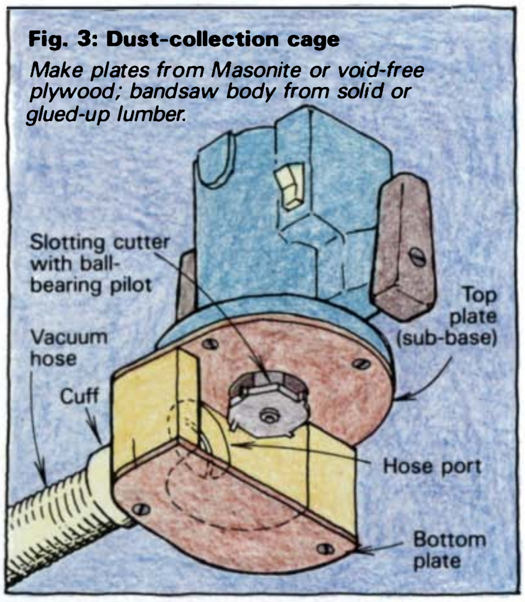
Trim the panel to within ¼ in. of finished length, clamp a straightedge or T-square fence in place, and rout away. Blocks clamped to each edge of the panel, flush with the end and top surface, will prevent splintering at the ends of the cuts. End grain is very hard on edge tools, so make several very light, full-depth passes rather than one heavy one. Remember to cut against the bit's rotation, moving the router left to right as you face the end—moving the other way causes the bit to grab and tear.

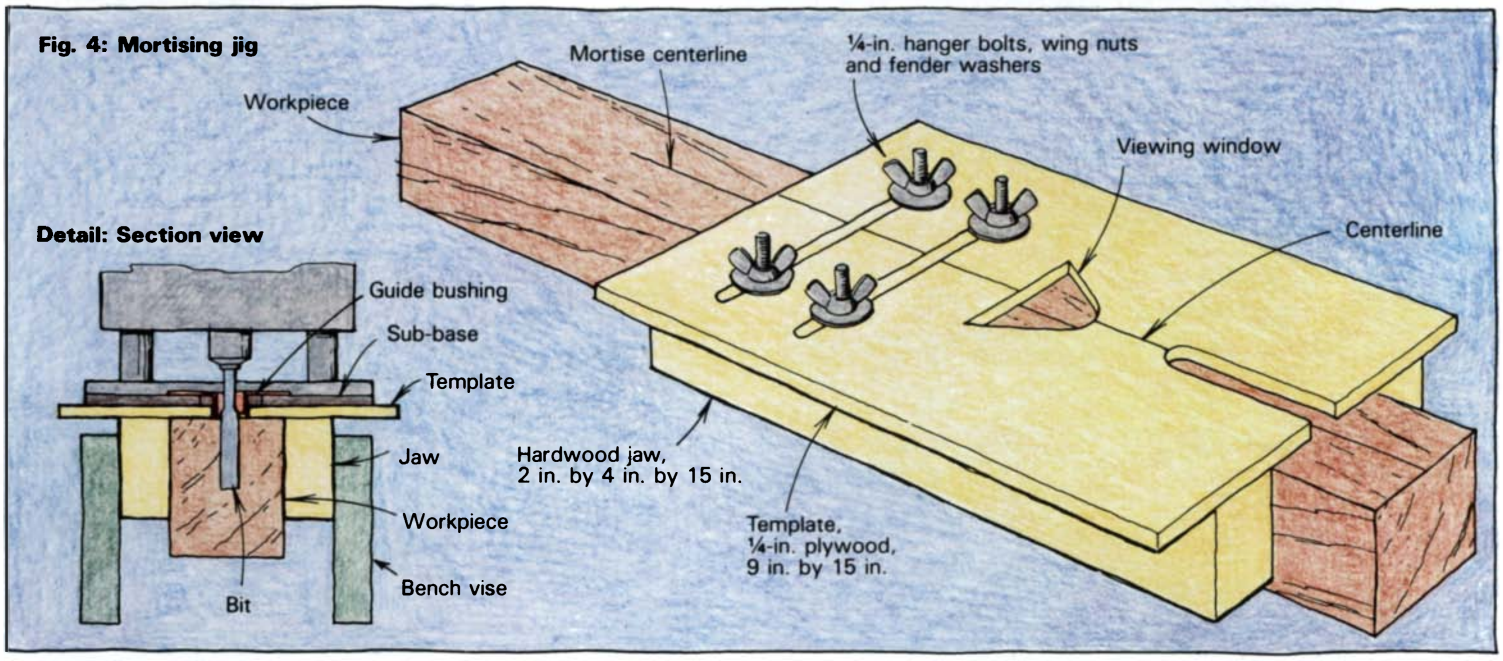
Aligning boards for edge gluing is easily and accurately done with splines in routed grooves. Shaper-cut edge-gluing profiles aren't an option for us, and doweling jigs have proved inaccurate and error prone. Stopped grooves, such a nuisance on a tablesaw, are a snap with the router. We cut the grooves with a slotting cutter consisting of an arbor, ball-bearing pilot, and the cutter itself. No fence is needed because the pilot bears on the edge to guide the cutter. Cutters commonly have either two, three or four wings and come in a range of diameters and kerf sizes. I like four-wing cutters because they cut more smoothly and put less strain on the router. Set the cutter at about the middle of the edge; exact centering isn't important as long as you run the router on the same face of each board to be joined.

The only drawback to a slotting cutter is the vast amount of dust and chips it generates. The chips shoot out of the machine in a trajectory that is usually painfully in line with your forearm. To handle the dust and chips created by this and other large bits, we connect a Shop-Vac to the dust collector shown in figure 3. The collector is basically a cage-like device attached to the router in place of the normal sub-base. We make the top and bottom plates of Masonite or void-free hardwood plywood, and bandsaw the body from a block of any available lumber. The hole in the top plate (the sub-base), should be just as large as the cutter, and the clearance between the collector body and









the cutter should also be kept to a minimum. These close tolerances maximize available suction. We bored the hose port in the body with a multi-spur bit. Shop-Vac hose cuffs are usually 2¼ in. in diameter, and tapered; jamming the cuff into the hole should be sufficient to hold it without an additional fastener. Position the port so that its center is in line with the trajectory of most of the chips.

Mortise-and-tenon joints are strong, dependable, and basic to much woodworking. However, they require a flair for hand tools or a retinue of expensive stationary power tools, both of which can be discouraging to novices. The plunge router presents a low-cost, quickly mastered alternative. It's possible to cut mortises and tenons using just the factory-supplied machine-mounted router fence, but we developed a simple pair of jigs (figures 4 and 5) to eliminate the possibilities of wander or run-out that can occur when guiding the router with only the fence.

The mortising jig consists of two hardwood jaws, about 15 in. long, fastened by hanger bolts and wing nuts to a ¼-in.-thick template of void-free plywood. Oversized fender washers prevent damage to the template. Mill a slot down the center of the template, 5 in. or 6 in. long and just wide enough for a snug, sliding fit on your router's template guide bushing. A window in the template helps when aligning the template and mortise centerlines.

To use the jig, mount it on the workpiece, template resting on the top surface, then clamp the jaw/workpiece sandwich in a

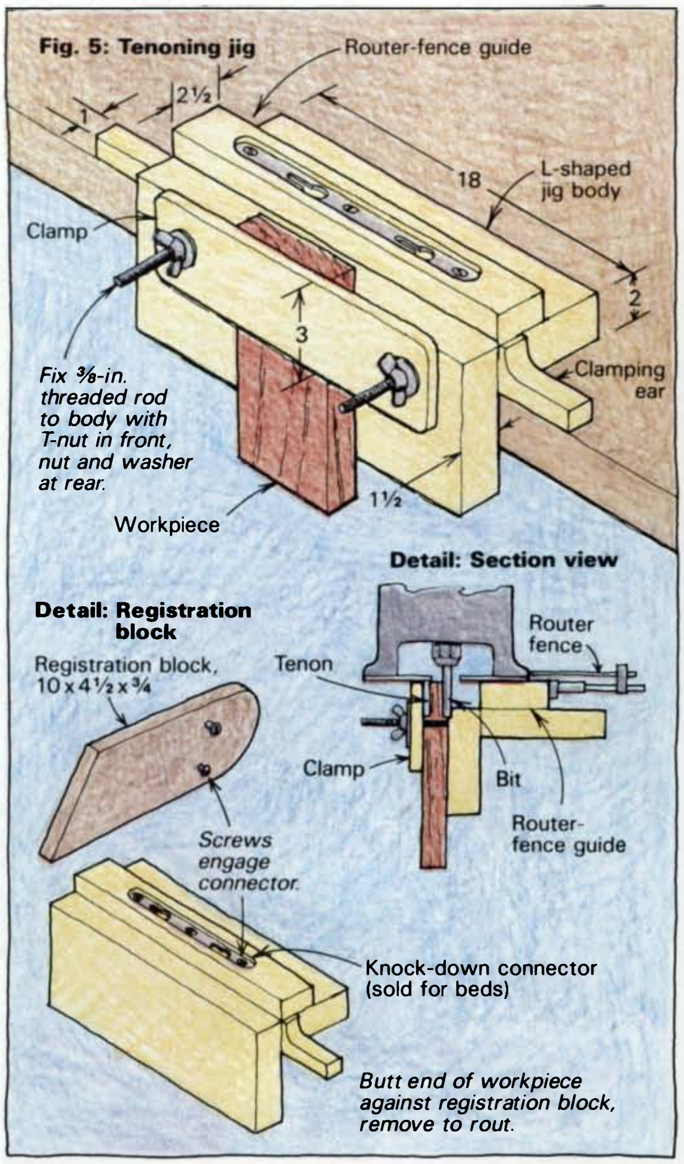


Fig. 5: Tenoning jig
Router-fence guide
1
2½
18
L-shaped jig body
Clamp
2
3
Clamping ear
Fix ⅜-in. threaded rod to body with T-nut in front, nut and washer at rear.
1½
Workpiece
Detail: Section view
Router fence
Tenon
Clamp
Bit
Router-fence guide
Detail: Registration block
Registration block, 10 x 4½ x ¾
Screws engage connector.
Knock-down connector (sold for beds)
Butt end of workpiece against registration block, remove to rout.

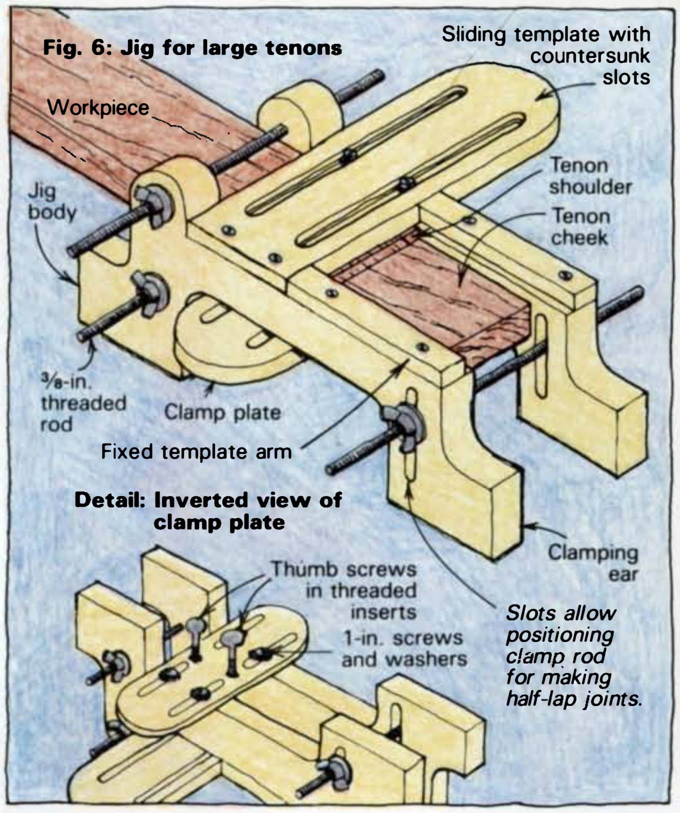


Fig. 6: Jig for large tenons
Sliding template with countersunk slots
Workpiece
Jig body
Tenon shoulder
Tenon cheek
⅜-in. threaded rod
Clamp plate
Fixed template arm
Detail: Inverted view of clamp plate
Thumb screws in threaded inserts
1-in. screws and washers
Clamping ear
Slots allow positioning clamp rod for making half-lap joints.

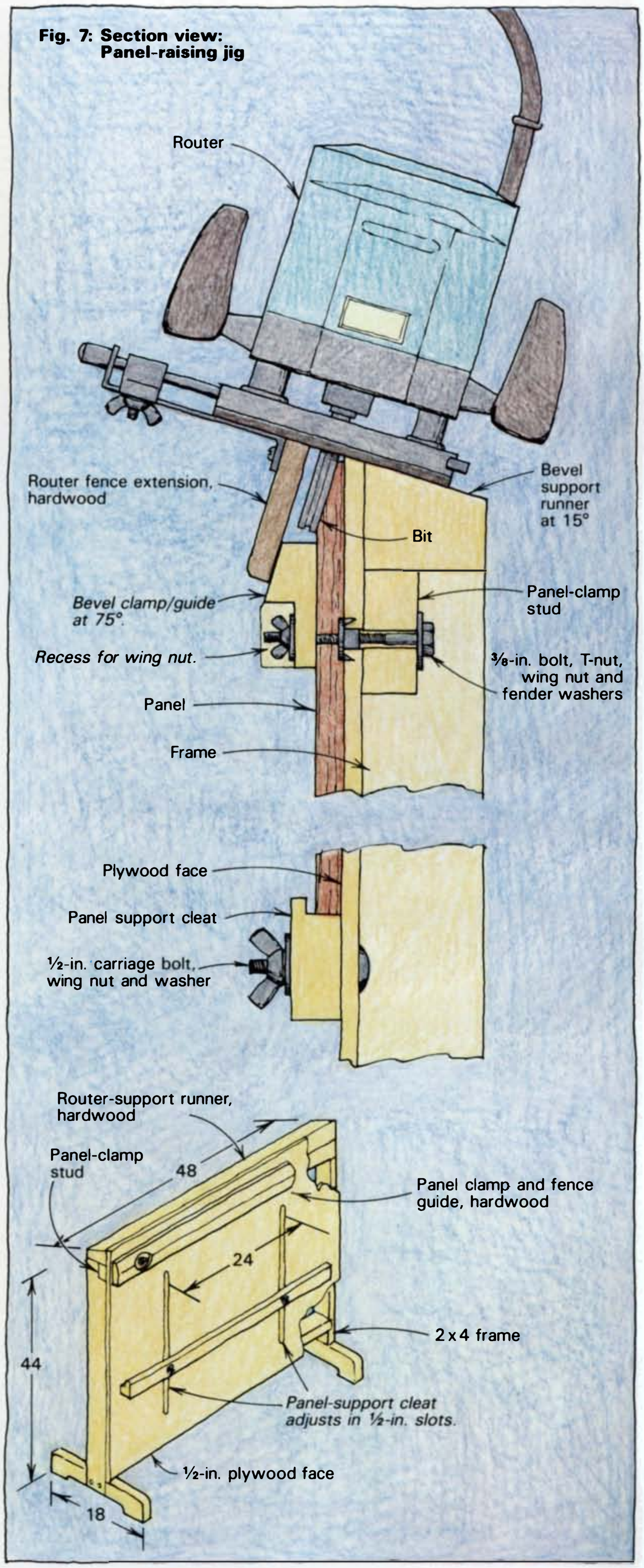


Fig. 7: Section view: Panel-raising jig
Router
Router fence extension, hardwood
Bevel support runner at 15°
Bit
Bevel clamp/guide at 75°
Panel-clamp stud
Recess for wing nut.
⅜-in. bolt, T-nut, wing nut and fender washers
Panel
Frame
Plywood face
Panel support cleat
½-in. carriage bolt, wing nut and washer
Router-support runner, hardwood
Panel-clamp stud
48
Panel clamp and fence guide, hardwood
24
2 x 4 frame
44
Panel-support cleat adjusts in ½-in. slots.
½-in. plywood face
18

bench vise. Adjust the template to align the centerlines, then tighten the wing nuts. If you're cutting an open mortise on the end of a piece, as for a bridle joint, the template should extend an inch or so beyond the end so that the guide bushing is fully engaged before cutting starts. If you wish, clamp stop blocks for the mortise length. Cut the mortise in several passes. The same jig works for dovetail slots. Hog most of the waste with a straight bit, then rout the dovetail slot in one full-depth pass.

The tenoning jig (figure 5) is equally simple, and can be used with regular routers as well as plunge routers, though deep mortising is much easier with a plunge router. Built of 2-in. stock (any stable wood will do), it has an 18-in.-long L-shaped body that hooks over the edge of a workbench, where it is clamped by its two ears. Glued to the body's top surface is a precisely milled router-fence guide, about 1 in. thick by 2½ in. wide—make sure that it's thicker than the depth of your router fence. The guide is parallel to the front edge of the body and set back 1½ in. from it. The router's fence runs against the rear of the guide, making it impossible for the bit to wander or kick into the tenon. Two lengths of ⅜-in. threaded rod pass through the body to support the clamp that holds the workpiece. T-nuts at the front, and nuts and washers at the rear, lock the rod to the body. The top edge of the clamp should be level with, or slightly below, the upper face of the fence guide so it won't interfere with the router base. The detachable registration fixture positions the workpiece end at the correct height, although you could do this with a straightedge.

The tenon is cut vertically, the waste wood peeled away on the cheeks by the length of the bit, the shoulders cut square by the end of the bit. Adjusting the position of the fence varies the width of the shoulder and, therefore, the thickness of the tenon. Two setups are needed, one to cut each cheek. To register properly, the end of the workpiece must be square to its edges. Position the end of the workpiece with the fixture or straightedge, then tighten the wing nuts securely. Set the bit depth (or plunge depth stop) to the tenon's final length and adjust the router fence for the shoulder width. It's a good idea to cut a trial tenon in scrap to check the settings. Standing so the work is to your right, cut into the far edge of the workpiece slightly, pulling the router toward you. This prevents tear out when the cut is completed from the other direction. The bit will pull itself into the wood, so hold the router securely. Now, pushing the router, take several shallow passes to complete the cheek; for the last cut, push the fence firmly against the guide. Turn the piece around, re-register it, and cut the second cheek. You can trim the edges of the tenon in the same way, but for wide pieces it's just as easy to cut them on the tablesaw after routing the wide cheeks.

Using this jig, tenon length is restricted by the length of the router bit. In practice, we seldom cut them longer than 1¼ in. with this jig. For larger tenons, we use the jig shown in figure 6. The two halves of the jig slip over the workpiece, the sliding part of the template aligned with the shoulder line. The router rides on the template, the end of the bit milling the waste from the cheek. (Thumbscrews fitted in a plate under the jig push the workpiece tight to the sliding template.) For wide tenons, the extended router sub-base is helpful to span the jig. The guide bushing runs against the sliding template to cut the shoulder. (If your bit and guide bushing aren't the same diameter, be sure to allow for this when positioning the sliding template.) Repeat the process for the other cheek, and to remove the waste on the edges for the narrow cheeks, if you wish. By sliding the front bolt down in its slots, the jig can also be used to mill half-lap joints anywhere on the length of a board.

In frame-and-panel construction, beveling (also called "raising") the panel edges allows the panel to remain snug in the frame grooves as it expands and contracts with changing moisture content; raising also gives the panel a pleasing appearance. A century or so ago, panels were beveled with hand tools—saws and panel-raising planes—and a good deal of expertise. Today, the job can be done by machine, as well as by hand.

The shaper, tablesaw, jointer, and radial-arm saw all offer methods for panel raising, but they share two drawbacks. First, panels, often bulky and unwieldy, must be moved over a stationary cutter, presenting control problems that can result in sniping, blade burns, runout and kickback. Second, the panels must be dead flat or the beveled surfaces will be irregular.

Figure 7 shows the router panel-raising setup we developed in the school shop. The panel is fixed securely to the stand; any cup or bow is forced out by the stout clamp, which also guides the router fence. The router slides on the angled support runner that forms the top of the stand's frame. We use the Freud 12-130, ½-in. carbide bit to cut the bevel. Adjusting the router fence determines the depth of cut and, therefore, the final thickness of the tapered panel edge.

We used dressed 2x4s for the stand frame, hardwood elsewhere. The face of the stand is a 4-ft. square of plywood, glued and screwed to the frame—recess the screws to prevent marring the panels. Plunge-rout the ½-in. slots in the plywood face for the panel-support cleat. Oversized holes in the cleat will prevent the carriage bolts from binding. The support runner, angled 15° from the horizontal, can be mortised or screwed to the uprights. The 75° bevel on the clamp/guide combines with the angle of the top support runner to create a right angle—if you alter the angles, make sure they add up to 90°. The router fence extension should be at least 1 ft. long, and deep enough to provide good support and contact with the clamp/guide.

To use the jig, set the panel on the support cleat, adjusted to place the panel's top edge flush with the support runner, then tighten the clamp. Set the router fence and the bit depth, then hold the router base firmly on the runner, turn on the machine and slowly engage the panel. Make several passes, gradually easing the fence extension onto the clamp/guide. Make the final pass with the router held firmly against the guide. Set up for the next edge or end, and repeat. Because the unusually long bit is fully exposed, be extra careful to keep clear of it. The resulting panel should be uniformly raised, without burn marks, and with miters meeting precisely at the corners. Light rippling on the surfaces vanishes with normal sanding.

Much as I like routers, they do have drawbacks. They're terrific generators of noise and dust, so be sure to wear ear protection and a dust mask or respirator. When chucking a bit, especially a large one, slide it into the collet until it bottoms out, then back it off about ¹⁄₁₆ in. before tightening down. Bits seated against the bottom can vibrate loose, no matter how much torque you apply when tightening. Routers need very little maintenance—my 25-year-old Stanley still has its original brushes and bearings. Plunge mechanisms, though, need periodic cleaning and some type of dry lubrication, such as silicone spray. Dust in a switch can cause arcing at the contacts and failure of the switch. We've found that packing the switch cover housing in non-conductive Plasticine (children's modeling clay) seals out the dust. □

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Cold-Molded Cradle

A boatbuilding method applied to furniture

by Larry Hendricks

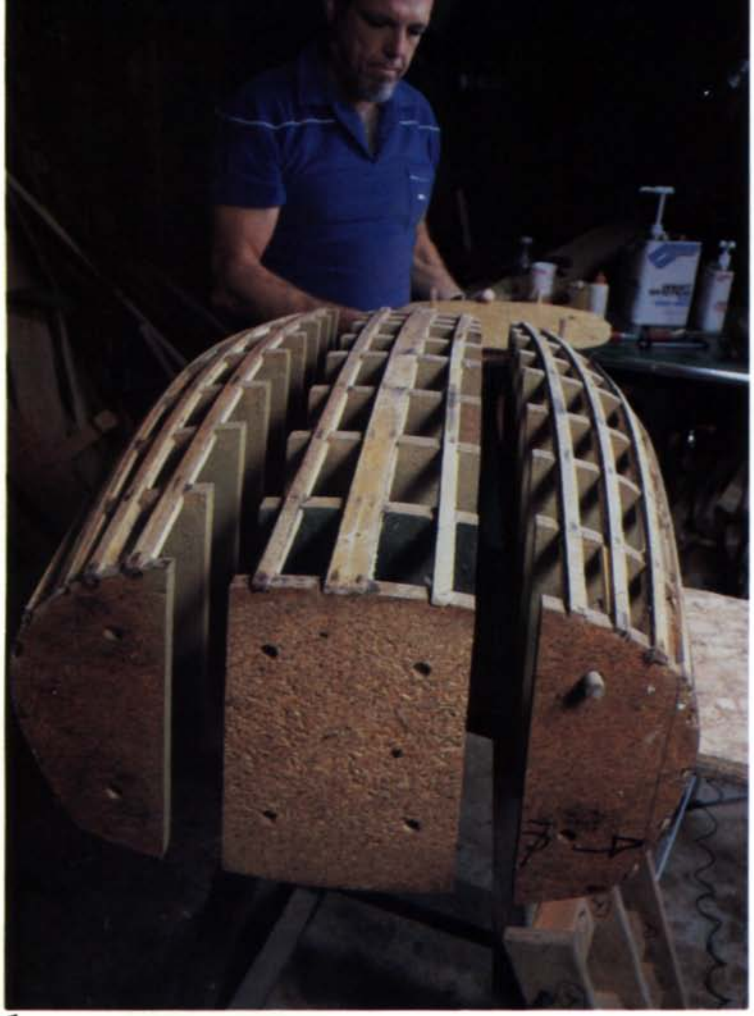
Resembling a truncated canoe, author's cradle was made using a boatbuilding technique called cold-molding. This cradle is made of African mahogany veneer, but teak was used for cradle shown in the construction sequence.

I first conceived of this cradle when I received a phone call from an acquaintance who wanted both a cradle for a soon-to-arrive child and a family heirloom that could be passed on to future generations. As we talked, I remembered the popular nursery rhyme in which Wynken, Blynken and Nod sail off in a wooden shoe, and the design popped full blown into my head. Sketching my idea on the back of an old envelope, the story of Moses in the bullrushes and the notion of launching an infant on a new life came to mind as the cradle took on its boat-like shape.

The boat idea suited my customer and me perfectly. I've always wanted to be a boatbuilder and the cradle project would give me an excuse to experiment with a boatbuilding method called cold-molding, a woodbending technique related to the form laminating process described in *FWW* #54. Cold-molding differs from form lamination in one important way: instead of bending the wood by laminating many glue-coated thin strips between two forms—a male and female—the curved shape is made by wrapping strips of veneer around a mold, layer by layer, until the desired thickness is achieved. Staples temporarily hold each layer in place until the glue cures, so you don't have to struggle with mating two forms accurately or with a lot of clamps. With cold-molding, compound curves are easily achieved and the resulting structure is so strong that internal bracing isn't needed. The process I've described here is readily adaptable for all kinds of curved furniture plus, of course, boats of all sizes, from canoes to schooners.

The photo sequence explains the order of events. As for materials, almost any veneer will do for the cradle's skin. For the project described here, I used ¹⁄₁₆-in.-thick teak, which is fairly straight-grained. Highly figured burl could be used, but the veneer must be thinner in order to lay flat. I used three layers of veneer for the cradle body, and five for the ends. Because it has good gap-filling properties, epoxy is the best adhesive for cold-molding, though plastic resin or yellow glue will also do. I used the West System epoxy, available from Gougeon Brothers, 706 Martin St., Bay City, Mich. 48706. A word about safety: all epoxies are strong irritants. Some people are more sensitive than others. I'm not affected by the resin so I'm working barehanded in the photos. I strongly recommend, however, that you use the protective gloves Gougeon sells.

Larry Hendricks makes furniture in Warren, Conn. For more on cold-molding, refer to issues No. 61, 64, and 65 of WoodenBoat Magazine, *P.O. Box 78, Brooklin, Maine 04616.*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Before molding begins, the mold must be built. Mine consists of nine particleboard patterns called stations, each a cross section of the cradle shape at a point along its length (figure 1). The stations are secured by a removable strongback that holds them vertical and parallel to each other. Pine strips, called ribbands, are nailed into grooves in each station to provide support when the veneer is molded. Before laying veneer, carefully sight the ribbands for fairness of curve. Plane or sand away humps, and shim flat spots. The body plan in the drawing gives a general idea of the cradle's shape, but you can alter it to suit yourself. To define shape precisely, boatbuilders use a technique called lofting. It's too complex to explain here, but a book on the subject is *Lofting* by Alan Eaitses, available from *WoodenBoat* (address at left). The finished cradle must be removable from the mold, or vice versa. Like a canoe, my cradle has tumble home—that is, the hull rises above the waterline to a maximum width or beam, then sharply tucks in to a narrower beam. To provide an escape route for the form, I made it in three sections (1) so it can be broken down inside the cradle and removed when molding is done. The three sections are held together by two false ends doweled into the end stations, as shown photo 2 and in figure 1. Before starting, coat the mold with paste wax so the epoxy won't stick to it.

Fig. 1: Cradle construction

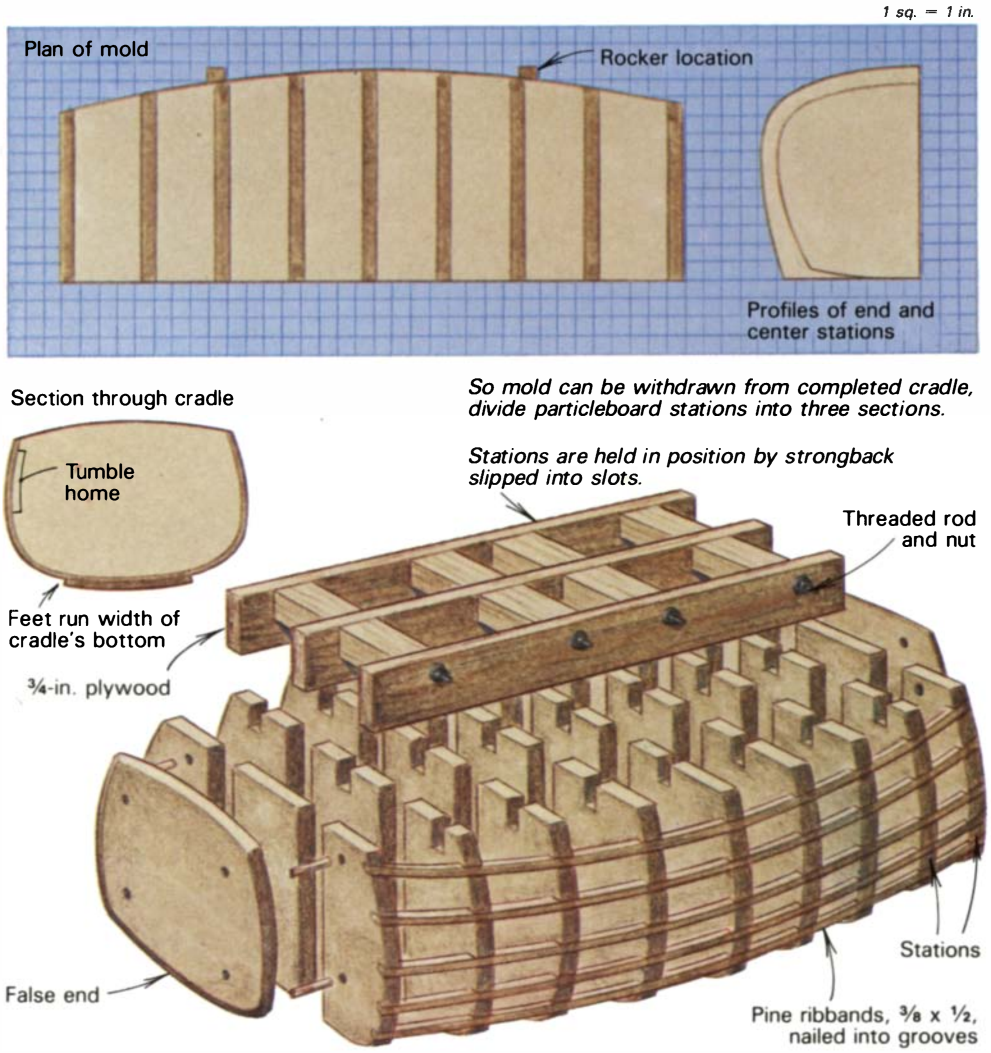

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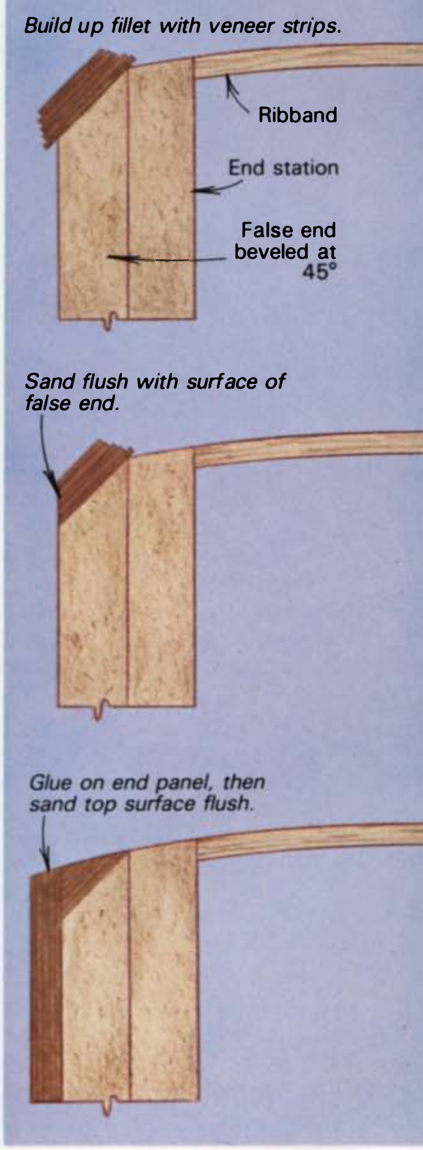
Fig 2: Fillet sequence



There is no joinery in the cradle—epoxy holds it all together. Because the joint between the end panels and body is only $\frac{5}{16}$ in. wide, it should be reinforced with fillets, which also form a smooth transition between the sides and end panels on the inside of the cradle. To form the fillets, I build up strips of veneer about 1 in. wide (**3**). The first fillet layer is stapled to the form's false ends, subsequent strips (four or five layers will be needed) are staggered to overlap butt joints in the lower fillet strips. Remove the staples before adding a new fillet layer. Once the glue cures, sand the fillet flush, as shown in photo 4 and figure 2.

I make the end panels next by gluing up an oversized blank consisting of five layers of veneer, alternating grain direction 90° for each layer (**5**). A veneer press is handy for this, but I placed the stacks of epoxied veneer between two plywood backing boards and piled 175 lb. of concrete blocks on top. Waxed paper between the backing boards and each end-panel sandwich keeps them from sticking together. Bandsaw the end panels a bit oversize, then glue in place, spreading epoxy carefully on the fillet, not on the form's false end. Once the epoxy has cured, sand or rasp the end panels to the shape of the mold, being careful not to remove too much material (**6**). Keep the shape as fair and smooth as possible.

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Begin molding in the middle of the form and work toward both edges. At this point the strips aren't glued edge-to-edge, but only where they land at the fillet/end panel juncture. Begin by wrapping a 3-in.-wide piece of veneer (jointed straight on both edges) diagonally around the form (**7**). When the strip is positioned properly, staple it first in the center then work toward the ends, stapling where necessary to make the strip conform to the mold. My staple gun has adjustable tension, which I set at light pressure to leave the staples proud for later removal. Or, you could use a small piece of cardboard under each staple. Measure and cut another strip for each side of the center strip (**8**). Only one edge need be jointed; the other will be scribed to the contour of the first strip using a technique boatbuilders call spiling. There are many ways to spile, but the method I use is to drive a $^5/_{16}$-in. staple in the new strip near the middle of the mold. The strip being spiled should be positioned so its edge just touches the previous strip at the center of its length. Working toward both ends, I use a small bullnose plane to trim the new strip's overlapping edge to a tight fit. The first and third layers of veneer must be tightly spiled, since they will form the inside and outside the cradle.

After the first layer is completed and cured, the second is laid diagonally in the opposite direction (**9**), again starting in the center. Spiling needn't be as accurate here since this layer will be visible only at the cradle ends. As you lay up this layer, mark a pencil line showing roughly where the strip will go and remove the first layer's staples only from this area. Spile, apply epoxy to the back of the strip and inside the pencil line, then staple.

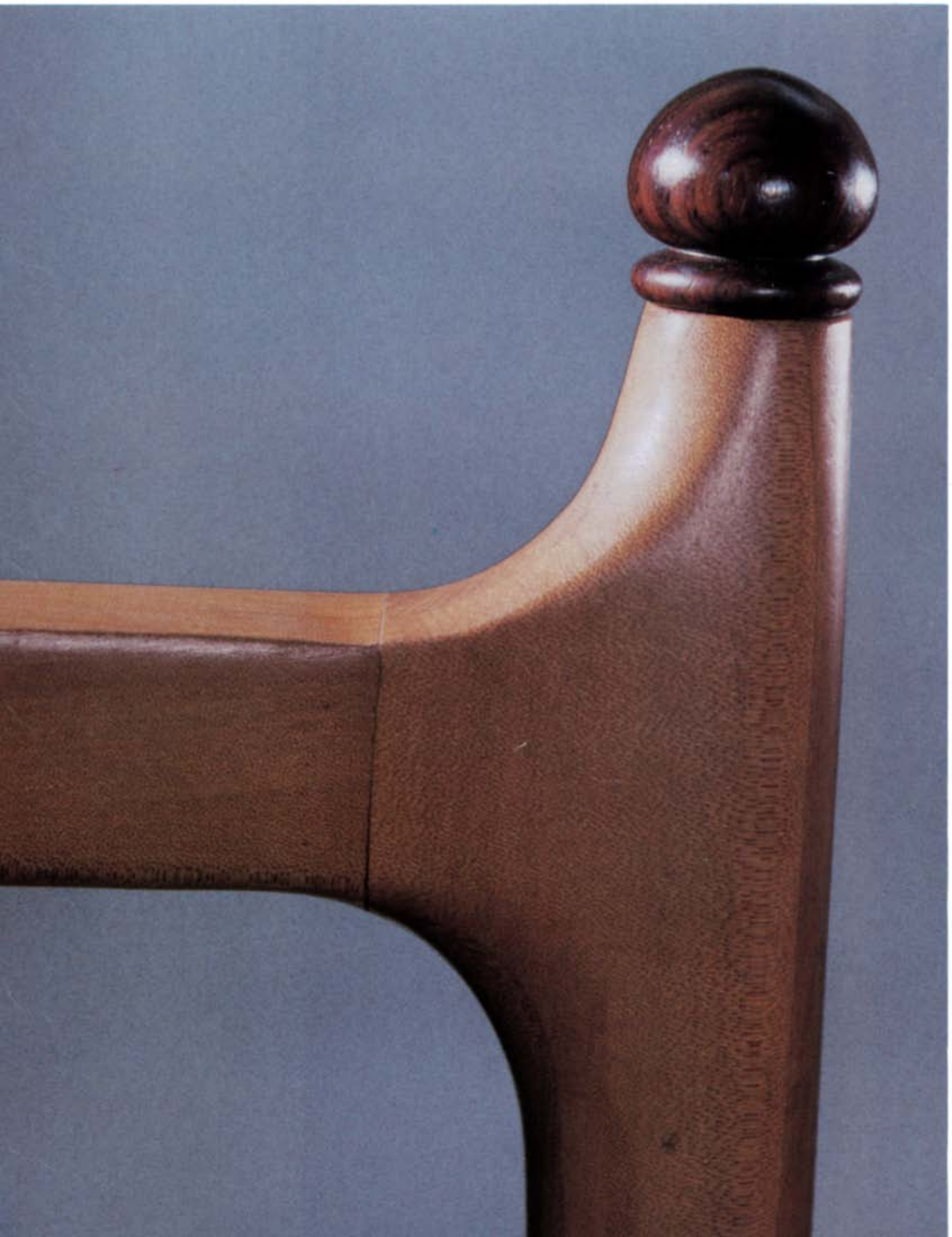
When the second layer has cured, remove all the staples and scrape or sand the surface smooth and fair. Trim off the rough ends of strips at both end panels and what will become the cradle's top edge, or gunwale. Later, when molding is completed, this line (the cradle's sheer) can be sawn and worked fair with a rasp or sandpaper. For appearance, I lay the third layer lengthwise, but it could be laid diagonally opposite to the second. Spile very carefully because the third layer is the most visible. To prevent marring, I use cardboard under the staples, and a lead weight helps hold things down while I plane the edges (**10**). When the glue has cured, remove all staples and sand or scrape to a smooth finish. If the surface is not fair enough to your eye, don't hesitate to add another layer. After finish sanding, add rockers to the bottom, then break down the form to remove it from the cradle (**11**). The inside will be rough from the staple holes, so scrape and sand thoroughly, then fill with an epoxy-sawdust mixture. I finished my cradle with polyurethane on the inside and tung oil on the outside. □

Close Ups

A detailed look at recent work

If form just exactly followed function, the shape of everyday wooden furniture would spring few surprises; a chair would have a back and a seat, a table legs and a top, and that would be that. Fortunately, the real world is not nearly so predictable. Messing around with how the parts fit together, playing with sizes and proportions, colors and textures livens up the contemporary furnituremaker's art. So does creating the details, the fine, whispered features that set one piece apart from another, as surely as fingerprints identify people.

Not so long ago, maybe six years, a nice detail might have been an exposed dovetail or a wedged-through tenon, or some other kind of subtle highlight that both caught the eye and explained how the piece was stuck together. Now, joinery is more often hidden, or at least the evidence of it isn't so celebrated. Exposed joints are bit players, having been supplanted by unabashed applied decoration like finials, marquetry and inlays, moldings, and vibrant paints and lacquers. Some of the details shown here, combed from various shows and galleries during the past year, look like, and are, finishing touches. But the reverse can be true. Inspiration comes from many sources and if inspiration is a detail, why not dream up something to hang it on? The best details are so well-integrated with the whole that they look as though they grew there, with not a hint of the toil that went into the cultivation.



Chairmaker Bob Erickson, of Nevada City, Calif., calls this his walking-stick chair, after the turned finials that cap its posts. The chair, displayed last summer at Santa Fe's Contemporary Craftsman Gallery, is of Pacific madrone, the finials and matching feet are rosewood. Erickson had a turner friend, Elliot Landes, make the finials. Dowels turned on the finials and feet fit holes bored into the posts. The rosewood would scuff the floor, so Erickson glued a nylon glide to each foot. The back slats are cold bent and fit into mortises in the crest and bottom rails. An upholstered leather pad serves as a seat. The chair, originally paired with a writing table, was priced at $1,190.

Photo left: Richard Sargent; above: Joe Schopplein

This clock, one of a pair made by Bruce Volz of Easthampton, Mass., was shown last summer at the Pritam and Eames gallery in Easthampton, N.Y. Volz intended the piece as a grandmother clock, so he detailed it with images reminiscent of childhood days spent on his grandmother's farm in Minnesota. The clock's carcase is of post-and-panel construction, with a purpleheart frame and pearwood panels. The spoons are inlaid holly and iroko. A miniature weathervane tops the Gothic hood. As with most tall-case clocks, the waist door opens, but this one conceals a set of shelves rather than a swinging pendulum and weights, thus the clock doubles as a storage cabinet. Price: $6,650.

Photos: Tommy Elder

Photos below and left: Joe Felzman Studio

For the past year, Steve Voorheis has been experimenting with casting his own hardware in a tiny foundry he has set up at the Primrose Center in Missoula, Mont., where he teaches woodworking. This chest (above) is detailed with a pull of silicon-bronze inlaid with macassar ebony (top left). The cabinet is made of padouk, the stand is of wenge. It appeared in a show that traveled around the Northwest last fall.

In New Mexico's harsh climate, adobe houses make perfect sense, but their thick interior walls complicate closet construction. Spanish carpenters brought to New Mexico a cabinet called a trastero—really an armoire—to solve this problem. Bruce Petersen's trastero, left, has more delicate proportions than the traditional version and is made of brighter woods; mahogany for the frames and Brazilian bloodwood for the panels. The rosettes on each muntin were bandsawn to shape, then carved (far left). Petersen showed the piece at the Contemporary Craftsman in Santa Fe. It was priced at $3,200.

Roy Slamm's round dining table is made of purpleheart veneer and maple. To match the top, Slamm inlaid strips of purpleheart into the turned legs, whose ends resolve themselves nicely into the cut-away apron. The table appeared last fall in a show sponsored by three Maine woodworking associations.

Cattails are a common sight in northern Minnesota, where Grey Doffin lives, so it was natural for him to incorporate them into this cradle. Doffin laminated maple blanks for the posts, then turned the finials on the ends after the parts were shaped. The end panel and side slat patterns were jigsawed. Parents hesitate to invest in an expensive cradle usable for only a year, so Doffin loans his out. The cradle held its first infant last summer. □

Photos/table: William Thuss; photos/cradle: Tim Weik, © Grey Doffin 1984

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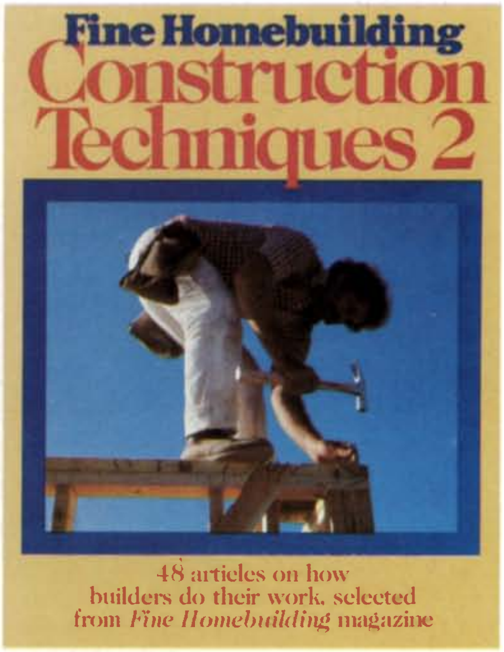

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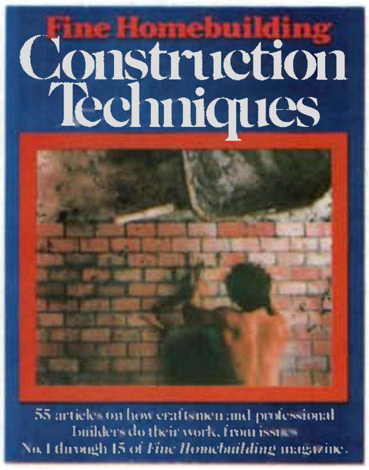

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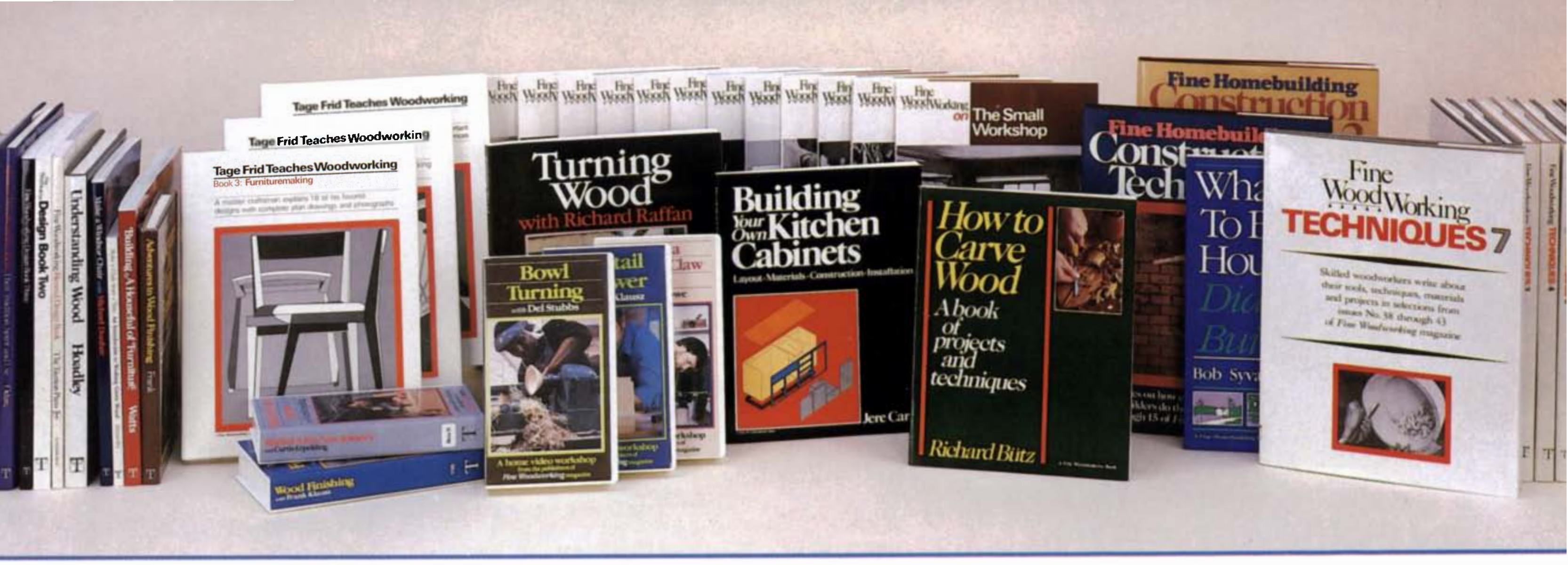

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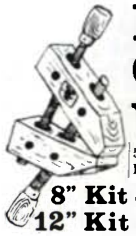

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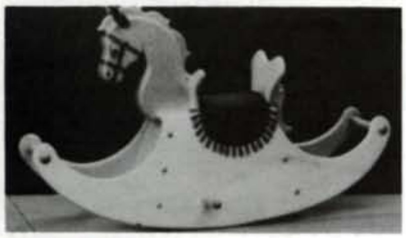

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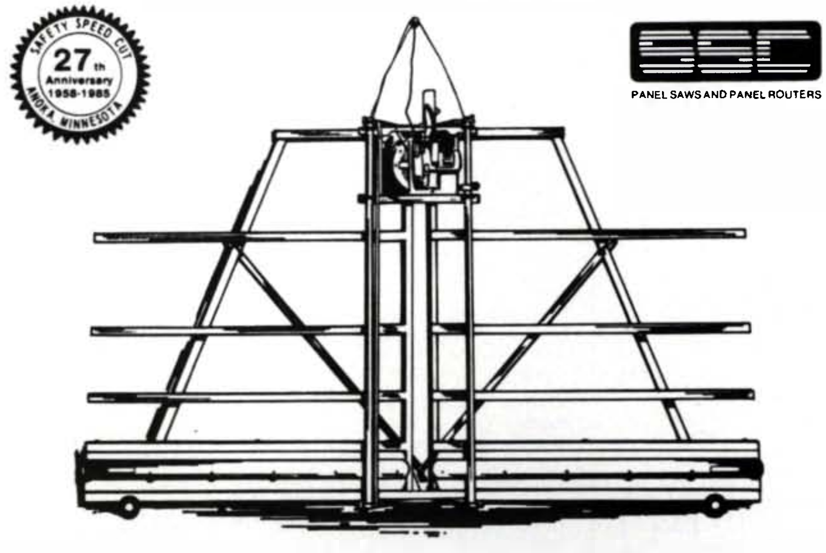

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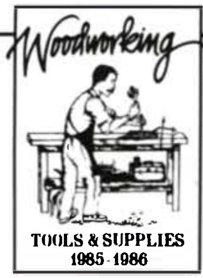

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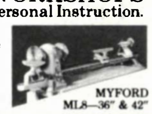

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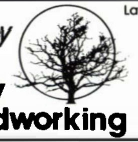

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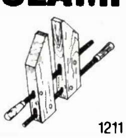

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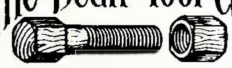

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Listings are free, but restricted to happenings of direct interest to woodworkers. Our May/June issue will list events between Apr. 15 and July 15; deadline Mar. 1. Our July/Aug. issue will list events between June 15 and Sept. 15; deadline May 1.

CALIFORNIA: **Workshops/classes/lecture**—Beginner and intermediate woodworkers. Liam O'Neil, woodturner, Mar. 4–6. Rosewood Tool Supply, 1836 Fourth St., Berkeley, 94710. (415) 540-6247.
Workshops—Woodworking for women, beginners and advanced, traditional furnituremaking, focus on handtools. Contact Debey Zito, 103 Wool St., San Francisco, 94110. (415) 648-6861.
Show—Machinery, tools, supplies, Feb. 28–Mar. 2. Pasadena Center "Exhibition Center," 300 East Green St., Pasadena. Contact The Woodworking Show, 1516 South Pontius Ave., Los Angeles 90025. (213) 477-8521.
Auction—Antique tool, Jack Bittner, Mar. 1. U.A.W. Hall, 2244 San Diego Ave., San Diego.
Class—Building Chamberlin dory-skiff, Simon Watts, Mar. 14–22, Apr. 4–12. National Maritime Museum Ass'n., 680 Beach St., San Francisco, 94109. (415) 673-0700.
Show—Wood Carving, Woodline-East Bay Woodcrafters 5th annual, Mar. 1–2. Woodline, The Japan Woodworker, 1731 Clement Ave., Alameda. Contact Dick Compton, 4351 Whittle Ave., Oakland 94602. (415) 531-6455 or Woodline, (415) 521-1810.

CONNECTICUT: **Show**—Wood vessels by Peter Petrochko, Merryll Saylan, Mar. 5–Apr. 5. The Elements Gallery, 14 Liberty Way, Greenwich, 06830. (203) 661-0014.
Workshops/exhibition—Numerous classes, through June 1. American woodturners, through Mar. 30. Brookfield Craft Center, Inc., PO Box 122, Brookfield, 06804. (203) 775-4526.
Juried exhibtion—29th Annual Crafts, sponsored by Guilford Handcrafts, Inc., July 17–19. Entry deadline Feb. 21. Contact 29th Annual Guilford Handcrafts Expo, PO Box 221, 411 Church St., Guilford 06437. (203) 453-5947.
Juried show—10th annual SONO arts celebration, Aug. 2–3. Entry deadline June 15. Contact Paula Mae Green, SONO Arts Celebration, PO Box 2222, Norwalk 06852. (203) 853-6155.

COLORADO: **Juried exhibition**—Sanctify Through Beauty, Apr. 13–June 20. Mizel Museum of Judaica, 560 South Monaco Parkway, Denver 80224. (303) 333-4156.

DISTRICT OF COLUMBIA: **Juried exhibition**—1986 Washington Craft Show, Apr. 18–20. Department-al Auditorium, 1301 Constitution Ave. NW, Washington. (202) 357-4000.
Symposium—Living with Wood, Apr. 19. Speakers: Paul Bertorelli, Wendell Castle, David Ellsworth. Carmichael Auditorium National Museum of American History, Constitution Ave. at 13th St. NW., Washington. Contact Judith Coady (202) 686-5262.
Exhibition—Masterpieces of Time: Clocks by Wendell Castle, through May 4. Renwick Gallery, National Museum of American Art, Smithsonian Institution, Pennsylvania Ave. at 17th St. NW, Washington.

FLORIDA: **Juried show**—Boynton's G.A.L.A., Feb. 28–Mar. 2. Civic Center Grounds, 128 East Ocean Ave., Boynton Beach. Contact Eleanor Wollenweber, PO Box 232, Boynton Beach, 33425-0232.

GEORGIA: **Show**—Machinery, tools, supplies, Apr. 4–6. Atlanta Civic Center "South Exhibit Hall", 395 Piedmont Ave., NE, Atlanta. Contact The Woodworking Show, 1516 South Pontius Ave., Los Angeles, Calif. 90025. (213) 477-8521.

HAWAII: **Lectures/workshops/exhibition**—13th annual Aha Hana Lima, greenwood turning hollow vessels with bent tools, David Ellsworth, Mar. 27–29. Honolulu Academy of Art, 900 South Beretaniai St., Honolulu. Contact Bob McWilliams, 899 Waimanu St., Honolulu 96813. (808) 538-7881.

IDAHO: **Classes**—Traditional woodworking and furnituremaking, through Mar. 13. Sun Valley Center for the Arts, PO Box 656, Sun Valley, 83353. (208) 622-9371.

ILLINOIS: **Seminars**—Table saw, routers, finishing, May 12–17. Woodworking Lab, Still Hall 103, Northern Illinois University, DeKalb, 60115. (815) 753-1457.
Juried exhibition—7th annual Fountain Square Arts Festival, June 28–29. Outdoor show. Entry deadline Apr. 11. Contact Evanston Chamber of Commerce, 807 Davis St., Evanston, 60201. (312) 328-1500.
Class—Wood: A Cabinetmaker's Perspective, 6 sessions, Dudley Greeley, Feb. 19–Mar. 26. Field Museum of Natural History, Roosevelt Rd. at Lake Shore Dr., Chicago, 60605. (312) 322-8855.
Workshops/demonstrations—Tools, carving, finishing, techniques, through Apr. 26. The Hardwood Connection, 420 Oak St., DeKalb 60115. (815) 758-6009.

INDIANA: **Juried show**—Wood furniture, modern, classic, traditional, Sept. 1–Oct. 12. Entry deadline May 15. Chesterton Art Gallery, 115 South 4th St., Chesterton. Contact Marsha Demkovich, Chesterton Art Gallery, PO Box 783, Chesterton 46304. (219) 926-3041.

KANSAS: **Juried exhibition**—Topeka crafts competition 10, Apr. 6–May 4. Entry deadline Mar. 9. Gallery of Fine Arts Topeka Public Library, 1515 W. 10th, Topeka 66604. (913) 233-2040.
Juried show—2nd annual Lenexa, 3-dimensional art, May 2–4. Sar-Ko-Par Park (87th St. Pkwy at Lackman Rd.), Lenexa. Contact William H. Nicks, Jr., Show Director, City of Lenexa, PO Box 14888, 12350 West 87th St. Pkwy, Lenexa, 66215.

KENTUCKY: **Show**—Sponsored by High Country Craftes, Inc., May 9–11. Heritage Hall, Lexington Center, Lexington. Contact High Country Crafters, 29 Haywood St., Asheville, N.C. 28801. (704) 254-0070.
Juried exhibition—Kentucky Guild of Artists and Craftsman's 25th anniversary, July 25–27. Entry deadline Mar. 15. Water Tower, Louisville. Contact KGAC 25th Anniversary, Water Tower Art Assoc., 3005 Upper River Rd., Louisville 40207. (502) 896-2146.

LOUISIANA: **Workshops**—12th Annual, Louisiana Crafts Council, wood with Bob Trotman, Feb. 15–16. Nicholls State University, Thibodaux. Contact Louisiana Crafts Council, 720 Terrace Ave., Reddy Cultural Center, Baton Rouge, 70802. (504) 381-9562.

MAINE: **Workshops**—Summer session, beginners, intermediate, advanced. Application deadline Apr. 15. Haystack Mountain School of Crafts, Deer Isle 04627. (207) 348-6946.
Exhibition—Decorative arts, Feb. 20–Mar. 29. Maple Hill Gallery, 367 Fore St., Portland 04101. (207) 775-3822.
Workshops—Woodworking for high school students, summer sessions. Horizons: The New England Craft Program, 374 Old Montague Rd., North Amherst 01002. Contact Jane Sinauer, (413) 549-4841.

MARYLAND: **Juried exhibition**—12th Anniversary Maryland Crafts Council, through Feb. 28. Courtyard Galleries, Baltimore City Hall, Baltimore. $1,000 in awards. Contact Nancy Press, Maryland Crafts Council Biennial, 6206 Lincoln Ave., Baltimore, 21209. (301) 358-7743.
Exhibition—Artscape '86, juried, outdoor, July 18-20. Mid-Atlantic states. Entry deadline Mar. 31. SASE to Crafts, Artscape '86, c/o MACAC, 21 S. Eutaw St., Baltimore, 21201. (301) 396-4575.
Juried exhibitions—20th anniversary Maryland Crafts Council, two simultaneous shows, through Feb 28. Courtyard Galleries, Baltimore City Hall, 100 North Holliday St., Baltimore. Contact Nancy Press, (301) 358-7743.
Juried shows—11th annual spring arts and crafts, Apr. 18–20. Montgomery County Fairgrounds, Montgomery. 9th annual spring crafts festival, May 2–4. Maryland State Fairgrounds. Contact Deann Verdier, Sugarloaf Mountain Works, Inc., Ijamsville, 21754. (301) 831-9191.

MASSACHUSETTS: **Workshops/seminars**—Numerous events. Contact The Woodworkers' Store, 2154 Massachusetts Ave., Cambridge. (617) 497-1136.
Exhibitions—The Human Touch, sculpture, Mar. 10–Apr. 30; students work Professional Craft Studies Program, May 10–20; 16th Annual Worcester Craft Center's, May 16–18. Contact Ann Rogol, Worcester Craft Center, 25 Sagamore Road, Worcester, 01605. (617) 753-8183.
Exhibition—Handmade furniture, Rosanne Somerson, through Mar. 22. The Society of Arts and Crafts, 175 Newbury St., Boston 02116. (617) 266-1810.
Exhibition—Furniture by Kopf, Stayman, Madsen, Faner, Volz, Mar. 2–29. Ten Arrow Gallery, 10 Arrow St., Cambridge 02138. (617) 876-1117.

MICHIGAN: **Show**—6th annual woodcarving, Metro Carvers of Michigan, Apr. 5–6. United Food and Commercial Workers' Hall, 876 Horace Brown Dr., Madison Heights. Contact Metro Carvers, 2619 Aberdovey, Royal Oak 48073.

MINNESOTA: **Workshops/seminars**—Numerous events. The Woodworkers' Store, 3025 Lyndale Ave. S., Minneapolis. (612) 822-3338.
Show—Annual Minnesota Woodcarver's Association, Mar. 15–16. Northtown Mall, University Ave. NE and Hwy 10, Minneapolis 55434.

NEW HAMPSHIRE: **Workshop**—13th annual violin and bow maker's summer institute, Univ. of New Hampshire, Durham. Early registration advised. Contact Summer Violin Institute, Univ. of N.H. Continuing Education, 24 Rosemary Ln., Durham 03824. (603) 862-1088.

NEW JERSEY: **Juried show**—Super Crafts Star, Mar. 21–22. Meadowlands Stadium Club, Giants Stadium. Contact Creative Faires, Ltd., PO Box 1688, Westhampton Beach, N.Y. 11978. (516) 325-1331.
Seminar—Lathe and woodturning, Palmer Sharpless, Apr. 26. Brookdale Community College, Newman Springs Rd., Lincroft 07738. Contact Dr. Gabriel Longo, (201) 842-1900 Ext.586.

NEW YORK: **Juried exhibition**—10th Anniversary American Crafts, June 28–29 and July 5–6. Lincoln Center for the Performing Arts, NYC Contact Brenda Brigham, American Concern for Artistry and Craftsmanship, PO Box 650, Montclair, NJ 07030. (201) 798-0220.
Juried show—2nd annual spring fling crafts festival, May 2–4. Nassau Coliseum, Uniondale, L.I. Contact Creative Faires, Ltd., PO Box 1688, Westhampton Beach, N.Y. 11978. (516) 325-1331.
Juried exhibition—33rd annual national, sponsored by Mamaroneck Artists Guild, Oct. 24–Nov. 9. Community Unitarian Church, Rosedale Ave., White Plains. Entry deadline Apr. 21. Contact Open Juried Exhibition, Mamaroneck Artists Guild Gallery, 150 Larchmont Ave., Larchmont 10538.
Workshops—Numerous classes through June. The Luthierie, 2449 West Saugerties Rd., Saugerties 12477. (914)246-5207.
Juried exhibition—9th annual Great Hudson River Revival, June 21–22. Entry deadline Feb. 28. Croton Point Park, Croton-on-Hudson. Contact Clearwater's Great Hudson River Revival Crafts Committee, c/o Joan Silberberg, RFD 2, Pudding St., Carmel 10512.
Juried shows—Furniture, architectural crafts, May 24–26; Aug. 30–Sept. 1. Ulster County Fairgrounds, New Paltz. Entry deadlines Mar. 1. Contact Scott and Neil Rubinstein, Quail Hollow Events, PO Box 825, Woodstock 12498. (914) 679-8087 or (914) 246-3414.

NORTH CAROLINA: **Show**—Woodcarving, sponsored by Charlotte Parks and Recreation and Woodcarving Club, Mar. 1–2. Park Center 310 North Kings Drive, Charlotte 28204. (704) 336-2584.

OHIO: **Show**—Woodworking World, sponsored by Woodworking Association of North America, Feb. 14–16. Veterans Memorial Hall, Columbus. Contact W.A.N.A., PO Box 706, Plymouth, N.H. 03264. (603) 536-3876.
Seminars—Reproducing early American furniture, Thomas Stender, Mar. 15–16; classical English woodworking skills, Kenny Bowers, Apr. 12–13; woodbending techniques, William Keyser, May 17–18. Center for Wood Design and Craftsmanship, University of Akron, 150 East Exchange Street, Akron 44325. (216) 375-7575.
Seminars/demonstrations—Inca Machinery owners, Feb. 26–27. Restoration, finishing techniques, veneering table furniture, and more, Mar. 8, 15, 22, 29, Apr. 5. Renaissance Wood and Tool Co., 1313 Old River Rd., Cleveland 44113.

OREGON: **Show**—Machinery, tools, supplies, Mar. 14–16. Multnomah County Exposition Center "South Hall," 2060 N. Marine Dr., Portland. Contact The Woodworking Show, 1516 South Pontius Ave., Los Angeles, Calif. 90025. (213) 477-8521.
Workshop—Bentwood woodworking, Seth Stem, July 7–11. Register early. Oregon School of Arts and Crafts, 8245 SW Barnes Rd., Portland 97225. (503) 297-5544.

PENNSYLVANIA: **Exhibition**—Wharton Esherick, sculpture, furniture, utensils, daily. The Wharton Esherick Museum, PO Box 595, Paoli, 19301. (215) 644-5822.
Workshops—Traditional joinery, handtools, with Jasper Brinton, Bob Harrington, Michael Burgoon, through Apr. 10. Brinton Studio, Western Rd., RD 2, Phoenixville, 19460. (215) 935-2851.
Juried show—8th Annual Longs Park Art and Craft Festival, Aug. 30–Sept. 1. Entry deadline Feb. 15. Contact Dick Faulkner, Longs Park Art and Craft Festival, PO Box 5153, Lancaster, 17601.
Juried exhibition—Market House '86, 5th annual, sponsored by Conestoga Valley Chapter, Penn. Guild of Craftsmen, May 4–25. Entry deadline Mar. 1. Market House Craft Center, Queen and Vine Sts., Lancaster, 17604. (717) 295-1500.
Juried show—4th Annual Pennsylvania National Arts and Crafts, early American and contemporary designs, Mar. 28–30. Penn. State Farm Show Complex, Harrisburg. Contact Pennsylvania National Arts and Crafts Show, PO Box 11469, Harrisburg, 17108-1469. (717) 763-1254.

Juried exhibition—20th annual sidewalk sale Central Pennsylvania Festival of the Arts., July 10–13. Entry deadline Mar. 14. Campus of Penn State, State College. Contact Central Pennsylvania Festival of the Arts, P.O. Box 1023, State College 16804. (814) 237-3682.
Show—14th annual volunteers antiques, May 23–26. Brandywine River Museum, Brandywine Conservancy, PO Box 141, Chadds Ford 19317. (215) 388-7601.
Workshop—30th annual one-week hardwood lumber grading and inspection, Feb. 24–28. Penn. State University, University Park. Contact Agricultural Conference Coordinator, 410 J. O. Keller Conference Center, University Park 16802. (814) 865-9547.
Symposium—"Something New," woodturning with Ellsworth, O'Neil, Sharpless, Mar. 7–8. Bucks County Community College, Newtown. Contact Jon Alley, (215) 968-6417/8431.
Seminars—Decorative furniture carving, Mar. 22; Inca power tools, Apr. 4–5; woodfinishing, George Frank, May 9–11; cabinetmaking, Will Tillman, June 21. Olde Mill Cabinet Shoppe, Box 547A, RD#3, York 17402. (717) 755-8884.

TENNESSEE: **Workshops**—Spring program, designing furniture, veneering, marquetry, woodturning and more, Mar. 10–28. Contact Arrowmont School of Arts and Crafts, PO Box 567, Gatlinburg 37738. (615) 436-5860.
Classes—Designing contemporary furniture, Stephen Crump, Mar. 10–14; veneering, marquetry, inlay, Silas Kopf, Mar. 17–21; woodturning, functional and artistic, Liam O'Neil, Mar. 24–28. Arrowmont School of Arts and Crafts, PO Box 567, Gatlinburg 37738. (615) 436-5860.
Juried shows—Dogwood Arts Festival, Apr. 11–13. West Town Mall, Knoxville. Festival's Master Cabinetmaker, Apr. 18–20. East Town Mall, Knoxville. Contact Dogwood Arts Festival Office, 203 Fort Hill Building, Knoxville 37915. (615) 637-4561

TEXAS: **Juried exhibition**—1986 Houston Festival, Apr. 3–13. Streets and parks downtown Houston. Contact Barbara Metyko, Crafts and Arts Manager, The Houston Festival, 1964 W. Gray, Suite 227, Houston 77019. (713) 521-0993.
Exhibition—19th Annual Winedale Spring Festival and 11th Texas Crafts, Apr. 5–6. Early entry is advised. The University of Texas Winedale Historical Center, P.O. Box 11, Round Top, 78954-0111. (409) 278-3530.

VIRGINIA: **Exhibition**—11th Annual Mid-Atlantic Wildfowl, sponsored by Back Bay Wildfowl Guild, Mar. 7–9. Virginia Beach Pavilion, Virginia Beach. Contact Archie Johnson, PO Box 1086, Virgina Beach, 23451. (804) 425-1530.
Show/seminar—Woodworking World - Washington D.C., Feb. 28–Mar. 2. French polishing, George Frank, Mar. 1. Hyatt Regency Crystal City, Route #1, Arlington. Contact W.A.N.A., PO Box 706, Plymouth, N.H. 03264. (603) 536-3876.

WASHINGTON: **Workshops**—Flat-bottomed skiff, Mar. 15–16; tools, Apr. 19. Northwest School of Wooden Boatbuilding, 251 Otto St., Port Townsend 98368. (206) 385-4948.
Seminars/workshops—Lofting, Simon Watts, Feb. 20; lapstrake, Watts, Feb. 22–Mar. 1; metallurgy, Paul Ford, Mar. 8; lapstrake, Eric Hvalsoe, Mar. 9–14; boat auction/sale, Mar. 23; casting, Ford, Mar. 29 and Apr. 5; advanced lofting, Hvalsoe, Apr. 6–12. Center for Wooden Boats, 1010 Valley St., Seattle 98109. (206) 382-2628.

WEST VIRGINIA: **Juried exhibition**—Mid-Atlantic woodworking, functional, sculptural, Jun. 22–Aug. 24. Entry deadline Apr. 1. Oglebay Institute, Stifel Fine Arts Center, 1330 National Rd., Wheeling 26003. (302) 242-7700.
Workshops—Designing for wood production, Mark Sfirri, Mar. 3–7; Windsor stoolmaking, Randall Fields, Mar. 24–28. Crafts Center, Cedar Lakes, Ripley 25271. (304) 372-6263.

ONTARIO: **Exhibition**—Mixed media including carvings, Daniel Griffith, Mar. 1–31. Heritage Crafts, Sheridan Mews, 184-186 King St. West, Brockville.

AUSTRALIA: **Seminar**—2nd international woodturning, Brisbane, June 7–9. Contact John Anderson, 14 Bilsand St., Taragindi 4121, Queensland.

ENGLAND: **Exhibition**—Willow baskets, David Drew, through Mar. 30. Crafts Council Gallery, 12 Waterloo Place, London SW1Y 4AU. 01-930-4811.
Exhibition—Alan Peters: Furniture Maker, Feb. 20–Apr. 6. Crafts Study Centre, Holburne Museum, Great Pulteney St., Bath.

Alan Peters was taught the twisted dovetail some years ago by a Japanese furniture maker. His exhibition 'Alan Peters: Furniture Maker,' now showing in Bath, England, provided the opportunity to use it for this occasional table. The show looks at Peters' work of the past ten years.

Japanese Cabinetmaking: A Dynamic System of Decisions and Interactions in a Technical Context, by Carol A. B. Link. *University Microfilms, P.O. Box 1764, Ann Arbor, Mich. 48106; 1975. $25.50 for university students and faculty, $37.00 for others, paperback; 269 pp.*

Anyone whose approach to cabinetmaking is a continuing search for optimum strength and beauty of result will want to look this book over carefully, at leisure. It contains the clearest description I have yet read of the classical Japanese approach to cabinetmaking, and holds the most explicit written instruction now available to us on their use of their traditional hand tools. The book is couched in plain workman's terms everywhere but in the author's academic argument, which, read in shorter takes, can equally strengthen any craftsman's approach to the logic of his or her own work. In sum, it may be a generation before we again see anything as fine on this subject, crafted expressly for the American eye and mind.

In the early 1970s, Link, then an anthropology student at the University of Illinois, became interested in Japanese woodworking as an example of the relation of technology to culture. This book is her doctoral thesis. It is the first such item I have knowingly *and* willingly read. Link's sense of what scholarship ought to be sent her to Toyko in 1972, where she improved her fluency in spoken Japanese, and hunted hard for the finest makers of furniture in Japan's classical tradition. In that highly-structured society, this could not have been simple for a lone woman with roots in middle America. She must have endured weeks of discouragement, whatever her local sponsorship.

In time she discovered, apprenticed herself to, and lived for almost a year with the family of Yusaku Tsuzuki. Then age 74, Tsuzuki had lived in the same place for over 50 years, and had practiced his art for 62 years. Tsuzuki's peers consider him a *bijutsu-sashimono-shi*. "The whole term," Link explains, "can be translated as a joiner, [one] whose level of skill is so perfected that the cabinets produced are considered to be works of fine art just like paintings or sculpture. At the present time, there are only four or five *bijutsu-sashimono-shi* in the whole Kanto plain, and they are all older men ranging in age from 68 to 96." Tsuzuki's sole apprentice, still working with his master, was his son, Yukio.

At the heart of book and author is *michi*. "On a broad level," Link writes, "*michi* means the path that a person takes through life. Each person has their own *michi*. Some choose their own. *Ojiisan* [Link refers to Tsuzuki with the Japanese for grandfather] had his chosen for him. The life and work of a *sashimono-shi* has become his *michi*. He not only works as a *sashimono-shi* but he *is* a *sashimono-shi*. He has gained knowledge of himself and harmony with the world in the same way a Zen monk gains knowledge and enlightenment by the Zen *michi*. He is a happy man . . . ."

Dr. Link is a most human scholar. In a situation permitting her to write from books, she chose to write from lived experience; in a format that does not forbid deadly amounts of jargon, she chose plain English. In a discipline (anthropology) allowing her to inspect the human condition with a clinical knife, scraping old bones, her entire thesis is warmed by her respect and affection for *ojiisan* and the Tsuzuki family, and lighted by their practice of a great and ancient tradition of work.

After a year in which she clearly came to love the people, work and place, she has to go away and make sense of classical Japanese cabinetmaking for a required number of midwestern American professors. I once had to convince a frightening number of lawyers that I understood the cause of a fatal fire, one that seriously smoked a large building occupied by many holders of old, cold cash. In founding her thesis, Link did what I should have done then: she filled both hands with as many nodding lion beards as she could reach, and yanked firmly. Her review of precedent literature put daylight on a surprising number of toothless jaws in anthropology, in the sense that much of what seemed to be meaty discussion was, on close inspection, little more than a rustling of dry descriptive lists of artifacts.

Granting that many tools define their use on sight, and that many imply their technological origin (i.e., the hand can create certain things only in certain ways), describing a tool as artifact cannot honestly describe the rational acts that made it, nor the sets of procedures informing its user, nor the cultural matrix in which it evolved to present form and use. A good list can also be a thing of beauty, but to claim that a list describes a people and their way of life and work is dismal scholarship, lacking insight.

Link does not live by lists, and does not make unsupported claims; she makes sense of the unseeable; the relationship of men and women to their work and material, the true dialogue of the productive life. And, she does this in a way that will aid and ease the work of any receptive Western cabinetmaker.

As for technical discussion, Link takes her reader from rough stock through glue-up and trimming-to-size of the smoothed planks needed for a *Mittsu-shiki Temoto Bako* (3-drawer handy chest), of which *ojiisan* says, "If you can make this cabinet, you can make anything." At this point she stops: she has proved, step by step, and in painstaking detail, the academic argument demanding this foundation.

She does not joint, assemble or finish the case. Her reasons will be plain after your first glimpse of the astonishing quantity of instructive detail she provides. By the time she is done, a reader practiced in Western woodworking motor skills should be able to effectively (remember, I didn't say perfectly—perfect comes with practice) use *dai* and *koguchi dai* (bench and miter bench), *nokogiri* (saws), *natta* (chopper), *keshiki* (scribing gauge), *kanna* (planes), not forgetting *hata* and *himo* (clamps and cord).

Along the way, she describes—*precisely* describes—every single pertinent position and use of body, leg, foot, arm and hand required by *ojiisan's* 62 years of experience for the ideal performance of his art.

Link's long chapter of technical description is flawed only in its description of plane-sole preparation (due, I think, to the hazards of transliterating spoken Japanese into written English). Short of sitting ten years with *ojiisan* himself, I do not know how American readers can find a more explicit handbook for their practice with these tools. A master informs every page, and after a second reading, I'm still persuaded that only the mega-meanings of Japanese syllables kept this from being a piece of perfection.

Summing up, Link's scholarly purpose required that she examine a strictly technical behavior in context of its ecology and ethology (scientific study of behavior in relation to habitat). Try joining, without dowels, using only rubbed joints, three warped and wound oak boards into one seamless plank. You'll begin to see the task she set for herself, in a place she could assimilate only by use of an exotically different language rooted in yet a third culture, ancient Chinese. Link gave the Devil odds, and drew aces; the result made sense to her professors, and will surely make sense to readers of *FWW*.

The book is expensive. The author's sketches are fine, but the photos are a disgrace in a time when any document can be clearly copied. But, as you've noticed, this didn't stop my falling in love with an 8-*jo* (straw mat) shop, a wholly different way of life and work, and the entire Tsuzuki family. Live forever, *Ojii-sama*. May your tribe increase. —***John Willey***

John Willey works wood in Mt. Vernon, Maine.

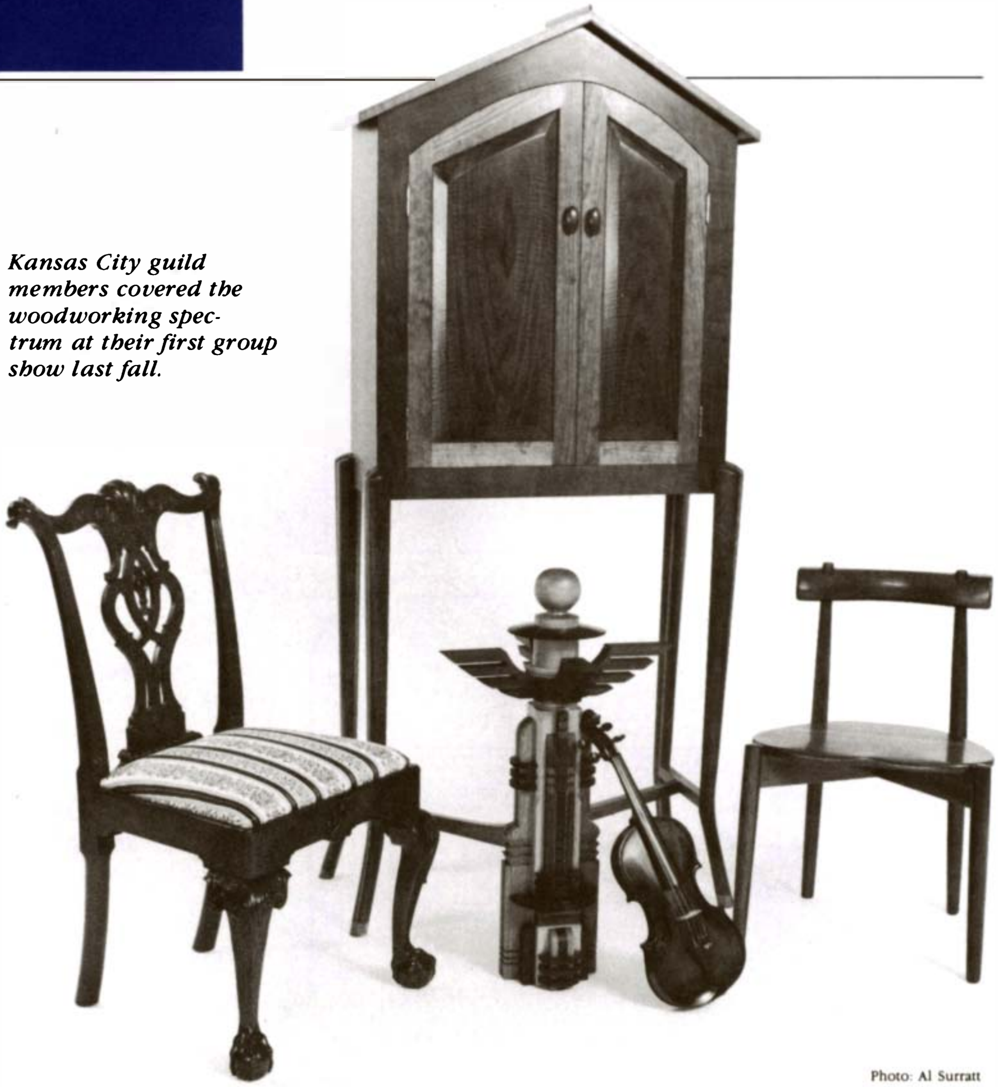
Up to date in Kansas City

In little more than a year since its founding, the Kansas City Woodworkers Guild has grown to a robust group of 105 enthusiastic members. To celebrate its first anniversary and to strut its stuff for the public, the Guild staged its first exhibition last November.

According to exhibition organizer Nancy Lindquist, the response from the members and the public alike was heartening. Thirty-three members submitted 97 pieces to the non-juried show. Two local woodworking suppliers, Paxton Lumber and Tropical Hardwoods, donated funds, and the Design Exchange, providers of a smorgasbord of product showrooms for the design trade, kicked in their mailing list and 3500 sq. ft. of downtown exhibition space at bargain rates. The three-day show drew over 750 people and a good deal of media coverage.

A handsome poster, featuring the photo at right, demonstrated the Guild's range. Clock-wise from left are Gary Derzinski's Chippendale side chair, Michael Bauermeister's tall cabinet and Clarence Teed's side chair. Rounding out the portrait, Wayne Trainor's violin leans against Michael Schembs' sculpture, "Night Light."

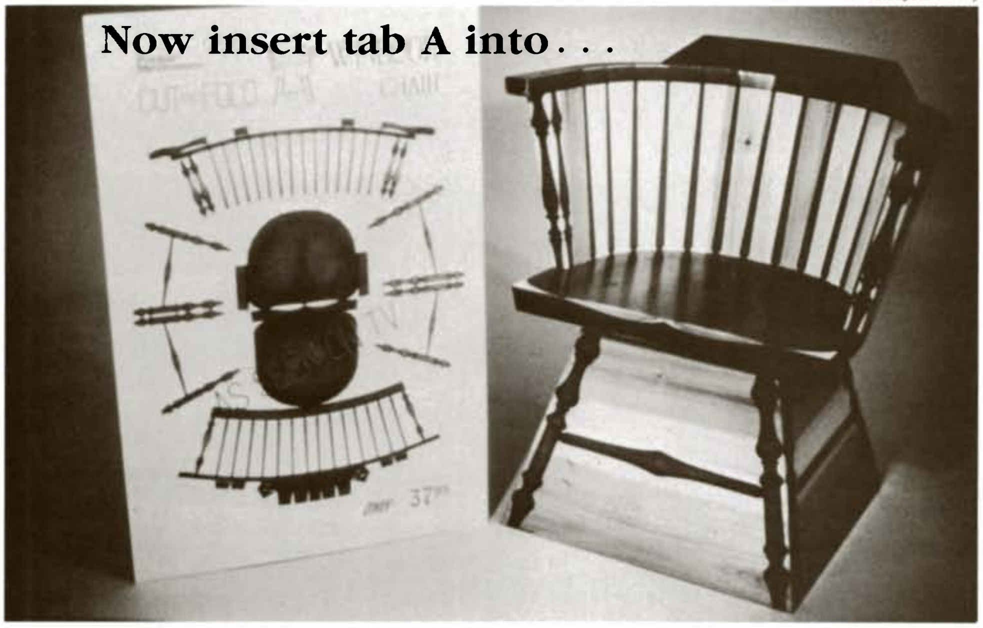
—Roger Holmes



Kansas City guild members covered the woodworking spectrum at their first group show last fall.

Photo: Al Surratt

Photo: John Casey



Tired of traditional joinery? John Casey's 'Cut and Fold Windsor,' shown above, may be the answer. In fact, Casey, who works in Kent, Ohio, airbrushed the tab-A into slot-A cardboard look onto rather sturdier poplar. The chair shared best of show honors at the 'Crafts: National' competition last fall at Buffalo State College, Buffalo, N.Y.

Product review

The Phoenix Clock, *Kassner Woodcraft Inc., P.O. Box 1878, Tuscaloosa, Ala. 35403; $450.*

Building the wooden clock movement described by Wayne Westphale on page 58 is hardly a project to be casually undertaken. If the thing is going to run as nicely as it looks, you can expect to invest many hours of fitting and fiddling. Patient work will be rewarded with a fascinating mechanical sculpture that keeps remarkably accurate time.

If the sculpture appeals but not the work, or at least not so much of it, a first-rate kit is available. It's made by Jim Kassner, a college professor who first turned to making wooden clocks as a hobby seven years ago, later developing his kit commercially. At $450, Kassner's clock is not so cheap that you would buy it on a lark, but neither does it require the commitment of building from scratch. The kits are sold in two models, a grandfather and a slightly smaller grandmother. The parts are made of maple dieboard, a special type of plywood that is stable and more attractive to finish than the Baltic birch plywood used in some imported kits. Each kit contains all the precisely milled wheels and pinions, arbors, pulleys, and finishing materials needed for one clock. Builders are left to devise their own cases, but with adapter bases supplied by Kassner, the clocks can be installed in case kits from Emperor Clock Co. and Westwood Clocks N' Kits.

When I visited Kassner last summer, he was preparing to move his clockmaking operations from Rolla, Mo., where he had been teaching college, to Alabama, where he will merge his clock business with a family furniture manufacturing firm. He took time out from packing to

Jim Kassner's Phoenix clock kit (left) is milled largely on the $40,000 computer-controlled router shown above.

Conference call

The American Craft Council will hold a national conference, their first since 1977, at the Oakland Museum in Oakland, Calif., June 4th through June 7th, 1986. The conference theme will be Art/Culture/Future and, as the theme implies, the program will focus on the role of crafts and the craftsperson in the realm of museums, galleries and the fine arts.

The ACC is soliciting papers on new ideas, technical breakthroughs and critical assessments of movements or trends in the crafts, for presentation at the conference. Submission deadline is March 15; for information send a SASE to Richard Carp, ACC Forum Program Chair, California College of Arts and Crafts, 5212 Broadway, Oakland, Calif. 94618.

show me how the kit parts are made. In principle, Kassner's methods are not that different from Westphale's; they're just more jigs-intensive. Before going into production, Kassner labored over dozens of specialized fixtures, practically one for each clock part. Gears are milled in multiples on a Bridgeport milling machine. The clock's sculptural framework presented a trickier problem. Its shape is suitable for pin-routing, but Kassner found the method too slow so he bought a CNC router, an enormous beast of a machine that squats in the middle of his shop. It's a computer-programmable router with four bits, each capable of a separate operation.

To demonstrate it, Kassner bolted two roughly bandsawn blanks to the CNC's sliding table, popped a program cassette into the machine's brain and punched the start button. The routers whirred to life, smoothly routing the outside profile of the clock frame in about a minute. Then the table slid on its tracks so the second pair of routers could work the inside profiles. It made pin-routing seem positively Stone Age by comparison.

I didn't build a Kassner clock, but his attention to precision ought to pay off for those who do. He's taken one other giant step to ensure success: an excellent instruction booklet. The 76-page manual is crammed with detailed drawings and in-process photos seasoned by enough horological theory to make for an interesting—and relatively painless—route to owning a wooden movement. —*Paul Bertorelli*

Furniture library

If you can count the furniture books in your local library on one hand, don't fret. Just hop a plane to High Point, N.C., and do your research at The Furniture Library instead. There, you'll find nearly 7,000 books on furniture or a related subject.

The Furniture Library houses the collection of Nathan Bienenstock, one-time publisher of the trade magazine, *Furniture World,* who started collecting furniture books back in the 1920s. Bienenstock, now in his 80s, is still the library's curator. Today his collection includes books on every imaginable furniture style, as well as such rarities as original editions of the complete works of Thomas Chippendale and George Hepplewhite.

The library is open to the public Monday through Friday, but it's a good idea to call first. All research must be done on the premises—books can't be taken out. The library also sells some furniture books. For a mail-order catalog, write to The Furniture Library, 1009 N. Main St., High Point, N.C. 27262. —*David Sloan*

Photo: Tim Matson

Don Lawrence fires up his Wood Mizer portable band mill. Rather than moving the log past a stationary blade, the Mizer moves motor and blade through the log.

One sawmill, to go

In the hills, timing is everything. April Fools' had come and gone, and the heap of spruce timbers still lay spread across the vegetable garden. Steady rain had been pelting the country for a week. Damn it, I thought, if I don't get those winter logs off the garden soon I'll be buying the year's food, not growing it. Unfortunately, the driveway was stuck in the middle of mud season, nowhere near ready to support a 14-wheel logging truck. Besides that, the timber didn't add up to half a truckload. It wouldn't be worth hiring a truck, mud or no mud.

But bad timing can be offset by a good neighbor. In this case it was a logger who lives down the valley. He'd just seen the first portable sawmill in town.

"The kerf's just $\frac{1}{16}$ in. You gain 20% on your lumber right there!"

Not only did the thin bandsaw blade chew up less lumber than the $\frac{1}{4}$-in. circular saw at the local mill, but there wasn't any trucking expense. That night I booked the mill, sight unseen.

A week later a gray van scooted up the driveway, a bright orange two-wheel trailer clattering along behind. Light rain drizzled down half-heartedly as Don Lawrence cut the engine, shouted hello, and jumped down from his seat. The van had no door.

Lawrence, who appeared to be about 50 and in good shape, untied the tarp covering the mill and pulled it aside. The mill resembled a boat trailer, without the boat. An air-cooled 14-HP Kohler engine mounted above the trailer was coupled to the saw blade suspended horizontally over the carriage.

Looking over this lightweight one-man mill, I had a hard time imagining Lawrence turning my timbers into lumber. When I'd phoned I explained that these were bully trees, including a couple of 7-ft. butt logs 30-in. through, and a bunch of 16- and 20-footers, 18-in. at the tapered end.

"No problem," he said. "You should have seen the pine I cut last week. Got 400 feet out of one log."

First we unhooked the mill from the van. I was surprised how easily it lifted. "Just weighs 35 lbs. at the hitch," Lawrence said, and together we pulled the mill halfway across the garden to the bottom of the slope, below the logs. Next, Lawrence dug a hole for the uphill trailer wheel to level the carriage laterally. Adjustments to a series of built-in corner jacks finished the leveling. Finally, he hooked a pair of steel ramps to the side of the bed and the mill was set for sawing.

I'd planned mostly 2x6s for a new barn, but the plan was flexible, which was a good thing, because the mill couldn't handle anything longer than 16 ft. after all. I decided to make the 16-ft. spruce into rafters, and cut the 20-footers into 12s and 8s for studs and loft beams.

With only one peavey between us, rolling the first 12-ft. log up the ramps onto the bed was pure grunt work. What we lacked in equipment, Lawrence made up in brawn. This mill was classified as a one-man saw, and there's no doubt about it; they meant one *man*. Later, hauling in the scattered 16-footers, Lawrence used the winch at the front of the mill.

By now, the rain had fizzled out and a bright morning sun threw a spotlight on the hills. The knotty old spruce lay prone on the mill bed like an etherized patient waiting for the knife. Lawrence leveled

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the log with a pink plastic wedge under the taper, then cinched the log tight with a vise-action binding clamp. He punched a button, the engine coughed and started. Next to the chugging muffler, the name plate caught my eye: *Wood Mizer*.

I watched as Lawrence touched a toggle switch. The sawing unit—engine and blade together—began to trolley backwards toward the butt of the spruce. When it cleared the end of the stump, he touched another switch. The saw began to descend. He stopped it when the blade dropped just below the butt bark. All this time the Kohler engine had been idling, the blade still. A small electric motor powered the sawing unit on a track.

Lawrence eyeballed the log. He yanked a lever, the engine roared, and the saw began to whirl. Again he set the cutting unit in motion, now forward. The saw screeched into the log. Powdery sawdust sprayed out and the saw sliced sideways down the length of the log. Lawrence stopped the blade and disengaged the engine. He pulled a 16-ft. slab off the spruce. Underneath, the fresh cut lumber gleamed white and juicy.

It was my first glimpse of a portable sawmill in action and I understood my neighbor's enthusiasm. This sawmill was doubly mobile. It was a roving mill and the saw itself moved. I'd heard of portable mills before, so cumbersome they needed the equivalent of a logging truck to get around anyway. And a substantial set-up charge and minimum sawing order. Nothing new there. Those mills required a complex drive system to move the log through the blade. On the other hand, reversing the technique—moving the saw rather than the log—is a real breakthrough.

Wielding the peavey, Lawrence flipped the log and sliced off the three remaining slabs. Now the log was roughly square. He squared the log again, this time lopping off four 1-in. boards. On the bed now lay a perfect 12-in. by 14-in. beam, 16 ft. long. Lawrence sawed this down the center and then diced each half into seven 2x6s. It was the most efficient use of timber I'd ever seen. A conventional sawyer would have squared that log in four quick cuts, discarding the 1-in. boards in the slab pile. Not only was the bandsaw's thin blade conserving timber; here was a skilled sawyer making the most of the outside of the log.

While Lawrence sawed I began to stack and sticker the lumber. It wasn't a flawless sawing operation. The blade had a tendency to bob up and down over the knots in the spruce, leaving a wavy surface. This was due, in part, to the pitch in the bark. Lawrence suggested that it would have been smart to saw the lumber in winter, when the bark was frozen, or later when it was bone dry. So we chipped off the bark down the line the saw would follow. This helped prevent the spruce gum from building up on the blade. After the slabs were sliced off, the pitch was no problem.

The second day Lawrence arrived with a newly sharpened set of blades. He'd set the teeth with a slightly wider kerf to get through the tight spruce grain and the knots. Instead of powder, the blade sprayed sawdust with long, thin fibers. The spruce cut perfectly. Lawrence smiled.

"I'm a fussy guy," he said. "I want to cut lumber I'd be proud to use myself."

During the sawing I kept the one-gallon water tank over the blade filled. Lawrence had devised this system to lubricate and cool the blade. Sawmills sometimes use kerosene for this, but Lawrence preferred water; it's cheap and clean. When he told the people at the Wood Mizer plant about his watering device, they incorporated it into the design.

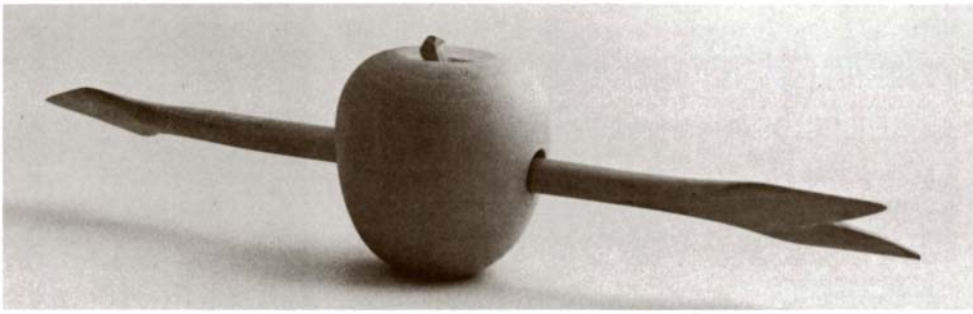
On the last day, I scaled a handsome spruce log before we rolled it up on the bed. It was a 16-footer, 18 in. at the taper. According to my log rule, it would yield 230 bd. ft. When we toted up the boards, I had 290 bd. ft. That's close to a 25% increase over the standard sawmill yield.

I was beginning to see my woodlot with a new eye. No more trucking costs. Better than 20% increase in timber. Getting exactly the sticks and boards you want from each log. A pile of slabs for firewood, kindling, and tomato stakes. Sawdust for animal bedding and blueberry mulch. Pointing to my firewood log pile, Lawrence suggested cutting and stickering some of the ash and oak there, "I'll bet you'd find a cabinetmaker who'd buy it."

It was over after three days of work. I had 2,170 bd. ft. of spruce and balsam, the frame for my new barn, plus a couple of hundred feet of boards. Counting the set-up fee, sawing, and a few hours of jigging around, it averaged out to $.15 a board foot. That's five cents more than they charge at the local mill. But when you figure the savings in trucking—$100 minimum—and the gain in lumber, plus sawdust and slabs, it's a bargain. No wonder a stream of local woodlot owners ran through here while we were sawing, eager to sign up.

"I used to do mostly carpentry," Don Lawrence told me just before he pulled out. "I got this sawmill as a sideline. Now there's no time for anything else." □

Tim Matson, of Thetford Center, Vt., has written A County Planet, *available from Countryman Press, Woodstock, Vt., $9.95. For information on the Wood-Mizer, write Wood-Mizer, Dept. Z10, 8180 W. 10th St., Indianapolis, Ind. 46224.*



Okay, we give up . . .

A while back the brow-wrinkler shown above appeared in our mail bag, sent by Fred Laughon, a retired clergyman and woodworker in Richmond, Va. As you see, it is a wooden arrow in a wooden apple. The arrowhead and feathers are about 1-in. wide, the hole in the apple about ½-in. in diameter. Laughon's wife bought it in Kentucky from a maker who refused to divulge the trick. After a couple years of intermittent torment and fruitless speculation, including an unsuccessful attempt to steam and compress a replica arrowhead, Laughon decided to call for help.

We poked and puzzled, and even brought technology, in the form of a 10X hand lens, to bear—no glue lines in either apple or arrow were revealed. Defeated, we shipped them to the helpful folks at the USDA Forest Products Laboratory in Madison, Wisc. The apple, they tell us, is sycamore, the arrow basswood. They don't know how the two got together, but they've got a few ideas. How about you? Send them to us and we'll publish the most plausible and amusing in a later issue.

Notes and Comment

What's new in woodworking in your area? Notes and Comment buys brief articles about interesting events, shows and people and welcomes all manner of commentary. Send manuscript, if possible with color slides or black-and-white photos (preferably with negatives), to Notes and Comment,* Fine Woodworking, *Box 355, Newtown, Conn. 06470.

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