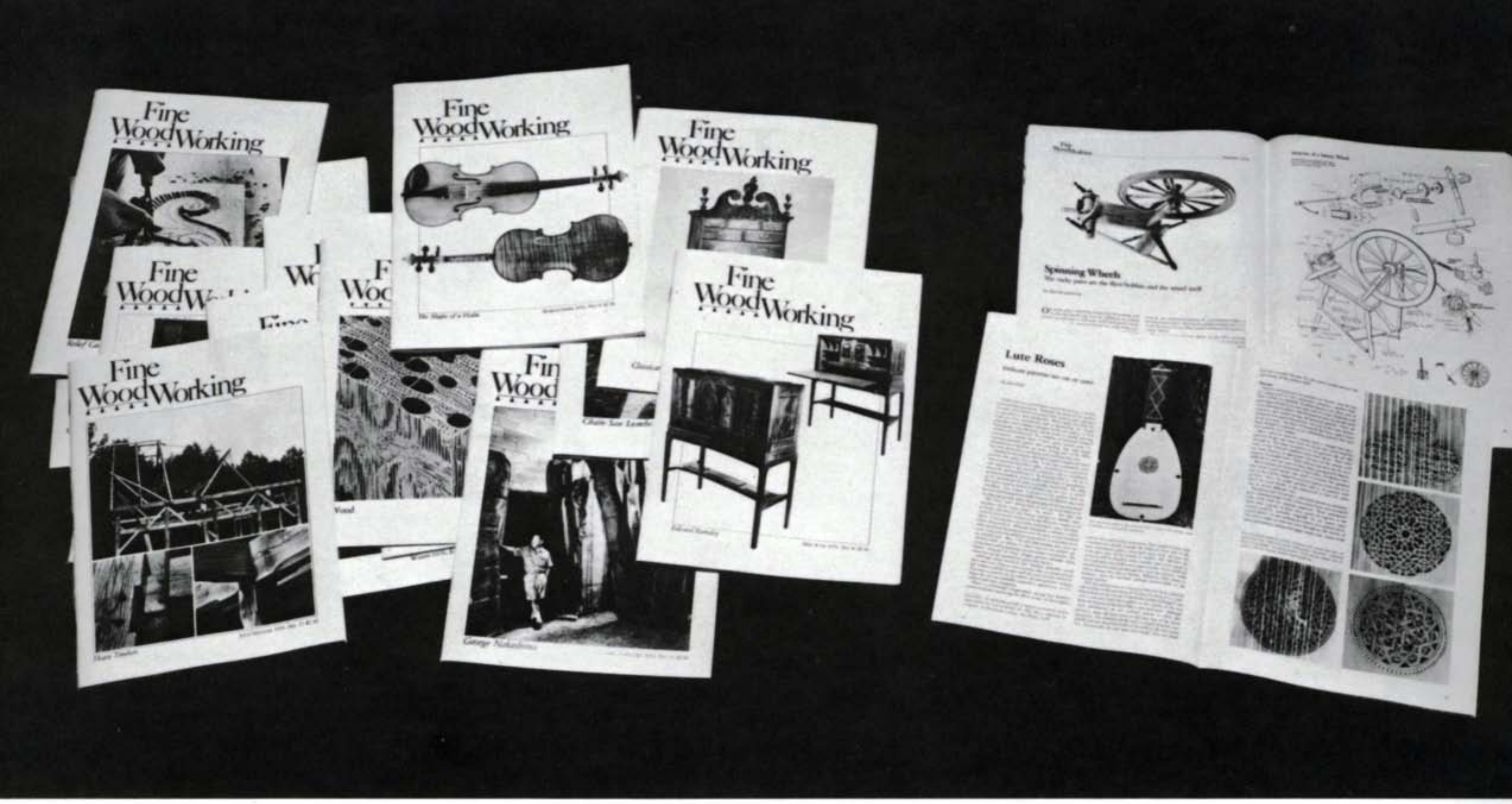
Fine WoodWorking

JANUARY/FEBRUARY 1980, NO. 20 $3.00

Michael Thonet



Find your specialties in these back issues of Fine Woodworking.

Each issue of *Fine Woodworking* takes a detailed look at many aspects of our craft, in effect building a growing reference of woodcraft techniques. And because there's always so much of interest to cover, *Fine Woodworking* never repeats itself. Small wonder one new subscriber in 20 requests the complete set of back issues. Here's valuable information you can't find anywhere else and that doesn't go out of date.

Winter 1975, No. 1—The Renwick Multiples, Checkered Bowls, Tramp Art, Hand Planes, Carving Design, Decisions, Woodworking Thoughts, Marquetry Cutting, Which Three?, Library Ladders, A Serving Tray, Stamp Box, All in One, French Polishing, Birch Plywood, Bench Stones.

Spring 1976, No. 2—Marquetry Today, Split Turnings, Eagle Carvings, Hand Dovetails, Mechanical Desks, Textbook Mistakes, Antique Tools, Spiral Steps, Gustav Stickley, Oil/Varnish Mix, Shaker Lap Desk, Chair Woods, Back to School.

Summer 1976, No. 3—Wood, Mortise and Tenon, The Christian Tradition, Hand Shaping, Yankee Diversity, Plane Speaking, Desert Cabinetry, Hidden Drawers, Green Bowls, Queen Anne, Gate-Leg Table, Turning Conference, Stroke Sander, Furniture Plans.

Fall 1976, No. 4—Cabinetmaker's Notebook, Water and Wood, Hidden Beds, Exotic Woods, Veneer, Tackling Carving, Market Talk, Abstract Sculptures from Found Wood, Workbench, Ornamental Turning, Heat Treating, Mosaic Rosettes, Shaped Tambours, Buckeye Carvings, Hardwood Sources.

Winter 1976, No. 5—Stacking, Design Considerations, Keystone Carvers, Carcase Construction, Dealing With Plywood, Patch-Pad Cutting, Drying Wood, Gothic Tracery, Measured Drawings, Wood Invitational, Guitar Joinery, The Bowl Gouge, English Treen, Shaper Knives.

Spring 1977, No. 6—The Wood Butcher, Wood Threads, The Scraper, California Woodworking, Bent Laminations, Dry Kiln, Expanding Tables, Two Sticks, Stacked Plywood, Two Tools, Pricing Work, Going to Craft Fairs, Colonial Costs, Serving Cart, Woodworking Schools.

Summer 1977, No. 7—Cooperative Shop, Glues and Gluing, Winter Market, Three-Legged Stool, Lute Roses, Bowl Turning, Wharton Esherick, Doweling, Spalted Wood, Antiqued Pine Furniture, Solar Kiln, Carving Fans, Bending a Tray, Two Meetings, Index to Volume One.

Fall 1977, No. 8—Out West, Steam Bending, Triangle Marking, Painted Furniture, Chain-Saw Lumbering, Rip Chain, Getting Lumber, Sawing by Hand, Gaming Tables, Two Contemporary Tables, Wooden Clamps, Elegant Fakes, Aztec Drum, Gout Stool, Two Tools, Measuring Moisture, The Flageolet, Young Americans.

Winter 1977, No. 9—Repair and Restoration, Designing for Dining, Tall Chests, Entry Doors, The Right Way to Hang a Door, Drawer Bottoms, School Shop, Health Hazards in Woodworking, Basic Blacksmithing, Carving Cornucopia, Carving Lab, Routed Edge Joint, Shaker Round Stand, Cutting Corners, Small Turned Boxes, Unhinged.

Spring 1978, No. 10—Two New Schools, Wooden Clockworks, Hammer Veneering, Claw and Ball Feet, Block-Front Transformed, Hot-Pipe Bending, Furniture Galleries, A Two-Way Hinge, Laminated Turnings, Chain-Saw Carving, Circular Saws, Louvered Doors, Small Workbench.

Summer 1978, No. 11—Harpsichords, Spinning Wheels, American Woodcarvers, Drawers, Turning Spalted Wood, Scratch Beader, Leather on Wood, Notes on Finishing, Building Green, Parsons Tables, Hanging a Door, Pencil Gauges, Dulcimer Peg Box, Tiny Tools.

September 1978, No. 12—Community Workshop, Greene and Greene, Holding the Work, Scandinavian Styles, Tambours, Stains, Dyes and Pigments, Spindle Turning, Cleaving Wood, Whetstones, Sharpening, Cockleshell, Dust-Collection System, Sanding, Used Machinery, Wooden Wagon.

November 1978, No. 13—Making Ends Meet, Scientific Instruments of Wood, Making a Microscope, The Harmonious Craft, Laminated Bowls, Preparation of Stock, Tung Oil, Relief Carving, Roll-Top Desks, Shaped Tambours, Cylinder Desk and Book-Case, Basic Machine Maintenance, Portfolio: A.W. Marlow, End-Boring Jig, Scale Models, The Purpose of Making, Lumber Grading, On Workmanship.

January/February 1979, No. 14—Guitarmaking School, George Nakashima, Lester Margon's Measured Drawings, Tapered Lamination, Improving Planes, Restoring Bailey Planes, Box-Joint Jig, Five Chairs: One View, World Globe, Koa Table, Incised Lettering, Bolection Turning, Air-Powered Tools, Polyhedral Puzzles, Design Sources, Have a seat.

March/April 1979, No. 15—College Dropouts, The Shape of a Violin, Stalking Mesquite, The Mortise & Tenon Joint, W.A. Keyser, Router Tables, Treadle Lathe, Freewheel Lathe Drive, Milk Paint, Flying Woodwork, Routed Signs, Staved Containers, Carved Shells, Flight of Fancy.

May/June 1979, No. 16—Working With a Handicap, Edward Barnsley, Locking the Joint, Harvesting Green Wood, Shop-Built Vacuum Press, Five More Chairs: One View, Hollow Turnings, The History and Practice of Marquetry, Silas Kopf's Marquetry, Before the Finish, Workbench, Circular Stairway, Three Stairways, Spiral Staircase, The Machinist.

July/August 1979, No. 17—Frederick Brunner, Sawmilling, Working with Heavy Timbers, Portfolio: Woodworking Women, Bending Compound Curves, Furniture from Photographs, Routing for Inlays, Precision: Tips from the Die-Making Trade, Finishing Materials, Solid Wood Doors, Library Steps, Norwegian Woods.

September/October 1979, No. 18—Showcase Cabinets, Tapered Sliding Dovetails, The Haunched Mortise and Tenon, Methods of an Old World Cabinetmaker, Production Problem, Drop-Leaf and Gate-leg Tables, Making the Rule Joint, Woodturning Chisels, High School Woodwork, To Finish the Finish, Cabriole Legs, Making Cabriole Legs, Contour Tracer, Cabriole Template, Paneled Doors and Walls, Rhinodesk.

November/December 1979, No. 19—Wharton Esherick, Ringed Rattle, Another Rattle, Dragonfly, Two Toy Trucks, Oyster-Shell Veneering, PEG for the Woodworker, Tips from the Turning Conference, Old-Fashioned Turners' Gauges, Oil/Varnish Finishes, Portfolio: Charles Rombold, Chip Carving, Copenhagen 1979, Mortise & Tenon by Machine, East Comes West, The Jointer, More Mortising: Sloping Wedges and Shims, Band Saws, The Woodchuck, Mother Nature, Woodcarver.

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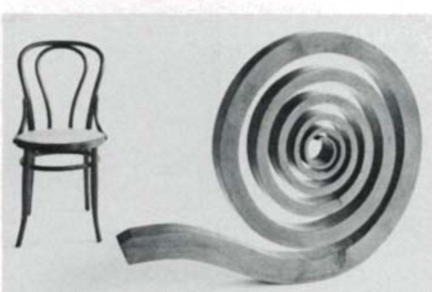

Cover: The spiral measures 52 in. long by 38 in. wide. It was steam bent by the Thonet firm in 1880, from a 28-ft. oak tree, to demonstrate the process perfected by Michael Thonet, the father of bentwood furniture. One of his chairs, above, indicates the spiral's size. Beginning on p. 38, this issue contains a number of articles featuring wood as a flexible material. Photo: Doug Long.

Fine WoodWorking®

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DEPARTMENTS

ARTICLES

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I teach woodworking to grades two through nine at the Park School in Brookline, Mass. I have found that the children have far greater success by having the coping-saw blades cut on the pull stroke (Japanese style) instead of the usual push stroke. This works especially well for the younger children, as it facilitates a smoother cut and a less frustrating experience. I explain to the children about Japanese saws vs. American saws. The second-graders "like the Japanese way much better."
—Randy Altshuler, Newton, Mass.

I am a retired industrial-arts teacher with over 29 years of working with children. Your article "The Woodchuck" (Nov. '79) is a fine article, however, Makowicki had better get lots of malpractice insurance to protect himself, with students working machines with loose sweater sleeves unrolled, and especially children working in a shop without safety eye protection. In New York state, all students and instructors must wear eye protection in the shop, and even visitors must wear the same protection. It's state law. . . .
—Lester R. Bernstein, Spring Valley, N.Y.

I have never written a letter commenting on anything before, but after reading the Sept. '79 issue I felt compelled. Specifically, I am referring to the editorial comments in the article by Alasdair G.B. Wallace. In it he prolongingly details his feelings about machines versus hand work. I can't help but feel after reading this and similar articles that we woodworkers as a group are too esoteric and philosophic about our craft. We often lose sight of what we are trying (or should be trying) to do. Wallace in his article even states that his product is secondary to the process. Wallace and others I have heard from are obviously too emotionally involved with the esoterica of woodworking to see that anytime results are put in a secondary position, the product has to suffer.

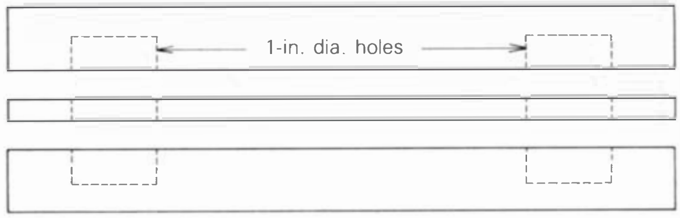
My personal opinion is that the only correct procedures are those that produce the finest piece possible (and in the shortest amount of time if you are making it for sale). As long as design doesn't suffer, I feel any tool, machine or procedure is acceptable to accomplish the final results. After all, the buying public or the appreciating eye couldn't care less whether or not you derived sensual pleasure or therapy during the construction of the piece, as long as it is beautiful. Our product is, after all, the true extension of ourselves, not the labor or procedures that go into making it.
—Peter Kemmer, Albany, N.Y.

As a professional toymaker, I was very interested in your issue on toys (Nov. '79). However, your two articles on baby rattles present a significant hazard. Neither rattle design will meet current U.S. regulations on baby rattles. That regulation bans any rattle that can go through an opening 1⅓ in. by 2 in., to a depth of 1¼ in. The handles of both rattles in your articles will not pass that criterion of safety.

We make a rattle similar to John Townsend's rattle, but we meet the regulation by making a double-ended rattle with both ends over 1⅓ in. in diameter. We stopped making the ring-type rattle when the new regulation came out.

This is not an idle regulation, as the U.S. Consumer Product Safety Commission has documented 10 infant choking deaths, and 19 other incidents where the child did not die, since 1943.

Two other notes on the shaking-rattle design. We use



mung beans because they are smaller and seem to give a better noise. We also laminate the rattle blanks before turning, as illustrated. A central piece of contrasting wood, or two kinds of wood, make the lamination decorative and part of the design instead of something to hide.

—Don Olney, The Toycrafter, Rochester, N.Y.

Like H.N. Capen (Q&A, Sept.'79), I had never filled an open-grained wood and had the finished surface flat. About five years ago I took an oak table I had just made to the best cabinetmaker in the Cleveland area and asked him what I was doing wrong. From him I found out that I was applying my filler too thick and letting it dry too much before wiping.

Every filler label I have ever seen says, "thin to the consistency of thick paste." That's a trap. Now I use no less than five parts of naphtha to one of filler. It may seem as if you're just brushing thinner on the wood, but when you wipe you'll find that there's more than enough silex there to do what you want it to. Wipe across the grain when the thinner just starts to flash. That way you won't have to bear down so hard you pick the filler out of the pores. If you have a piece that is going to get an opaque finish (an ebony piano, for instance) you can go on after the normal filling operation to put as many coats as you wish of gray automotive primer. Spray it on and sand with 600 emery paper, and it will make even a piece of oak smooth as a sheet of glass.

—Andrew Takas, Chagrin Falls, Ohio

...Paste fillers I have used work best if a good sealing coat has first been used. With open-grain wood this usually means more or heavier sealing coats than on close-grain, even if you have to sand the surface back down to the wood after the next-to-last coat. (I always do that anyway.)

Next, the manufacturer's instructions—as is so often the case—ought to be taken seriously, particularly with regard to the solvent. If they stipulate benzine (the non-poisonous stuff) then it's going to work out easier and better if you don't substitute some other stuff. The correct mix is important. Usually the instructions contemplate much larger quantities than the average home worker is going to use, and measuring small quantities of gooey paste is hard to do accurately. My usual mistake is to make it too thick. It is easy to assume that the right mixture doesn't have enough filler in it to do the job. Here is where a little experiment and/or experience pays off. One can always lay on another coat, so it's better to lean toward a thin mixture. For wiping off... burlap is better than anything else I've tried. Don't try to make this procedure perfect—or at least satisfactory—too quickly. Go ahead and leave streaks and excess filler behind as you work over the surface. Here is where one can dig out too much of the filler, leaving only a partial fill. Do the surface several times. Allow the burlap to build up a loading of moist filler paste so that your swipes across the grain act as much as a padding step as a wiping one. This can be overdone if you've used a lot of filler, or a thick mixture. The correction is merely the exercise of patience as you shift to a new burlap surface and build up a new "pad," working back over any grain still open, or reopened, by the fresh burlap. Here, as in all kinds

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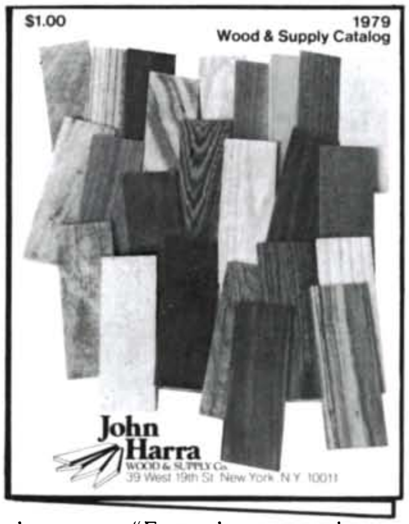

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of finishing, placing the work so that a strong light will form a reflection on the surface in front of you is a very great help.

At no part of the process should one yield to the temptation to get strong with the wiping-off. This is particularly true if you finish, as I do, by wiping with the grain. When you do this, be prepared to go back and refill any open pores with the filler padded into the burlap.

Now this "padding" business may excite some who are more skilled than I, but I find it works. I like to get as much off the surface as possible before the filler dries because the stuff I use dries hard and it's difficult to keep an even tone to the wood (stained or not) if you have to resort to sanding after the filler does dry. Rubbing gently, but well, avoids most surface residue before drying. After drying, I use 4/0 steel wool, which works well and leaves a shiny, hard surface ready for finishing. I prefer to use shellac as a sealer, and (at least) as the first coat over the filler if I'm not using shellac for the entire finish anyway. With shellac, the filler is well protected from the action of the benzine and other finish solvents, top and bottom. . . .

Here's a tip: In many applications, automobile rubbing or polishing compound is a cheap, easy substitute for pumice and rottenstone. It works on many materials, including print and plastics. *—Henry T. Kramer, Somerville, N.J.*

Two table-saw jigs, one for crosscutting and one for mitering, were presented in your Nov. '79 issue, and both authors recommended using wood for the guides. As woodworkers with a reverence for wood, this is understandable. However, in this case I believe aluminum guides are superior. Wooden guides fitted during dry weather will bind and leave the jig unusable in wetter weather, while wooden guides fitted during the more humid months will shrink, resulting in a sloppy fit during dry weather. Aluminum guides can be fitted as snug as desired in any humidity conditions and the jig will slide smoothly, without excess play, all year long. Aluminum strips ⅛ in. by ¾ in. by 6 ft. can be purchased at most hardware stores and are perfect for the job.

—Don Cullen, Manchester, Conn.

I found the jointer article by Tage Frid (Nov. '79) very interesting, and I'd like to add one small insight which probably didn't take me more than ten years to discover on my own: When determining the direction of the grain in wood, it may be of help to recognize that there is a difference between "grain" and what I call "figure." To me, figure is the prominent light/dark growth rings of the tree, while grain is actually the direction indicated by the less prominent pores in the wood. Pores are easier to see in open-grain woods such as walnut and mahogany than in close-grain woods such as cherry and maple, and planing or jointing should be with the pores (grain) rather than with the figure. Occasionally the figure can appear to follow a different direction than that of the pores and the subsequent tearing or fuzzing that results should be a tip-off that this is the case.

—L.L. Chapman, Newark, Ohio

C. Housego answers a letter about placement of screws and comments on the difficulty of using brass screws (Nov. '79). Sure agree. Our solution is to use the same size steel screw and place it in the properly drilled hole first. This sets the hole to exact shape and the brass screw can be easily placed.

J. Philip Bromberg comments on the use of an ice pick to hold materials against the rip fence. We have made a push stick from 12 in. of ½-in. diameter dowel. Drill a small hole in one end and place a finish nail with the head cut off. The

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dowel has gotten nicked a couple of times but not the nail as of yet. Another hole is drilled through the other end for a leather thong. This allows hanging the push stick with others on each machine. —*F. Richard Boller, Buffalo, N.Y.*

I have to comment on the ice-pick controversy. We have been using this method for fine, close work for the past 33 years with no problems. First of all, there are no bystanders in my shop when a machine is running. This is quite a distraction in itself. I use a modified screwdriver about 12 in. long as a pusher. Grind the tip to a sharp point. Find one that has a comfortable handle (preferably grooved for a good grip). The long length will keep the hand a respectful distance from the cutting blade. —*Cliff. M. Wolstenholme, Milton, Del.*

I have lately seen several methods for attaching wood facing blocks to steel bar and pipe clamps. I have an alternate method which works well for me, with no fuss. The blocks are attached with a small dab of silicone adhesive. The compound is sold as window caulk, tub and tile caulk, and as instant gasket for auto use. It is all basically the same and any type will work. The advantages are no fuss, a flexible joint securely attached, yet easily removed with one stroke of the knife. —*John D. Foote, Clarkesville, Tenn.*

Regarding the tools David Ellsworth described (May '79) for hollow turning, any offset of the cutting edge from a centerline through the handle makes a lathe tool unstable and therefore dangerous. The top inside corner of a narrow-mouth pot can readily be reached with a tool shaped like a stretched-out question mark and this has the edge in line. A bit of ¾-in. copper pipe works fine as a ferrule.
—*Dave Dickey, Bozeman, Mont.*

The article by Edwin Krales on making cabriole legs (Sept. '79) was an excellent one—please have more of this type. Having made a good many such legs myself, I would offer some suggestions to refine his methods. The scraps from the first band-saw cut should be nailed to the waste rather than held together by tape. This offers more security from slipping as with tape when it is cut. Be sure nails are flush.

The stock should be 2 in. to 4 in. longer than the legs are intended to be so they can be fitted into a jig while working on them. This method allows the edges to be on top and easily accessible. Also, when not working on them they are protected from marring and will not roll off the bench. After completion, the blocks are sawn off each end and the legs are ready for assembly. —*R. Yates Dillard, Memphis, Tenn.*

We are in the process of forming a woodworkers' guild here in Seattle. The reason for forming this group is to be able to deal more effectively with lumber purchases as well as gather and share information. We would like to know if you can put us in contact with other groups, so that we can get some help in putting this guild together and listen to experiences other groups have had. It would be nice, too, if you could make notice of our group so that we can maintain communication on a national level.
—*Christopher Webb, 418 N. 35th, Seattle, Wash. 98103*

The Ontario Woodworkers Association has been created (at a meeting Sept. 23 in Toronto) to serve two main functions—to promote communication and special services within the woodworking community, and to provide a strong voice for that community in promoting its interests to the outside. The OWA is meant to be the voice of and for Ontario's growing

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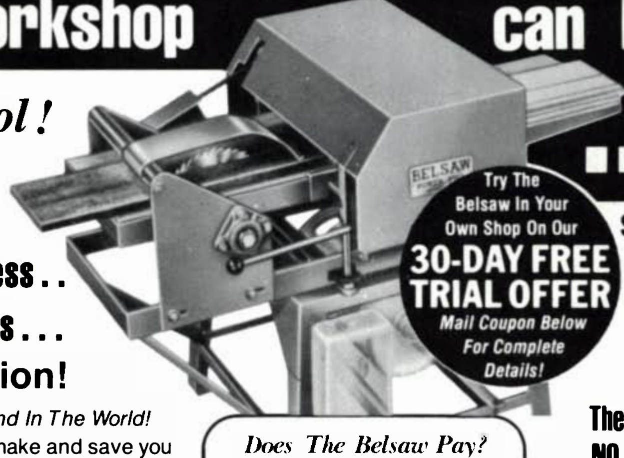

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woodworking community. This letter represents a call for membership, aimed at all those interested in woodworking, whether as a full-time, part-time or leisure-time activity, and to all those for whom wood as a craft material is of special interest. . . .For the present, all inquiries should be directed to me at the address below.

—Paul Epp, 134 Cornell St., Cambridge, Ont. N3H 1K4 Canada

Re band saws (Nov. '79), I love my Powermatic model 141 band saw. You have maligned this great machine. I shall now come to its defense: In your comparison chart it is listed at 225 lb. This is true only for the machine itself. Motor and stand bring the total weight to 355 lb., so price per pound shifts from $3.95 to $2.50.

This machine is a heavy, compact and accurate workhorse. The ball-bearing upper guides work well. The angled steel plate guides below the table hold the blade close to the work and are not subject to clogging. The latest model features a dust chute that when fitted with a vacuum hose effectively keeps the dust situation under control. The table adjusts 45° to the right and 15° to the left. With judicious use of an auto grinder under the left side of the table it can be made to tilt 20° or more to the left. . . .

—Michael Ivan Gorchov, Jamison, Pa.

Here is a way to gain an additional ¾ in. in depth of cut on a Powermatic 141 band saw. The finger screw and knurled rod that tighten and adjust the upper blade thrust bearing must both be cut off so that no more than ¼ in. protrusion remains. The ends of both are then slotted with a double-bladed hacksaw to permit screwdriver adjustment. With the blade guard removed, the support shaft slides further up into the casting. I've had no problem resawing 7-in. boards.

Further gains may be had by relieving the lower of the two support-shaft keeper bars and grinding away some of the casting. In fact almost 1 in. could be had, at the sacrifice of table tilting, by modifying the table supports so it can be dropped.

—J.A. Hiltebeitel, S. Burlington, Vt.

I have just read Simon Watts' article, "Drop-Leaf and Gate-Leg Tables," in the Sept. '79 issue and am very impressed with his work. However, in studying the drawings of the drop-leaf table, there is an error in the measurement of the tabletop in the end view. If Watts generally makes his tops from 18 in. to 22 in. wide, and his leaves 10 to 12 in. wide, there is no way the width of the top and one leaf could possibly add up to 19⅝ in.

I was wondering if Watts has done or considered making the end of the table shorter and placing a drawer in the end, as the Shakers have done. . . .

—Ralph E. Huss, Okemos, Mich.

Simon Watts replies: The top and one leaf should be 29⅝ in. Yes, I have put drawers in on occasion. With a drop-leaf table the overhang has to be kept small or the drawer is too far back under the tabletop. This can interfere with seating. Without leaves you can put the drawer anywhere you want but aprons deeper than about 3 in. can get in the way of people's knees. This means the drawer cannot be much deeper than 2½ in.

In Brian Donnelly's article "Tapered Sliding Dovetails" (Sept. '79), surely there is an error in section 5-c of the illustration. It seems clear from what goes before (both the print text and section 4-b of the illustration) that the masking-tape shim should be on the *bottom* rather than the top face of the shelves. . . .

John F. Harrison, Lexington, Ky.

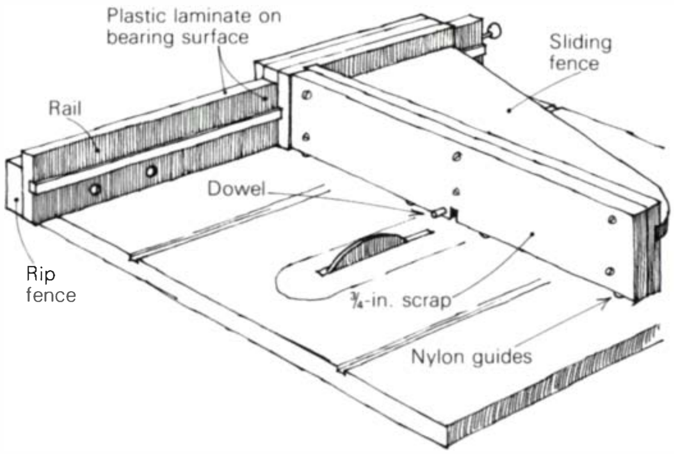
Finger-joint jig

Here is a box or finger-joint jig like Tage Frid's *(Fine Woodworking,* Winter '76), except that it uses the table-saw rip fence rather than the miter gauge—a sturdier, easier-to-adjust arrangement. It consists of a guide rail bolted to the saw's rip fence, and a sliding-fence assembly that holds the work. Make the guide rail from particle board or hardwood plywood and cover both sides with plastic laminate to reduce sliding friction. Bolt the rail to the rip fence with four ¼-in. bolts. Countersink the bolt heads on the inboard side.

As with the rail, the sliding-fence assembly is made from particle board or plywood with plastic laminate glued to the bearing surfaces. An essential part of the jig is the hardwood tongue installed in the rail that slides in a groove in the fence assembly. Tack nylon furniture glides to the bottom of the fence assembly to allow the jig to ride freely along the table.

Set-up time is fast—a good-fitting joint can usually be achieved in two test runs. The first step is to install a dado blade for the desired finger size, say ⅜ in. Raise the dado blade about 1/32 in. above the thickness of the stock to be cut. Now screw a scrap of ¾-in. material to the front of the sliding fence assembly to serve as a disposable fence. Drill a ⅜-in. hole in the center of the scrap fence about ½ in. from the saw table. Insert a short ⅜-in. dowel in the hole to act as a guide pin. Now adjust the rip fence/rail so that the distance between the guide pin and the dado blade is equal to the size of the dado—⅜ in. in our example.

Using a piece of scrap, start a test pass. While holding the stock vertically against the fence assembly and against the guide pin, pass the stock over the dado blade. After each cut, shift the stock to the right so that the previous cut registers



over the guide pin. Start the cut in the second test piece by lining it up with the sawcut in the fence (rather than the guide pin). The joint should be snug but loose enough to allow gluing. If the joint is too tight, move the rip fence to the left. If it's too loose, move the fence to the right.

—*Tom Burwell, St. Paul, Minn.*

Cheap stain

At the picture-frame manufacturing company where I work, 12-ft. bundles of frame molding are dumped into a vat of stain and then put aside to dry. I noticed that much stain was lost as it dripped off the drying bundles and asked the owner why he let the stain drip away without any attempt to collect and reuse it. His answer was that the "stain" was actually lap cement (an asphalt-based roofing product available at building-supply stores) diluted with turpentine, so inexpensive he didn't bother to reclaim it.

Our shop mixture of 5 gal. lap cement to 50 gal. turpentine produces a medium walnut color. At home I find a half cup of cement to a half gallon of turpentine will stain pine a deep golden brown. —*George Kramer, Santa Rosa, Calif.*

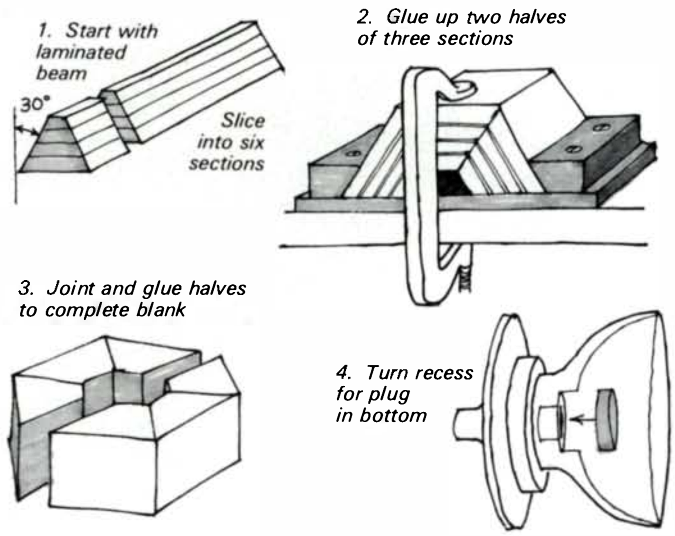
Masking out squeeze-out

Glue squeeze-out problems can be avoided by covering areas near joints with masking tape. Carefully place the tape during final assembly so that it covers the area but doesn't get caught in the joint. This technique is especially useful on the inside corners of joints (drawers, boxes, etc.) where cleanup is a problem. —*Tim Rodeghier, Highland, Ind.*

Laminated bowls

The method I use to make six-sided bowls creates boldly repeating patterns and reduces layout and blank-assembly time. I start by laminating a wedge-shaped beam with 60° sides, sandwiching veneer of various thicknesses between four ¾-in. hardwood boards. The widest part of the wedge (which I make of a highly figured wood) will be the outermost part of the bowl, and 5 in. here will produce a 10-in. diameter bowl. The length of the wedge will determine the bowl's height.

I set the jointer fence at 30° and joint off two sides of a scrap 2x4, leaving a chunk of wood angled 60° on each edge. Then I cut off six thin wafers, arrange them in a circle and check for proper fit. If there are gaps, I adjust the angle of the jointer fence and try again. When the angle is correct, I joint both sides of the laminated beam deep enough to clean out depressions and glue. Then I cut the beam into six equal sections and dry-fit.



Now glue up two bowl-blank halves of three sides each. Use a clamping jig. Next, dry-fit the two halves and, if they don't fit perfectly, run the faces of the two sections over the jointer. Glue the two halves together to complete the blank. When you turn the blank, simply make a recess for a round plug to fill the hole in what will be the bottom of the bowl.
—*Roy Ashe, Luther, Mich.*

Faceplate taping revisited

Dennis Castagna's procedure for taping bowls on a faceplate ("Methods of Work," May '79) prompts me to suggest a similar method using double-faced tape.

First, sand and clean the back of the work to ensure good contact. Then apply a layer of double-faced tape to the faceplate without overlap. Attach the work to the faceplate by squeezing momentarily in a vise. For larger workpieces use two layers for more holding power.

Remove the work by wedging a chisel between the faceplate and the workpiece. —*Max Kline, Saluda, N.C.*

EDITOR'S NOTE: Standard hardware-store "carpet tape" may be adequate only for smaller projects. Kline recommends a special tape manufactured by Nashua Corp., Nashua, N.H., which, because the adhesive is partially cured, softens less during the heat of sanding.

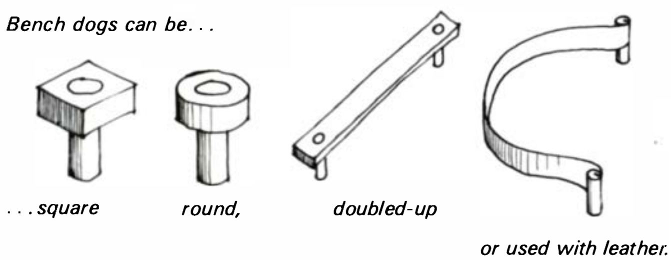
Another proponent of double-faced tape, Russ Zimmerman (RFD 3 Box 57A, Putney, Vt. 05346), recommends Permacel—a thicker, cloth-backed tape with more holding power. Zimmerman will sell and ship the cloth-backed tape for $7.50 a 75-ft. roll.

Zimmerman states that "most people start using this tape cautiously, but confidence builds." He now uses the tape for 15-in. wide, 4-in. thick bowls.

Bench dogs: round versus square

While building a European-style workbench, I experimented with both square and round bench dogs. I concluded that round dogs (wooden or steel) are superior in several important ways. First, it is much easier to put a round hole into a bench top (or anything else). Second, the round dogs are easily made in a variety of shapes that will rotate in the hole to conform to the shape of the work. Square steel dogs cannot rotate, more easily mar the work, and can drop through the hole in the bench top.

Round dogs can be turned on the lathe or built up from ¾-in. doweling by gluing hardwood shapes to the tops of the dowels. A wide variety of shapes, padded or in combinations, can be used as the work requires.



If I had a bench with square dogs, I would convert it to use round dogs by filling the square holes with wood of the same density as the top and redrilling new round holes.

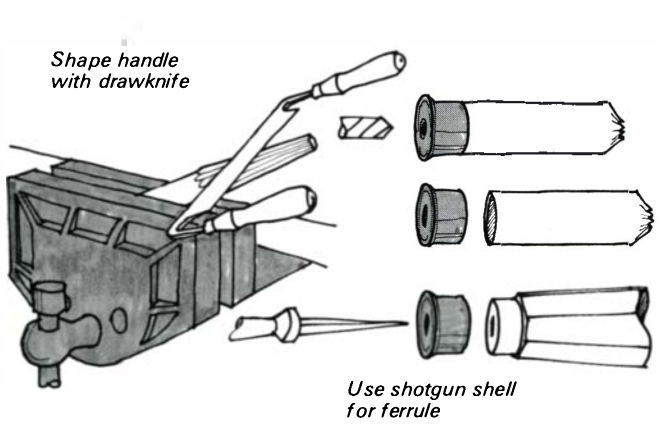
—*William E. Betzner, St. Petersburg, Fla.*

Recycling tool handles

One way I beat inflation is by making my own tool handles from old mop, broom and shovel handles, usually made of ash, hickory or beech, that the average homeowner pitches in the garbage.

Here's how I make octagonal handles for new carving-tool blades (which I buy unhandled). First, clamp a beech mopstick in the vise, leaving about 6 or 8 in. protruding diagonally at the top. Mark the handle length and taper the sides from this line to the ferrule end with a drawknife. Take shallow cuts at first, turning the stick frequently for uniformity.

For the ferrule, use the metal end of a spent 20-ga. shotgun shell. If you're not a hunter, look for empty shells at a skeet shooting area. To separate the ferrule from the shell, drill through the center bottom (where the shotgun hammer hits the shell) with a ¼-in. bit. This releases the hull and inner packing, which can then be pulled out with pliers. The hole that's left is usually the right size to receive the carving tool's tang. To mount the ferrule, mark its length on the handle,



and with a second-cut wood file, remove enough wood to seat the ferrule snugly.

Beech works well for carving-tool handles, but other woods are more suited to striking-tool handles. Old shovel handles (usually hickory) are best for replacement hammer handles; I work them down also with a drawknife. Broken ash baseball bats (check the local high school's practice field) are excellent for hammer, hatchet and lathe-tool handles. I finish all these handles with a couple of coats of tung or linseed oil.

—Rob Russell, Joliet, Ill.

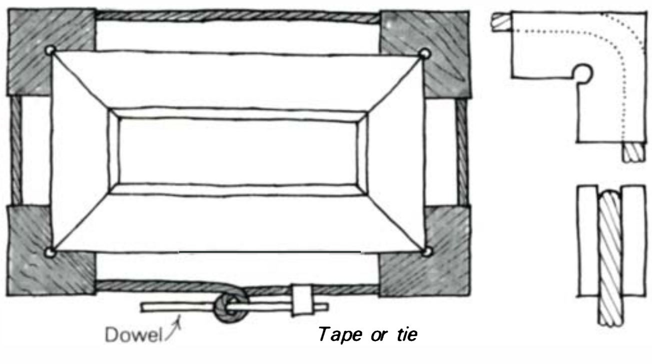
Another no-cost picture-frame clamp

My modification of Duane Waskow's picture-frame clamp (November '78) uses a tourniquet to apply pressure at the glue joints. To make the clamp, cut four *L*-shaped clamping blocks from ¾-in. pine and groove the outside edges of the blocks a little wider than the rope diameter. Then round, smooth and wax the grooves to minimize friction. Cut or drill a circular area at the inside corner of the blocks to allow for slight inaccuracies (which accumulate at that point) and to permit excess glue to escape. When you're ready to glue, place a piece of waxed paper under each block to prevent it from becoming glued to the frame.

For the rope, choose something with a little stretch—I use ⅛-in. nylon. Tie a loop in the rope just long enough so that it can barely be snapped over the blocks. This will hold the frame together while final adjustments are made in the glue joints. When the joints are right, twist a dowel onto the rope and turn it to produce whatever pressure is desired. The leverage is tremendous so don't overdo it. It's a good idea to put a weight on the frame while you're applying pressure. If one corner comes up a little, the whole assembly may twist and fly apart.

When the pressure is sufficient, tape or tie the dowel to the rope. Always maintain a tight grip on the dowel—it can unwind with surprising force.

—H.N. Capen, Granada Hills, Calif.

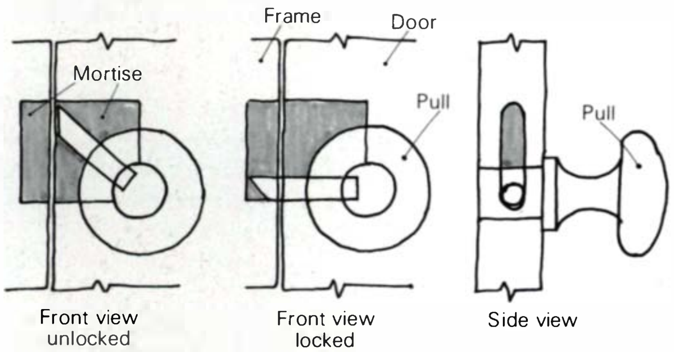


Wooden pull/catch

This cabinet door pull serves a double function—it's also a locking catch. The material cost is negligible but you'll spend about an hour making and installing the pull. The catch is designed for doors hung flush with the framing, so a separate door-stop must be incorporated.

First, square a line from the edge of the cabinet door at the position you want the pull. Bore a ⅝-in. hole through the cabinet door 1 in. from the door's edge and centered on the line. Then cut a 1-in. deep, ¼-in. wide mortise into the door edge. Start the mortise ⅛ in. below the position line and stop the mortise 1 in. above the line. Cut a corresponding ⅜-in. deep mortise in the frame.

After the mortises are completed, lathe-turn the pull handle with a knob on the front and a round tenon on the back. The tenon should slip-fit in the ⅝-in. hole and be as long as the door is thick. Dry-fit the pull in the hole and, while holding the knob at the locked position, reach through the mortise and drill a ¼-in. hole in the tenon to receive the latch/dowel.



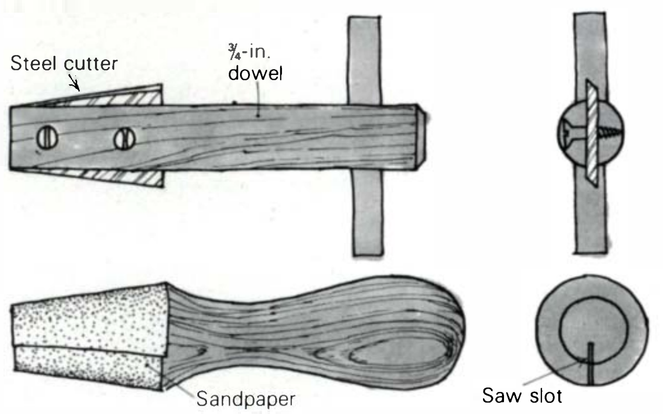
To complete the pull/catch, coat the tenon with beeswax, put a drop of glue in the latch-dowel hole and set the pull in place. Insert the latch-dowel through the mortise into the hole. Then, with the handle turned to the unlock position, cut the latch-dowel flush with the door edge.

—Michael Lynch, San Francisco, Calif.

Socket reamers

Here are two spur-of-the-moment, large-diameter reamers that work well for tapering candlestick sockets and the like. Since a candlestick reamer won't be used often, practically any scrap of steel will do for the cutter on the "deluxe" version. Install the sharpened cutter in a saw kerf with a screw. Use two screws or pin the blade through the dowel body if the cutter shifts in use.

You don't need a lathe for the sandpaper version—it can be whittled and filed sufficiently round by hand. Install one end of a sandpaper strip in a slot in the head. Then wrap the

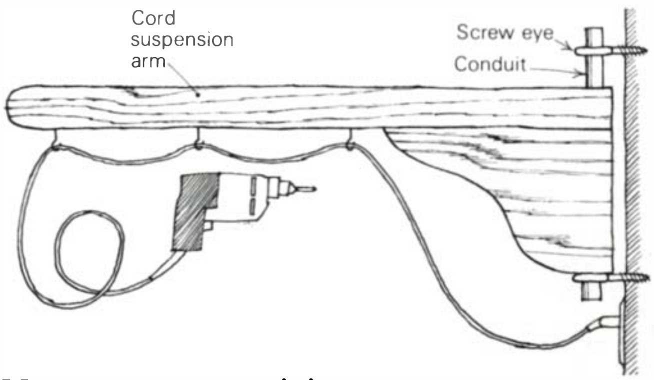


strip around the reamer; there's no need to fasten the other end of the strip. *—Van Caldwell, Cincinnati, Ohio*

Electric-cord suspension arm

It is much easier to use portable electric tools if the cord can be suspended from above so it doesn't drag across your workbench. This cord suspension arm is designed to move easily to different heights or to different locations in the shop. The arm pivots on electrical conduit pipe, which is cheap and light but strong enough. The conduit slips into 1-in. screw-eyes spaced so that when the arm is raised, the lower pipe will disengage for removal.

—Pendelton Tompkins, San Mateo, Calif.



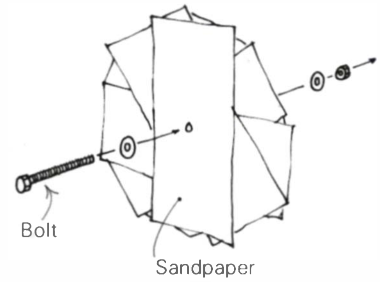
No-mess epoxy mixing

To mix small amounts of epoxy, simply squeeze equal amounts of resin and hardener into the corner of a plastic sandwich bag. Twist and mix the two until a uniform color appears. Then puncture the bag with a pin and squeeze out the glue as required. No clean-up is required—just throw the bag away. *—Edgar E. Gardner, Nashua, N.H.*

Sanding mop

To sand hard-to-get-at spots, make a sanding mop from a nut-and-bolt arbor and a handful of small pieces of sandpaper. Overlap the sandpaper like shingles around the arbor and chuck it in a drill. The irregular edge eliminates the hard sanding line produced by rubber-backed discs.

—Allan Adams, San Francisco, Calif.



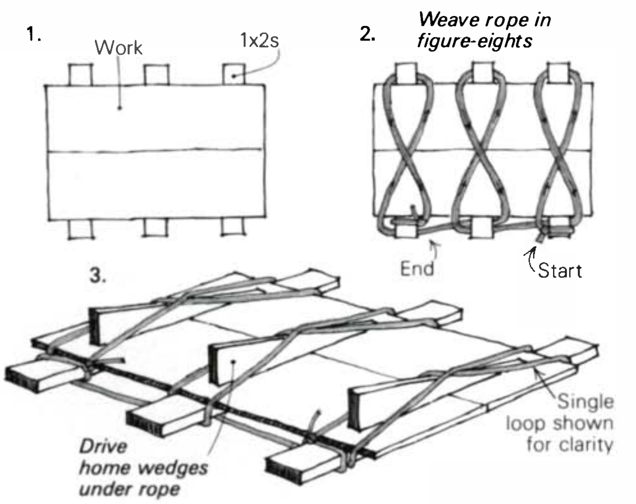
Spanish luthier's clamp

I know of no simpler, cheaper or more convenient method to clamp up edge joints than the Spanish luthier's technique for joining guitar tops and backs. Though intended for thin wood, the technique is easily adaptable to any thickness, width or length required. All that is needed are several long wedges, a few 1x2s (longer than the work is wide) and a length of ¼-in. rope.

When the work is ready to be glued, lay it on the 1x2s as shown. Tie the rope to the right-hand stick and weave it over the work and around both ends in a figure-eight. The diagram below shows one figure-eight loop for clarity but several are necessary. Moving to each 1x2 in turn, repeat weaving the figure-eights, tying off the rope on the last stick.

Now insert the wedges under the middle of the figure-eights and drive them home with a mallet. This will apply clamping pressure without danger of the wood buckling and damage to the edge. Wax the wedges and 1x2s to prevent their being glued to the work by squeeze-out. The whole process is fast, but it's advisable to practice a few times to get the hang of the rope weaving.

—Douglass Peoples, Arlington, Va.

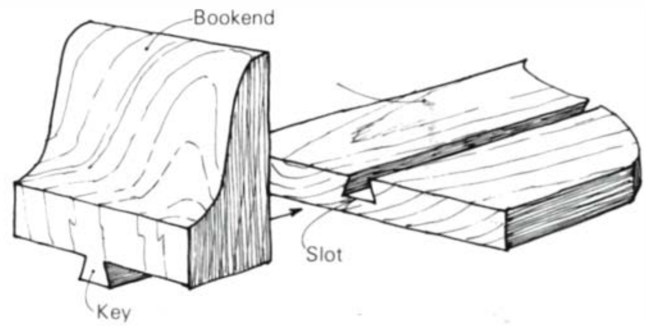


Sliding dovetail bookends

Most furniture designed to hold books doesn't. Shelves must be filled with books end to end or pairs of movable bookends must be used. I make integral, sliding bookends from the same wood as the bookshelf. Cut ½-in. dovetail keys across the bottoms of matched blocks. Then rout a mating dovetail slot in the shelf end to end. The fit of key to slot should be smooth but not loose. Allow for swelling during humid seasons. Slide the bookends into the slot prior to final assembly. Books placed between the bookends supply the necessary leverage to jam the key tight in the slot. Bookends can be easily repositioned if book tension is relaxed.

An alternate approach for open shelves is to stop the slot a few inches from each end. Widen the slot (with a straight router bit) in the middle of the shelf to insert the bookends.

—Rick Kramer, Beech Creek, Pa.



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.*

Q & A

Is there a clear thin wood sealer (for dip coating) that will not raise the grain? I make wooden hair-combs, and it is not practical to resand and repolish between the teeth. I have tried many finishes but am not satisfied.

—*H. Warren Beach, Edgartown, Mass.*

I would dip the combs either in a half-and-half mixture of clear lacquer and clear lacquer thinner, or into tung oil cut slightly with mineral spirits (about 80% tung to 20% mineral spirits). After thorough drying, I would rub in between the teeth with a nylon thread twisted into a strand, something like a horse's tail. Dip the horse tail in some fine garnet abrasive powder (you can buy it from Universal Shellac and Supply Co., 495 W. John St., Hicksville, N.Y. 11801) and hang it from the ceiling. Put a flat container underneath to recover the powder that comes loose. Then comb the horse tail until the comb is perfectly smooth between the teeth. With 4/0 steel wool I would make the outside as smooth as a good sales pitch, and my combs would be ready for market. —*George Frank*

Most good sealers or thin finishes should not raise the grain. Is it possible that what you thought was raised grain was simply dust or dirt particles present in the finish, which became apparent when the finish dried down hard? To eliminate this possibility, strain your thinned finish through fine, clean cloth before dipping. Waterlox Clear Transparent Seal should work well. Deft (clear lacquer) should also serve your purpose, and will dry faster than the Waterlox varnish sealer. Thin down any finish you use to almost water consistency before dipping to prevent the narrow spaces between the teeth from clogging. —*Don Newell*

When you acquire bent C-*clamps, how do you straighten them?*

—*Thomas R. Wood, St. Paul, Minn.*

If they are twisted, you can put the unthreaded end in a heavy vise, insert a bar or pipe, and untwist them. If the back is bent (though to bend a clamp in this way one must be as strong as a bear), you had best take them to a machine shop that has a hydraulic press to have the kink taken out. C-clamps aren't designed to be tightened with anything other than a hand—if you put a wrench on the handle, you're over-tightening. —*Simon Watts*

Without heavy metalworking equipment or without an available blacksmith, try to find a hot enough torch (propane or MAPP) to make the clamp at least a dull red before hammering it straight on a flat piece of iron.

—*Andy Marlow*

My work so far has involved a fair amount of miter cuts, and my $20 miter box is not accurate. Therefore, I waste a lot of time trimming. I am ready to invest in an expensive miter box if it will indeed give the "perfect cut every time" promised. Or should I save my money toward a table saw and do all my miter cuts with that?

—*Barbara Emley, San Francisco, Calif.*

I would definitely not buy a miter box. For carpenter's work it's okay, but no miter boxes are accurate enough to cut a smooth joint. I would invest in a good 10-in. table saw with at least a 1-HP motor. In my new book, *Tage Frid Teaches Woodworking—Joinery* (available from The Taunton Press), I describe how to make an accurate miter jig for the table saw.

—*Tage Frid*

I think that a good, clean miter joint is one of the hardest joints to make. A table saw is no better than the miter gauge that comes with it for making this joint, and your best bet might be to invest in a miter trimmer. A radial arm saw probably does a better job than a table saw because the work doesn't drag on the saw table. I cut miters (when I have to) on the table saw and then make the final adjustment on a disc sander set accurately to 45 °. It may be cheating but it works.

—*Simon Watts*

EDITOR'S NOTE: Also see the Methods of Work column of the November '79 issue; it contains a number of miter jigs.

Have you ever heard of mixing white shellac (preferably 3-lb. cut) with an equal amount of boiled linseed oil and using it as a finish? It sounds incompatible—a solvent release and a chemical reactive finish. It also seems that you would have drying problems. But this is not so according to my mother-in-law. A number of years ago, she was told by an old refinisher to use it as a finish on her old piano.

—*Carmine I. Santarelli, Lorain, Ohio*

I tried mixing shellac and boiled linseed 50/50 and it does not work for me. Mixing the boiled linseed and shellac together, then shaking vigorously, produces a milky suspension of oil in shellac. Upon standing, the oil separates out and rises to the top. I applied the shellac/oil suspension to a previously varnished surface and to new unfinished wood, rubbing it over and in with a cloth pad soaked in the mixture. Upon

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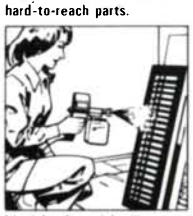

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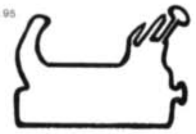

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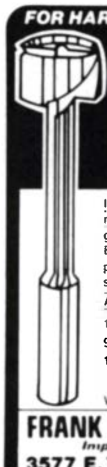

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standing, the oil separated from the shellac and came to the surface in an oily layer that would not dry. I wiped the oil away and was left with an uneven, unacceptable film of shellac on the varnished surface. Over the new-wood surface, the shellac and some of the oil apparently went into the wood, as expected, but an oily layer remained on the surface.
—*Don Newell*

Don't ever argue with your mother-in-law. Let her use the mixture of shellac and oil on her finishing projects, and use the good old proven finishing materials on yours. You will not be sorry. She will. —*George Frank*

My assembly procedure for mortise-and-tenon joints is to finish the pieces prior to assembly, then to apply glue only to the surfaces of the mortise, not to the surfaces of the tenon. This eliminates glue squeeze-out problems, but will this joint be strong enough?
—*Brad Miller, Bangor, Pa.*

When gluing a mortise and tenon it is important to put a moderate amount of glue in the mouth of the mortise, and just a little on the beginning of the tenon cheeks. There should not be so much glue that it runs out over the work, bench and craftsman. Anyway, a tight joint does not allow room for too much glue. —*Tage Frid*

Depending on how tight a fit you made the joint, it is usually safe to give the mortise an ample coat of glue and the tenon a light coat to be sure there will be no unglued spots. —*Andy Marlow*

It is not good practice to put glue on only one surface when gluing two pieces of wood together—it makes for a weak joint. Glue squeezing out is a good sign, in spite of the mess. —*Simon Watts*

How can hard maple be stained so as to bring out the delicate grain? All commercial maple furniture is opaque red to orange. I'm doing a floor that needs the protection of a good finish and a nice light-brown to medium-brown color, with no loss of grain pattern.
—*James M. Harris, Chantilly, Va.*

Commercial furniture is usually finished with red to orange semi-opaque or opaque wash coats to achieve the particular manufacturer's standard maple tone. To accentuate the grain of maple, you must use a completely transparent stain. I would use an alcohol-based aniline stain, probably a "golden oak" color. Aniline stain is more likely to be absorbed selectively into the grain structure of the maple, thus highlighting it.

You didn't ask about a finishing material for your floor, so I assume you know what you want. But in case you haven't considered it, Waterlox Gym Floor Finish is good and durable. Another good finish is shellac. It is surprisingly durable, unless some of your friends happen to spill straight whiskey on it. —*Don Newell*

We have a rosewood-veneered tabletop that had been waxed but developed a 4-in.-diameter black ring when water leaked onto it around a silver vase. Having used salad oil to remove white watermarks, I tried this, but to no avail. Since the blemish apparently contains silver oxide, I also tried silver polish, which did nothing. Perhaps I'm not penetrating the waxed surface. Because the stain is dead center, I hesitate to use bleach, and because it's in a veneered surface, I suspect it's too deep to rub out. Any ideas? —Bob Frohwerk, Boise, Idaho

First clean the tabletop of all finish. Wax is hard to eliminate, and you'll have to do this in several steps. Soak the tabletop first with gasoline and wipe the melted finish off with rags. Repeat several times. When the top is clean, wash it two or three times with lacquer thinner, again using rags to wipe off the wax. Both these materials are extremely flammable, so be careful and ventilate your work area well.

Scrub your table with warm water and laundry detergent until it is free of wax, wiping the excess water off constantly. The spot should be gone. However, if it still persists, use a 2-in. by 7-in. fine-bristle wire brush with 1¾-in. long wires. Here's how: Wet the wood and wipe up the excess moisture, and brush the damp wood with a rotating motion. Some of the wires will reach into the bottom of the pores, and if you get the knack, will kick out all unwanted dust, finishing material and dirt.

Now, if after washing and wire-brushing the spot is still there, start with chemicals—first, simple Clorox. If this doesn't work, dissolve oxalic acid in alcohol and using rubber gloves, wipe the spot off. If either the Clorox or oxalic acid eliminates the spot, neutralize the wood with a vinegar wash. Under no circumstances use peroxide bleach. If neither the Clorox nor the acid works, I would dig into my vocabulary of Hungarian swear words and reveneer the tabletop. —*George Frank*

In January '79 you featured an article on pneumatic tools, picturing a rolling-pin sanding device that I have been looking *for. However, there was no mention of the manufacturer, despite a detailed listing of suppliers.*

—Kevin Sullivan, Eagle River, Alaska

The rolling-pin sander is made by Ekstrom-Carlson & Co., 1400 Railroad Ave., Rockford, Ill. 61110. A similar sander is made by Sand-Rite, 1611 N. Sheffield Ave., Chicago, Ill. 60614. Most major pneumatics manufacturers offer a similar machine.

Follow-up

In Sept. '79, a reader asked about using mineral oil instead of linseed oil to treat and protect wood, especially salad bowls. George Frank suggested using boiled linseed oil with about 5% Japan drier added in for a good, protective finish, but neglected to caution against using this treatment on wooden utensils for food.

Woodworkers should be aware that any item they sell to contain food or drink is subject to the regulations of the Food and Drug Administration, which restricts what coatings can be used in contact with food (Code of Federal Regulations, Title 21, Part 175.300). According to Ralph Mayer's *Artist's Handbook of Materials and Techniques*, most boiled linseed oil is not actually boiled, but is heated with driers; lead, though no longer allowed by the FDA, was one of the most common driers used. Likewise, lead has also been used in Japan driers, and even if the drier does not contain lead, there's a good chance it might contain toxic impurities.

—Michael McCann,
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New York, N.Y.

Supplies:

Finding exotic supplies and materials for woodworking is a constant problem. Here are some leads to inquiries from previous issues:

—Tires for a 9-in. band saw: Toolkraft Corporation, 250 South Rd., Enfield, Conn. 06082.

—Custom leather seats: Mountain Jim Leathers, Box 66718, Scotts Valley, Calif. 95066.

Readers can't find:

—Hinge blanks;

—A musical movement that plays "Pop Goes the Weasel;"

—Information and parts for a combination machine made by the Sidney Tool Co., Sidney, Ohio, now out of business.

Send questions, answers, comments and supply sources to Q&A, Fine Woodworking, *Box 355, Newtown, Conn. 06470.*

Books

Woodwork Joints (revised) by Charles H. Hayward. *Sterling Publishing Co., 2 Park Ave., New York, N.Y. 10016, 1979. $4.95 paper, 128 pp.*

There must be some woodworkers who don't read, who either have a complete repertoire of skills and techniques locked away in their mental vaults, or who have found things they're comfortable with and enjoy repeating them. Other woodworkers might prefer discovering new ways to do things by doing them, accepting the failed experiments and the $3-a-foot firewood. For the rest of us, *Woodwork Joints* deserves a place in our libraries.

The edition at hand is part of a revamped series familiar to woodworkers in its old form as the Drake Home Craftsman's Books. Sterling Publishing Co. is revising and reissuing the books but the changes are mostly cosmetic. Some woodworkers may miss the funky, slightly old-fashioned look of the old editions (though the text still says *cramp* for *clamp* and *rebate* for *rabbet*), but the general effect is brighter and crisper. The illustrations have been updated (partly by removing the shading), photos have been substituted for line drawings in a few places, and modern iron planes and vises have replaced some of the wooden ones. Metric equivalents have been added to the text.

What makes the book worthy of consideration, of course, is not its looks but what's in it. Hayward offers sound, basic instruction in all the common ways of fastening two boards together, and a good number that are not so common. He begins logically, with glued edge joints, and proceeds through an attractive wooden knuckle joint, which is part of a short chapter on moving joints, both with and without metal hinges.

In between there are mortise-and-tenon joints in great profusion—for grooved and rabbeted panels, for doors and frames, with fox wedges and tusks and pegs for draw-boring. A useful section about common errors includes a series of a dozen drawings, and some will look familiar to anyone who's ever tried to cut a mortise and tenon.

The chapter on dovetails is extensive and detailed, with sections on through, lapped, mitered and a half-dozen other varieties. They are described in enough detail to make one feel comfortable about trying them; the section on bevel dovetails (for use at the corners of boxes whose sides slope inward) for example, is systematic, clear and presents so many possibilities for error that it's enough to make the reader consider taking up macrame.

Other chapters deal with lapped joints, mitering and scribing techniques (like those necessary to join frame and sash bars on a window). There are also three pages of methods for joining boards along their lengths, as in house carpentry, and a useful chapter on joints for plywood and particle board, including a selection of methods for covering up the exposed edges of plywood on a door or tabletop.

—*Phil Ginsburg*

Furniture of Williamsburg and Eastern Virginia, 1710-1790 by Wallace B. Gusler. *Virginia Museum of Fine Arts, Box 7260, Richmond, Va. 23221, 1979. $24, hardcover; 194 pp.*

Wallace B. Gusler, furniture curator at Colonial Williamsburg, is among the new breed of museum people. A craftsman himself, he is just as interested in the construction of antique furniture as he is in its style and probable ancestry. And thus his book is of more than passing interest to the woodworker, for Gusler goes beyond the usual concerns of collectors and curators. He unfolds not only who made the furniture of Williamsburg and environs, but also how it was made, and how the daily shop practices of the various cabinetmakers differed.

I confess at the outset that I find most books about antique furniture of marginal use to the woodworker. Like most contemporary furniture historians, Gusler's premise and purpose is to establish Colonial furniture as an art form, and in this case to prove that Virginia furniture is as interesting and valuable as pieces made in Boston or Philadelphia. To do this he must first overturn the erroneous view that most Virginia furniture was imported directly from England, and then, since most of it was not signed by the maker, he must go beyond the surface appearances of style to the very innards of each piece. By showing how it was made, he can correlate many pieces with surviving account books to know who made it, and when. Along the way he reveals much of interest to cabinetmakers who reproduce period furniture.

For example, in analyzing case goods from the shop of Peter Scott (1694-1775), Gusler not only photographs the pieces from the front, but also takes the camera behind, underneath, and pulls out the drawers. He writes, "A study of the growth-ring

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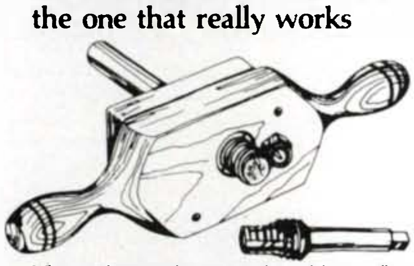

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patterns of the pine lamination backing the walnut primary wood shows very clearly that the [ogee bracket] feet were formed from long boards. They were first glued together to form the lamination and were then planed into the ogee shape from end to end. This contoured board was then cut into separate brackets and mitered together, a method that ensures that the feet are uniform in their ogee profile. . . ."

Gusler gets a good deal of help from the tremendous amount of research that has been done at the Williamsburg site, the pre-revolutionary capital of the Virginia colony. This includes archaeological excavation at the Hays cabinet shop, where furniture was made for at least 25 years under a succession of four gifted master craftsmen. The dig brought up not only broken tools and crockery, but also a number of broken parts from furniture in for repair, and half-finished parts that went awry during their manufacture. From this evidence Gusler is able to reconstruct and explain two different geometric methods of laying out ball-and-claw and paw feet, and to compare their results with legs carved entirely from memory, without layout lines.

Gusler's book is painstaking, meticulous and comprehensive. It is a welcome addition to my library, and I hope it inspires other curators to examine their relics from the cabinetmaker's point of view. —*John Kelsey*

The Restorer's Handbook of Furniture by Daniel Alcouffe. *Van Nostrand Reinhold, 7625 Empire Dr., Florence, Ky. 41042, 1977. $22.50, cloth; 129 pp.*

Alcouffe's book is for collectors, curators and restorers of European antique furniture. It is not a textbook for a beginner—though a beginner would certainly find it informative—because Alcouffe assumes knowledge of, and experience with, basic procedures of restoring. For example, he tells you which carving tools and chisels you will need for a certain piece and what sharpening stones to use, but not how to sharpen them. He tells you which varnish to use for a particular job, how to dissolve beeswax with turpentine and how to apply it, but not when to stop. The pieces Alcouffe restores are European, and for the most part he works with European woods. But if you went to the store to buy the chemicals he uses, you wouldn't have much luck—not unless you happened to know their American names. For example, he polishes with "tripoli," which you probably couldn't purchase here unless you knew it was also called "rottenstone."

Nonetheless, his accounts of the major causes of damage to furniture—shrinkage, splits and fissures—and the method of fixing them are applicable to any piece of furniture. Also, his points on filling dents and repairing tenons can easily be applied to American furniture.

Alcouffe explains such things as rot and worm damage and tells you five good methods for disinfecting furniture and four methods of stripping gilding and paintwork. He writes informatively about consolidation—the reconstitution of infected wood—and about little points that are crucially important, such as how to get animal glue to crystallize, not dissolve, by treating it with 95% surgical spirit when dismantling a piece.

The section on staining is particularly good—he tells you which stains do what, and that water stains can be used without risk but that acid stains will corrode glue in the joints of veneered furniture and can darken wood. Alcouffe explains how to change the shade of wood by oxidizing, and that a solution of ammonia and water will age oak and chestnut, but that great care must be taken even with this, because the solution will turn some woods black, grey or red (though he doesn't tell you which woods—that's left for you to find out on test pieces). Needless to say, he always stresses caution.

Alcouffe also presents a very good section on French polishing. His section on carving is not strong, but the parts—nearly half the book—on veneer work, marquetry, boulle work and gilding are excellent. The biggest lack in Alcouffe's book is that he just doesn't devote enough space to restoring solid wood furniture.

Throughout, Alcouffe stresses that "Restoration is a job for the proficient; a delicate and difficult job that places grave responsibility on the shoulders of anyone undertaking it." He emphasizes that a thorough knowledge of antique furniture, special training and a variety of skills are necessary for the restorer, and that ignorance is disaster. His rules are solid: "Conserve a maximum of original material." "Avoid radical measures." "Respect." He adds that "one must make it clear to people that spending money on restoration is. . . a long-term investment."

Alcouffe writes with a knowledge borne of countless hours of research into journals kept by 18th-century French restorers and quotes liberally from these past masters. And he writes with the experience of the curator in the department of objets d'art at the Louvre, a post he has held since 1962.

The only drawback to Alcouffe's book is the layout of pictures and text. Though the illustrations are extremely well done, they do not appear on the pages where they would be most useful. You have to search for them. But, this is insignificant in light of his excellent observations and explanations. —*Mark Bieluczyk*

Chair, edited by Barbara Prete. *Thomas Y. Crowell, 10 E. 53rd St., New York, N.Y. 10022, 1978. $19.95, cloth, 138 pp.*

This book projects itself in bold, straightforward typefaces, lined-in text, photos set off by heavy black frames, and multicolored typographics with slim arrows zooming directly from text to illustrations. One is awed by its design, but the meat of the matter is in what is being said, not in the visual presentation.

A lecture series, "The Evolving Chair," delivered by a panel of eight representatives of the design world, comprises the bulk of the text. The lectures were given in 1976 at the Cooper-Hewitt Museum in New York. Subjects range from pure design to manufacturing, marketing and distribution realities. The other lecturers say, in essence: "Since we can't make chairs comfortable, at least we can (and should) make them beautiful or unique."

Chair concludes with more than 500 contact prints of ¼-scale pieces entered in a 1976 international competition sponsored by the American Institute of Architects. These chairs have only one thing in common: They can be sat upon. From the entries submitted, nine finalists were chosen and given $1,500 each to build full-sized prototypes of their designs. The four winning entries were chosen in May 1977.

Someone taped the jurors' review of the finalists' work, and the transcribed text, which appears in this book, is instructive. No entry was judged with comfort as a criterion, but on design, use of materials and appearance. The jurors seem most captivated by the folding aspect—the four winning chairs are all collapsible.

One of the not-so-obvious messages of this book is that we possess the technology and knowledge today to provide comfortable seating. As a documentary of contemporary attitudes, the book will probably prove invaluable to our

descendants, who may want to find out why they inherited such peculiar things to sit on. —*Alan Marks*

Phil Ginsburg is executive director of the New Hampshire Council for the Humanities; Mark Bieluczyk restores antiques in Woodbury, Conn.; Alan Marks lives in Pacific Grove, Calif.

Events

20 Californians—furniture show, Jan. 4-30. Los Robles Galleries, 167 Hamilton Ave., Palo Alto, Calif. 94301.

Wood: A contemporary view of a traditional material—seminar, Feb. 23-24. Univ. of California, Berkeley. Contact Steve Collins, U.C. Extension, 55 Laguna St., San Francisco 94102. (415) 666-3291.

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Expensive Tools Do Not A Craftsman Make

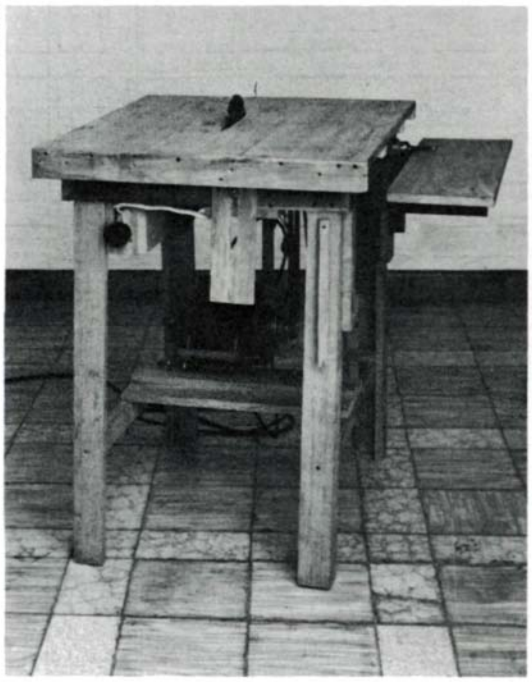
by William J. Taylor

Moving to Mexico last year was a difficult time in our lives. Thousands of decisions came up in our packing, since neither my wife nor myself wanted to part with our "treasures." For me the worst was what to do with my 30-year accumulation of tools. The final decision was that I could pack some hand tools if she could take her sewing machine. A handsaw, smoothing plane, four wood chisels, several rasps, a square, a ⅜-in. electric drill, a brace and a set of bits—I ended up with two boxes of miscellaneous tools, plus a portable circular saw and a router. Sadly, I turned my back on my radial arm saw, 10-in. table saw and lathe. Oh well, I said to myself, maybe I can get by.

We arrived without incident and finally found a house that had two extra rooms I could use for a shop and storage. The house was unfurnished and we had brought no furniture. First things being first, I made a simple platform bed and bought a foam mattress—no problem with the tools I had with me. While building the bed, I could hear from down the street the unmistakable whine of a table saw. At the first chance I followed the sound, like a bird dog after a covey of quail. Soon I was standing in the open doorway of a Mexican cabinet shop. The two men looked up, and I spoke one of the few Spanish phrases I knew, *"buenos dias."* One of the men said *"Pase, senor,"* which sounded like "pass" so I walked in. The shop was poorly lit and the workbench primitive, with little equipment beyond hand tools in evidence. Near one wall I saw the source of the saw noise—an unpainted, roughly made wooden frame with a 12-in. circular sawblade projecting through a slit in the wood top. It seemed unbelievable that they actually expected to turn out work on this thing. The two cabinetmakers and I became friends when they found out that woodworking was my hobby. Watching what they could do with that saw soon opened my eyes. In addition to the usual saw functions, a drill chuck stuck out the side of the table frame with an adjustable shelf under it. With this arrangement they would drill and clean out mortises by sliding the work back and forth on the shelf. I had to have one of these saws.

I bought some pine lumber, arbitrarily decided on a table of 28 in. by 30 in., then built the frame to fit. The tabletop hinges at the far end, so to lower the sawblade you raise the table's near end. I acquired a ¾-HP, 3450 RPM electric motor and felt like a child at Christmas. I bought two ball-bearing mandrels from Sears, mounted one for the sawblade, and the other alongside the first with its threaded shaft sticking out a hole in the side of the frame. I put step pulleys on both mandrel shafts and another on the motor, using a mounting device that I had discovered 30 years earlier when my only power source was a salvaged washing-machine motor that drove several tools. I put a wood base on the motor into which I placed two eye bolts, with two more eye bolts on the tool I wished to power. I then could connect the motor to the tool by putting a ½-in. rod through the eye bolts, so the motor could slide sideways to accommodate the pulley steps. By taking the *V*-belt off the saw mandrel and putting it on the drill mandrel, I had a horizontal drill and could also attach a sanding disc. Now, I thought, we are getting somewhere, and what else could I do with it? As I

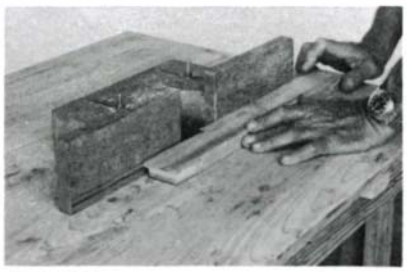
Photos: William J. Taylor



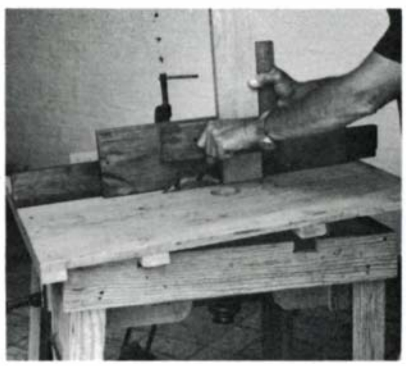
Taylor's homemade table saw. The top is hinged at the far end and raised to adjust depth of cut, by means of the slotted board and wing nut attached to the frame. The mortising spindle and an adjustable table are mounted on the right.

The crosscutting fixture consists of two crossed boards, glued and screwed at 90°. One board rides the edge of the table, the other pushes the work. A similar device permits 45° miter cuts.

Horizontal mortising: Workpiece is pushed into bit and moved from side to side to clean out waste.

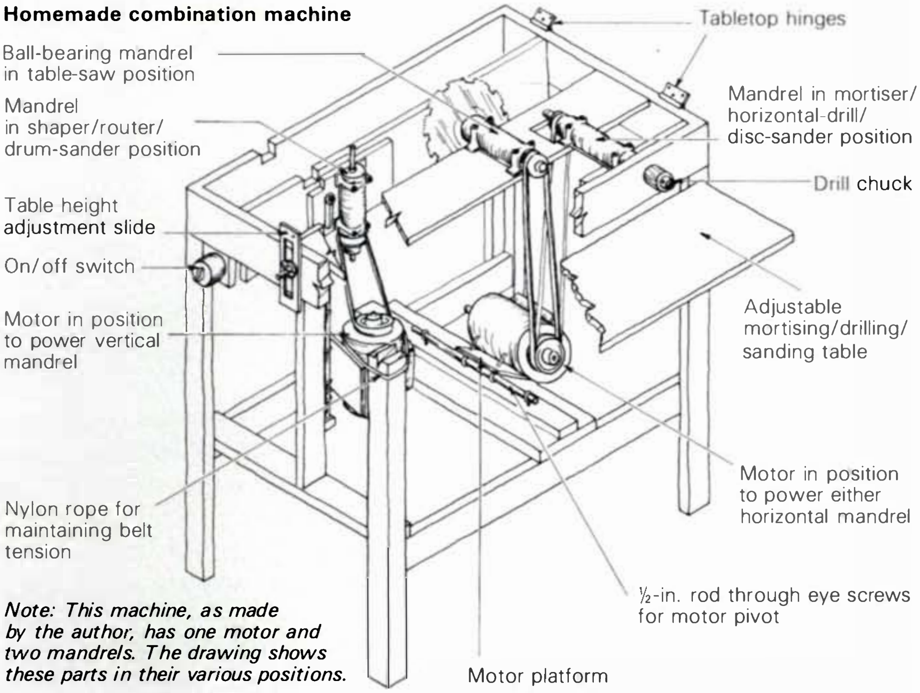


Mounting the mandrel vertically makes the machine into a shaper. The same arrangement can accept drum sanders, or a chuck for router bits.



Once you've come this far, a tenoning jig is easy.

Homemade combination machine



Note: This machine, as made by the author, has one motor and two mandrels. The drawing shows these parts in their various positions.

still had some inside space to work with, I decided to rig up a vertical motor mount so I could have a shaper as well. Working this out took a few days—no use overdoing in the tropics. When I finally got it all together, the ugly thing worked, and I gleefully dragged my wife out to the shop for a demonstration.

By this time our furniture consisted of four Mexican leather chairs and a small, round, leather-topped table. After several shopping trips to Guadalajara, I decided that the furniture we could afford was of poor quality and shockingly expensive.

I am sometimes slow to catch on, but my wife would mutter as she served the evening meal, "It would be nice if I had some room to put down the dishes," and things like that. I agreed to make a table next, and she, knowing my limited ability, kept it simple by suggesting a Parsons design.

Pine is the usual wood in this area, but I finally found a hardwood called ollamel and started to design the table. As the wood was not kiln-dried and seemed a little green, I decided not to build the legs or sides of solid 4x4s and chose instead to use four 1x4s for the legs, with the edges cut at 45° and glued up with a spline. At the corners I had six pieces of wood with their ends cut on a 45° angle, all meeting at once. The corner joints were glue-blocked and screwed, and I crossed my fingers.

As Tage Frid has so often said, "Wood is going to move." But so far the joints have held up well; only one has opened about 1/32 in., which I can doctor up. For the top I set smoked glass into a rabbet.

As the table progressed, I kept asking my wife to give me some idea for the chairs. Finally we sat down with *Fine Woodworking's Biennial Design Book*. My wife picked the Michael Rosen chair on page 27. I made six of them without his consent, consoling myself that perhaps he would not mind, imitation being the sincerest form of flattery.

The table and chairs are great and the swivel back on the chairs was a stroke of genius on Rosen's part. Now we have a couch, two living-room chairs, a china cabinet and a dressing table in the planning stages. This should keep me out of the cantina for a while. I think I have created a monster in that table saw. □

Table and chairs, made with the homemade table saw.

Fine Woodworking *buys readers' adventures. Suitable length is 1,500 words or less—up to six typed pages, double spaced. Please include negatives with photographs.*

Illustration: Christopher Clapp

Michael Thonet

One hundred and fifty years of bentwood furniture

by John Dunnigan

The Vienna Chair, made of only six parts, is the result of the experiments of Michael Thonet, the Viennese cabinetmaker who in 1856 perfected a process by which solid rods of wood could be steam-bent into complex curves. By this process, the rear legs and backrest of a chair could be made out of one long piece of wood, eliminating much of the joinery chairs previously required and avoiding the short-grain problems of carved joints.

Called Armchair #9 when first produced in 1870, the Vienna Chair was successful from the start. The architect Le Corbusier selected it for use in several of his buildings, including his pavilion "L'Esprit Nouveau" at the 1925 Paris Exposition—more than 55 years after it was designed. Long before the tenets of Modernism were accepted, in Michael Thonet's furniture form and function were one. Twentieth-century designers such as Breuer, Aalto and Eames, as well as many contemporary designer-craftsmen, have been inspired by Thonet's bentwood techniques and timeless designs. But perhaps his most profound effect, fully realized with the introduction of tubular steel, plastics and other modern materials ideally suited for curvilinear design, is in his success at mass-producing furniture.

Michael Thonet (pronounced like *sonnet* and with a silent *h)* was born the son of a tanner in Boppard-am-Rhein, Germany, in 1796. He was apprenticed to a cabinetmaker, and by age 23 opened his own shop. By 1830 he was building furniture in the Biedermeier style, a provincial version of the Paris *meubles de luxe*. Like Empire in France, Regency in England and Federal in America, Biedermeier was high fashion for the first half of the 19th century.

Before long Thonet had established a reputation for technically skillful, innovative executions of traditional work. His earliest known bent work is in applied decorative elements on otherwise typical Biedermeier pieces. An engraving in the Technisches Museum in Vienna, on the facing page, shows a set of his furniture made between 1830 and 1840; the applique on the sofa and bed is probably typical of the kind of work Thonet produced a decade earlier as well.

With the exception of the front and back seat rails and the back support, his chairs of this period are made entirely of laminated strips of veneer. The lamination was done by loosely tying a stack of veneer strips, each measuring about 1/16 in. by 1 in. by 84 in., into a bundle and soaking it in a bath of hot glue. The glue, made from animal hide and bone, differed little from today's product. Once the bundle of veneer was completely saturated, it was removed from the bath and, before the glue started to set, pressed into a heated mold of the desired shape. After it was satisfactorily fastened to the form, the whole was left to cool and harden in place. After a couple of hours, Thonet had a curved piece of wood that was cheaper to make, lighter and more durable than anything he could have carved out of solid wood. In addition, the inner laminations could be cut from less expensive wood than the outside surfaces.

His Boppard chairs, made in the 1830s, reflect this technique. The rear and front legs, the side stretchers and most of the seat rail are one continuous lamination; the loops at the feet and slits in the stretchers compliment the construction. These chairs were a unique approach to a traditional design which, although full of new curves and innovative in profile, still looked somewhat stiff. Their curved sides are in single planes and are connected by flat horizontals at the seat and back—Thonet had not yet figured out how to make the compound bends for which he would later become famous.

He continued to experiment with new methods of bending, while taking out patents to protect his new laminating process (1840-41). Securing these patents in England, France and Belgium was expensive, requiring financial backing. Thonet invested everything he owned in developing his furniture and in marketing it around Europe.

In 1841 at a fair in Koblenz where he was exhibiting, Thonet made a favorable impression on Prince Metternich,

John Dunnigan makes furniture in Saunderstown, R.I.

Photos, except where noted: Thonet Industries chancellor to the Austro-Hungarian Empire. It was Austrian policy to seek out inventors and assist them in pursuing their ideas in the interest of the Empire; Metternich invited Thonet first to his castle in Johannesburg to learn more about his work, then to Vienna. In the spring of 1841, Thonet left the business with his wife and eldest son and traveled to Austria to secure a patent for production. The Prince recommended him to the court, Thonet writes his wife, "with such spirit about our things that he really let no one add a word; he rocked back and forth on the chair; he took the little bent rod he'd gotten from me in Johannesburg and described its strength as combined with remarkable thinness. He explained the construction as if he had worked with us himself, especially in explaining the merits of the [wheel] rims."

The Austrian court granted the patent Thonet requested a few months later; it gave him the right "to bend the most brittle kinds of wood in a chemical-mechanical way into desired forms and curves." However, for all his good fortune in Austria, Thonet had problems with his backers in Boppard who, having begun to worry about the apparent lack of success of the patents in England, France and Belgium, precipitated Thonet's bankruptcy. By the fall of 1842, Thonet moved his family to Vienna. After working a year for the established cabinetmaker Franz List, Thonet met Carl Leistler, a prominent parquet manufacturer. When Leistler saw Thonet's execution of a difficult, circular-patterned parquet floor, he engaged both Michael and his son Franz to work in their own section of his factory. The men worked together until 1846 on the renovation of the Palais Liechtenstein under the direction of the English architect P. H. Desvignes, and Thonet laminated parquets, furniture and moldings.

Over the years Thonet tried several techniques in an attempt to perfect his laminating process. Not satisfied with the one-plane bends of the earlier Boppard chairs, he tried resawing an already laminated curve perpendicular to the glue lines and regluing it on a second curved plane. This process was slow and impractical; the reapplication of hot glue weakened the first set of glue joints, and there was also the problem of trying to bend all the hard glue in the first lamination. The resulting pieces were too costly to be marketed widely.

As a next experiment, Thonet cut thin rods of square cross section and tied them into a bundle. Sixteen rods ¼ in. by ¼ in. made a 1 in. by 1 in. part. The bundle was cooked in a hot glue bath and bent to a mold, as in the first process. Although these strips bent easily, it was difficult to achieve a uniform glue line, so this approach was also impractical.

Thonet kept returning to his original method using a single stack of flat laminates and eventually found that simply by twisting it he could obtain the compound curves he wanted. Rectilinear surfaces, when twisted, lie in different planes and thus a wood-strip laminate can be bent easily in more than one direction, depending on the amount of twist. It was the logical next step, but it took 20 years to figure out.

Thonet applied this new technique while working with the architect Desvignes on the Palais Liechtenstein. He designed three chairs, apparently the first of their kind, each composed of six bundles of laminates. The first bundle goes up one rear leg, forms part of the back, and continues down the other leg; another bundle forms the seat frame and part of the back; the legs and seat rails are made from a series of laminates going up one leg, across to support a section of the seat, and down the other leg. Each leg is thus made up of two bundles glued in turn to one another with triangular inserts in the corners. Entirely laminated, these chairs seem to be without mechanical joints or fasteners.

The Liechtenstein chairs reflect various furniture styles from about 1650 on. Their lines build upon the Louis XIV and Queen Anne styles of the late 17th and early 18th centuries and were influenced by the Rococo as well—in fact they were made to be used in a Rococo Revival setting in the palace. The Classical Revival was also a major ingredient—archeological discoveries after 1750 brought ancient Egyptian, Greek and Roman furniture to the eyes of a fashion-conscious public. The Greek *klismos* chair particularly attracted the attention of furniture makers, whose attempts to copy its graceful leg curves proved problematic: Shaping from solid wood necessitated choosing grain configurations with too much discrimination for large-scale production; techniques like bending and laminating were solutions. Products of early industrial technology as much as of an older desire to imitate the art of the past, Thonet's Liechtenstein chairs constitute a crucial bridge between 18th and 20th-century furniture.

After the work on the palace was completed in 1846, Thonet continued to make unusual parquets and experimental bentwood furniture at Leistler's in Vienna. In 1849, when Leistler refused his offer of partnership, Thonet, then 53 years old, formed his own company. In a house in Vienna he and his sons set to work mass-producing bentwood furniture. At first he had to rely on the financial assistance of his friend Desvignes, with whose support he developed another new chair in 1850. This one, for the Palais Schwarzenburg, had lathe-turned front legs doweled into the seat frame; the rear legs and backrest were laminated as in the Liechtenstein chairs. Certain changes in the process, however, make these chairs an important step toward solid bentwood furniture. Instead of a dozen or so thin layers of veneer cooked in glue, the backs use only four thicknesses of ³⁄₁₆-in. mahogany; the seat rings have five layers. Thonet cooked the laminates in boiling water, bent them on the forms and dried them for a few days, then glued them together; this required fewer laminates, which saved time, and the glue was under much less stress. This is the first chair Thonet constructed using the boiling-water technique, and it eventually appears as chair #1 in the Gebruder Thonet catalog (p. 39).

In 1850 the family turned its attention to preparing for the great world exposition to be held the following year at the Crystal Palace in London. Thonet exhibited several pieces of furniture there, including a set of rosewood chairs and a settee with caned seats and backs in the Liechtenstein style. He sent pieces in mahogany and palisander as well, and tables with inlays of brass and tortoise shell. Thonet came away with a bronze medal (the highest awarded to an industrial product) and many important marketing contacts.

About this time Thonet received his first major public commission from the famous Cafe Daum in Vienna. From this point on, the bentwood chair would be known by many as the Cafe Chair (shown at bottom left on the facing page). The back is made of four layers of twisted mahogany laminates, while the front legs appear to be bent from solid stock with turned capitals, which act as shoulders for the tenon of the leg into the seat. The seat frames are made of five layers of mahogany, as they were in the Schwarzenburg chairs. Because of its lightness, durability and accommodating design, the bentwood chair was perfectly suited for public places. According to Hermann Heller, Thonet's biographer, Thonet shortly thereafter did a similar set of 400 chairs for a hotel in Budapest.

In 1853, Thonet founded Gebruder Thonet, registering the company in the names of his five sons. They were the proprietors, but Thonet still held directorship. Business was good enough to employ nine cabinetmakers, one lathe-turner, eight veneer-cutters, two gluers, eight sanders, two stainers, ten finishers and two assemblers. They rented a large building and, before the year was out, had installed a 4-HP steam power plant to run the machines.

It was in this shop over the next three years that Thonet, then almost 60, began to realize his lifelong goal of mass-producing solid bentwood chairs. He had been experimenting all along with solid-wood bending and had earlier tried with little success to bend slats for chair parts by cooking them in hot glue. It worked with the veneer but not with thicker stock. Having perfected the laminating process in the 1840s, Thonet continued to use thicker and fewer laminations in each successive design and with every passing year. In the mid-1850s he made a chair for the Palais Schwarzenburg which had a solid bentwood back made of one continuous rod that was full thickness in the rear legs but tapered to a thin strip at the top of the back where the bend was most critical. After it was bent, two additional thin strips were laminated to this top section to regain the desired thickness. The seat frame was made up of only three layers, which probably were also boiled, bent and dried before being glued.

The success of these products—not only Thonet's chairs but all kinds of furniture—was remarkable. The impetus gained from the Crystal Palace exhibition propelled the company into a worldwide market, and this, perhaps more than any other factor, conditioned the final form of the solid bentwood chair. Thonet had successfully shipped laminated chairs to several countries, but when he sent his first shipments to North and South America, he found that the glue wouldn't stand up to prolonged heat and excessive moisture. Although Thonet had been working diligently to solve such problems for most of his life, it is no small coincidence that the fate of the solid, steam-bent chair was resolved at the moment when the vast American market was to be gained or lost.

The problem with bending solid wood of substantial thickness was that it always broke first on the convex surface, regardless of how much boiling water or steam it was subjected to. The fibers stretched and tore apart on this outside face, while their compression on the inside or concave surface usually caused no damage. The very center of the piece probably remained constant in length and therefore neutral. To solve the problem, Thonet needed a way to keep the convex side of the bend from stretching, to make it act more like the neutral layer, and to transform the force of the bend entirely into compression. He fastened a strip of sheet iron to a still-straight piece of wood on what would be the convex surface and squeezed it at the ends with screw clamps. When the piece was bent, the convex side of the curve could not stretch, and the whole piece was under uniform compression—as though the neutral layer of fibers had been moved to the outer edge of the wood. Bending in more than one direction simply required additional straps.

To apply this technique to his furniture, Thonet first had to find a suitable wood. Mahogany, rosewood and palisander, which laminated well, did not bend in solid rods as easily as ash or beech. The long, straight grain of beech, coupled with its low cost, made it the logical choice. The process followed these lines: A straight-grained, branchless beech butt was crosscut to the desired length in the forest to avoid hauling unnecessary wood back to the shop. The log was ripsawn into rods of square section (approximately 2x2) and then turned to the desired shape on a lathe. Next, a rod was selected, probably before drying, and steamed for one to two hours, depending on its thickness. When the rod was pliable enough, it was quickly placed in the iron strap (or straps) and bent by hand on a cast-iron form to the desired shape. This could take only a couple of minutes. After the wood and strap were clamped to the form, the whole thing was placed in a heated room for a few days to dry. By this method Thonet could make the rear legs and back of a chair out of one long piece of solid wood. The front legs and seat rims went through an identical process on their way from log to chair. The legs were turned and tapered before they were bent, but the seats were bent, glued and screwed with a scarf joint and then finally the edges were rounded.

Thonet built his first factory at Koritshan in Moravia (now Czechoslovakia) in 1856; he designed not only the factory but much of its machinery (multi-bladed saws to mill the stock and a mechanical spoke-shaver to round and taper the rods) as well. The factory was situated at the edge of a beech forest, and it was powered completely by water and steam. Some craftsmen were still needed, of course, but most of the work could now be done by cheaper, unskilled labor from the village of Koritshan. Before long, the factory employed virtually all the village men, women and children who went to work in the forests, the factory, and even in their homes.

Thonet's factory made the transition from the artisan's small workshop to mass production, and by 1859 the technique of bending solid wood into almost any shape had been perfected. In that year Thonet designed his most popular chair, the #14 side chair, (at right on facing page). The refinement of his earlier chairs, #14 retains the fluid lines of the Liechtenstein chairs while reinterpreting them as mass-produced items. As in the #9 armchair, Thonet reduced the chair to a minimum of six parts, easily produced, shipped and assembled, since the members were bolted or screwed together. The front legs no longer had capitals at the joints, and they were screwed into the seat with threaded mortise and tenons. The chair cost less than the average worker earned in a week, and it became the company's best seller—fifty million sold in the first fifty years. Here was a chair elegant enough for the finest salons and inexpensive enough for the masses.

Thonet designed his first bentwood rocker in 1860, at which point rockers were still a novelty in Europe although they had been popular for more than a century in America. In rocker #1 the parts were bent of solid beech and then laminated to one another. Most of the joints were also laminated (only a few screws appearing in this piece), although in later models all parts were fastened by screws. The Gebruder Thonet catalog of 1873 features more than 30 different models of bentwood rockers, testifying to their growing popularity. Unlike most rocking chairs, which are just chairs with two curved pieces stuck on the bottoms of the feet, Thonet's rocker expresses in detail and overall image that its very essence is to rock; it looks always in motion.

At his death in 1871, Thonet had achieved his goal—to perfect the process for making furniture from bent wood. He had developed a product that was affordable, functional and beautiful. He left behind him a furniture empire consisting of four large factories, as well as showrooms in many major cities of the world. Although he was not the only one in the 19th century to use lamination and steam to bend wood, he was certainly the most successful. The simplicity, efficiency and grace of Thonet's work, techniques and designs have helped pave the way both for modern methods of large-scale production and for the design styles of the 20th century.

Thonet's legacy — Gebruder Thonet continued in the vanguard of design, with an impact on the Vienna Secession, Art Nouveau and Art Deco movements as well as on the Bauhaus. Many leading designers and architects collaborated with Gebruder Thonet, among them Otto Wagner, Josef Hoffman, Marcel Breuer, Ludwig Mies van der Rohe, Pierre Jeanneret, Charlotte Perriand, Mart Stam, Anton Lorenz and Walter Gropius. In the 1920s the Thonet Company pioneered tubular-steel furniture and merged with Kohn-Mundus to form a conglomerate of 21 factories throughout Europe.

In 1938, with the world on the brink of war, the company decided to move to the United States. After the war a large nationalized bentwood furniture industry grew up in Poland, Czechoslovakia and Romania and still operates in many of the old factories. The original Thonet family continues to operate two of its factories in West Germany and Austria and maintains headquarters in Frankenburg, West Germany.

In the United States the third of the separate companies is Thonet Industries (pronounced *Thonay*). With plants in Sheboygan, Wis., Statesville, N.C., and York, Pa., Thonet Industries makes furniture in wood, metal and plastic, and still produces the old bentwood classics.

Today the steam-bending of furniture is done very much the same way it was a century ago. However, the same quantity and quality of beech is not available in the U.S. as it was in Europe, and consequently one of the biggest problems in producing bentwood furniture in America is in obtaining the raw materials. For thirty years Thonet Industries used northern rock elm. Lately because of supply difficulties they've begun using southern elm and ash. How the people at Thonet Industries in Statesville, N.C., produce a bentwood chair is shown in the photo-essay on the following pages.

Thonet's chair in production

1. The wood is air-dried to 20% (moisture content) before milling to size and shape. Only straight-grained, clear stock can be used, so there is a good deal of waste. Leg-back units for a Cafe Chair are crosscut to 90 in. and then run through a variable cam-rod machine that turns out round pieces tapering from 1¼ in. in diameter at the ends and in the center to 1½ in. diameter at the two points between which they will join the seat. They are heaviest where the joints will be. The rods are soaked in water overnight to raise the moisture content of the outer shell to 30% to 40% while keeping the center of the rod at about 20%. Softening the shell allows shorter steaming time.

The rods are put into the steamboxes and subjected to wet steam pressurized at 5 PSI, kept at 200° F. The steaming time for different chair parts might be anywhere from 10 minutes to an hour, depending on the extent of the bend and the size of the stock; the leg-back rods usually stay in for about 30 minutes. The rods must be flexible but not soft. Too little cooking leaves the wood brittle and, when it is bent, the fibers will snap on the outside; too much cooking destroys the bond between the fibers and compression cracks and crumpling on the concave surface result. There are many steam retorts throughout the Statesville, N.C., plant, so there is always a piece ready for bending.

3. When pliable, the wood is removed from the steam and bent, one piece at a time. The benders work in teams of two in the department where they make the leg-back unit. The 90-in. tapered rod is taken out of the retort, quickly placed in an aluminum strap, and both are clamped in the center to the stationary form. A centerline marked on the form, strap and rod facilitates this part of the operation, and the benders know from experience how best to orient the grain of the wood to the bend. Next the bending clamps are attached to the ends, pulling the strap tightly against the rods and applying pressure to the ends of the rod to prevent the fibers from stretching. The strap acts as the convex surface of the wood and consequently keeps the whole piece in compression during the bend.

4. The rod is bent in and up; then it is twisted slightly and pulled back down in order to make it fit the complex curve of the form. The benders work one side at a time, with a steady, smooth motion; experience tells them instantly if a breakage occurs. If it is only a minor split, they will attempt to repair it, but many pieces do not survive the bend and there is a high failure rate in the move from rough stock to finished product. The return curve shown here is the most critical part of the bend.

When the operation is completed, wedges are driven between a block on the end of the strap and a bracket on the form that holds the wood in place; then the bending clamps are removed for re-use. The bending process, from steamer to clamp removal, takes less than two minutes.

The bent wood, still on the form, is stacked on a cart, which, when full, will be wheeled into the kiln for overnight drying. About 120 of these leg-back members are bent each day. Generally the moisture content of the wood is reduced to 8% after about 16 hours in the kiln.

The seat rims are soaked and steamed a little longer than the legs because they are much thicker. Seat rims can be successfully bent only by machines that wind the wood around a circular form.

8. The smaller parts, like the hairpin back inserts shown above, are bent eleven at a time in a simple machine press. For more on steam-bending, see *Fine Woodworking*, Fall '77, pp. 40-45.

EDITOR'S NOTE: *This being the 150th anniversary of furniture by Thonet, Dover Publications is reprinting the original 1904 catalog (to appear this summer) and Barron's will publish (this fall)* Thonet: A History of the Firm *by Christopher Wilk. Also, in June at their Chicago showroom, Thonet Industries will exhibit some of their original designs.*

Before Thonet, and afterward

In Boston Samuel Gragg (1772-1855) patented his "elastic chair," right, in 1808—the first piece of American furniture to feature a bentwood, cantilever back. It is modeled after the ancient Greek *klismos* chair, a design for which appeared in Thomas Hope's *Household Furniture and Interior Decoration* (London, 1807). Hope's design used a continuous laminate curving from the top back rail to the front seat rail. Gragg carried the bentwood concept further by bringing the back member down past the front rail to become the front leg. The chair is steam-bent hickory, assembled with mortise and tenon, dovetails and screws. Gragg was a Windsor chairmaker who was probably trained as a wheelwright in New Hampshire before moving to Boston around 1800. More recently Seth Stem, 32, of Marblehead, Mass., made the continuous leg and back members of his asymmetric chair, shown from the front and side, by free-bending black cherry laminates, clamping with stretched inner tube wrapped around them in a candy-cane arrangement that permits adjustment under pressure. The front foot of a leg laminate is clamped to a 2x4 fixed to a particle-board base. Then the laminate is bent over, twisted (on the left) and brought down to be clamped to another 2x4 fixed where he wants the back leg. The seat rim is joined to the two leg arches by face-glued gussets, which are subsequently doweled and shaped. Stem simultaneously free-bent the three laminates that form the back, sitting in the chair with a glue-covered *T*-shirt to adjust their position to comfort. The chair is 39 in. by 32 in. by 21 in.

Seth Stem

A One-Piece Chair

They said it couldn't be done

One afternoon a couple of years ago, furniture maker Peter Danko sat in a bar near his shop in Alexandria, Va., slicing up the menu card with a Swiss Army knife. A few slits and folds, and there it was—the one-piece plywood chair he had been musing about ever since touring the Thonet plant in Statesville, N.C. (page 44).

"I had thought it was so foolish, to cut up and bend all that wood only to glue it together again," Danko recalls. "After I had made my menu-card chair, I put it aside and forgot about it until a few months later when I cut my hand and couldn't work. I still thought it would be neat to make a one-piece chair so I fooled around some more. I tried the idea out in Plexiglas, and there was nothing to it. I added an arm and that worked too, so I tried it in wood at ¼ scale.

"Then I went back to Thonet with my idea, only to learn that most designers have tried to make a one-piece chair. Thonet had even put a couple of staff designers on the problem, but the three-legged chair they came up with wasn't stable and couldn't be molded efficiently. They had concluded it was impossible, and seemed to think I was crazy."

Thonet doesn't think so any more, for the firm has contracted with Danko to produce and market his chair in quantity. It makes its debut this month at the contract furniture show in Dallas. But before Thonet would take another look at his chair, Danko had to prove the design by tooling up to manufacture several hundred chairs himself. He also persuaded the Museum of Modern Art to add one to its study collection, which impressed the Thonet people, and he got the chair into the American Craft Council's New Handmade Furniture show, which is now on national tour.

Danko recalls, "I went around to plywood jobbers, but they also refused to believe it could be done. So I showed my models to my dad, who used to be a pattern maker for the Navy. He thought it was nifty, and he agreed to build the press I'd need if I could come up with $1,800 for materials. I did, and three months later he'd done it." (See p. 48).

The chair consists of two face veneers sandwiching 10 layers of 1/12-in. poplar, glued with Franklin laminating glue 6W, for its long open time. It is formed in a two-part particle-board mold, lined with sheet aluminum, which weighs a half ton. Before pressing, the appropriate slots are template-routed into enough veneers for a batch of eight chairs. The piece that is later upholstered for the seat is cut out from between the chair's legs, and made only ½ in. thick by putting a piece of waxed paper in the middle of the stack before glue-up.

Another Danko invention is a spreader for coating the layers with glue. It's a contraption with rollers that looks something like an old-fashioned washing machine.

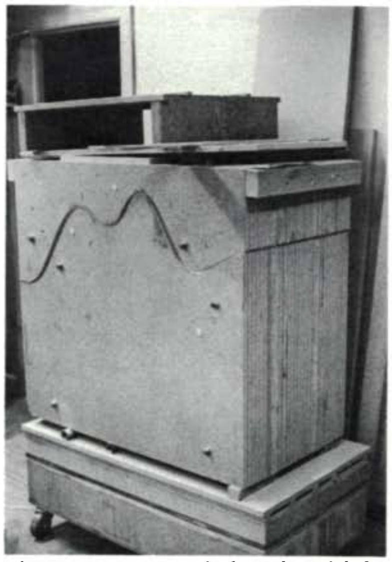
The chair cures for an hour in the press, then it's trimmed and finished with the aid of yet another of Danko's father's devices, a stationary pattern router. This machine consists of a horizontal pipe mounted about thigh-high, with a straight-flute router bit protruding through a hole in the top of the pipe. A template collar is welded to the pipe around the bit opening. Danko clamps a chair-shaped pattern to the rough stack that emerges from the press and runs the whole assembly over the pipe, the template collar guiding the pattern. About 15 minutes per chair and it's done.

In batches of eight, there's about 3½ hours of work in each side chair, and about $10 worth of materials. Danko sold the side chairs for $130 each. Thonet's price won't be fixed until a hundred chairs come off the line, but a spokesman says it will certainly be lower than Danko's price.

Although he's now out of the plywood chair business, Danko still makes sculptured furniture in his shop behind the Pond Gallery at 917 King St., Alexandria, Va. *—J.K.*

The sketch alongside is from an article about molded plywood in the January 1948 issue of the magazine *Woodworking Digest*. The author says the sketch was made from Scandinavian photographs "that turned up some ten years ago (late 1930s) and is evidence that molded plywood furniture, at least in the Baltic countries, dates back some years. . . . It is obviously one-piece construction and many arguments have taken place as to how it was cut and bent to the integral design illustrated."

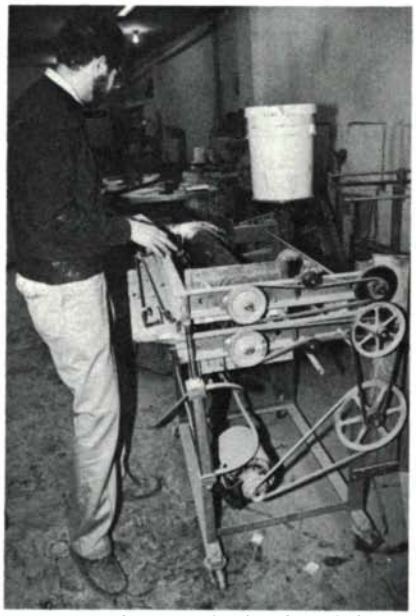
Peter Danko's one-piece plywood chair, left, is made from a 10-laminate sheet of slotted veneer, center. The pattern for routing the veneers for the chair with arms is at right.



The two-part particle-board mold for the armchair: The wavy line between the halves is, from left to right, the chair's leg, front, arm and back.

Danko opens the mold by bolting its top half to the upper platen of the press, built by George Danko to his son's specifications, and checks alignment as it moves up.

The long wedge hanging down from the mold forms the chair's rear legs; the rounded curve pushes the seat downward.



Glue-spreader coats both sides of the veneer in one pass. White bucket holds glue; plywood guard normally covers pulleys.

Danko runs jig over template router. Straight-flute bit protrudes through pipe; collar on pipe bears against jig.

Peter Danko

The Danko chair without arms.

Either version of the one-piece plywood chair can be stacked for storage.

Photos, except where noted: Staff

A Glue Press

by George Danko

My son's chair (p. 46) was amazingly strong, but to make it, a glue press was essential. His figures were out of this world: a 50-ton press with a 3-ft. by 4-ft. platen, with a lift of 80 in., for a shop with a 9-ft. ceiling. We discussed hydraulics, metering pumps and telescoping cylinders, but found their cost prohibitive. I am a devotee of simplicity. All that was needed was a huge, powerful clamp whose surfaces were always parallel, and long threaded rods would do.

A glue press is valuable in any woodshop as it can be used for an infinite number of operations. With this in mind we exceeded his minimum requirements: The final design consists of two platens 4 ft. by 6 ft., made of 7-in., 9.8 lb. channel iron, with a 2-in. dia. by 9-ft. long threaded rod at each corner. Roller-chain sprockets welded to nuts, driven by a single chain, provide the parallel clamping action. The power train is a 15-to-1 reduction gear and a 400 to 2,000 RPM variable-speed drive, powered by a $1\frac{1}{2}$ HP, 1,750 RPM reversible motor. A bicycle sprocket and chain linked to the speed control can vary the speed of the upper platen from 4 in. to 22 in. per minute.

To simplify the construction, I ordered all the steel cut to size, then welded 16 steel plates, 7 in. square by $\frac{1}{2}$ in. thick, to the corners. I drilled the plates on my Atlas lathe so the threaded rod could pass through: The eight plates on the bottom platen had 2-in. holes turned in them, and the plates on the upper platen were bored to a $2\frac{1}{2}$-in. dia. on the bottom side and $2\frac{3}{4}$ in. on the top side, each to receive a brass tube measuring 2 in. I.D. by $2\frac{3}{4}$ in. O.D. (turned down to a $2\frac{1}{2}$-in. shoulder on the bottom side, which secured the tubes in place). The brass tubes acted as bushings through which the threaded rods could slide. Four more steel plates, each bored through for the threaded rod to clear, were bolted through pipe spacers to the steel plates welded to the top of the top platen. These units trap roller-chain sprockets and washers welded to large nuts that fit the threaded rod. I added 4-in. squares of $\frac{1}{8}$-in. bronze, machine-screwed into each plate, to bear the thrust. All the plates were aligned on the same $\frac{3}{4}$-in. by 4-ft. by 6-ft. plywood template before welding. Nuts with a setscrew welded to the underside of the bottom platen kept the threaded rod from turning.

About this point I learned that the channel-iron platens had warped during welding, so I built them up flat with $\frac{1}{32}$-in. cardboard shims and added a $\frac{1}{8}$-in. hump in the center to compensate for the 50-ton load. Then two pieces of $\frac{3}{4}$-in. plywood were glued together and bolted to the steel platens, with a sheet of 14-gauge steel plate secured to the bottom platen to make glue removal easier.

The press groaned and squeaked, but it worked. However, some parts of the chair showed spaces between the veneers because the press just did not exert quite enough pressure. The drive sprocket would actually turn inside the chain, and the chain would not move. Peter thought of laying flat lengths of fire hose on the bottom platen, attaching them to an iron pipe manifold, and blowing them up with 90 lb. of air pressure. Since the working area of the hose totaled almost 1,500 sq. in., this provided more than 130,000 pounds of force, plenty to close the joints. □

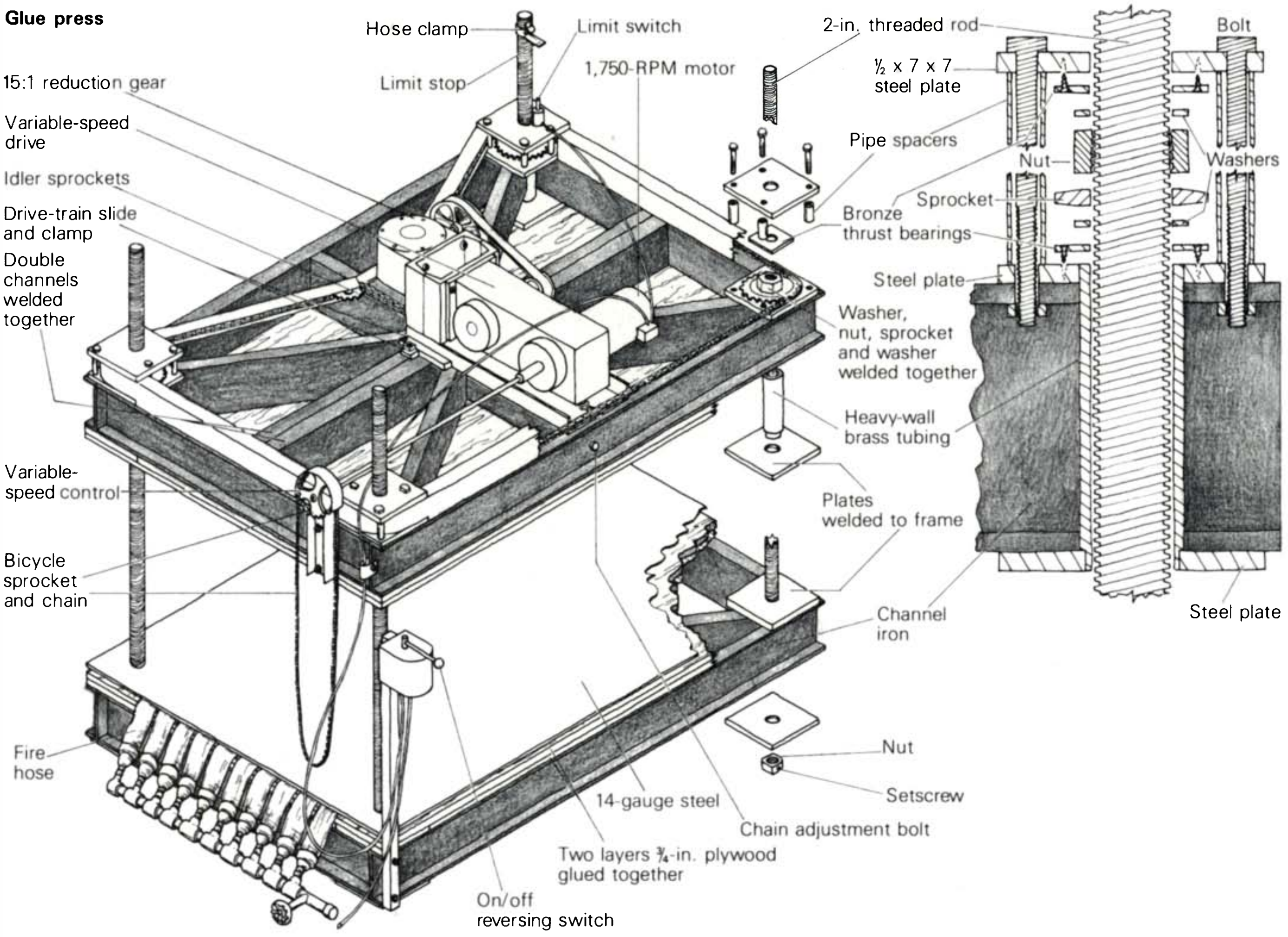


Illustration: Christopher Clapp

Working Woven Cane

Spline holds cane firmly on the frame

by G.A. Michaud

Though hand-caning was a staple project in every industrial-arts program around the turn of the century, the time when caning techniques were common knowledge has long since past. The rebirth of interest in restoring antique furniture and the lovely, sometimes startling application of cane in contemporary furniture, however, has created a demand for practical information about this craft. The easiest, most economical way to learn how to insert cane is to install it on a piece of existing furniture. Inserting machine-woven cane into prepared grooves is the quickest method. The photo below shows a chair seat and the materials you'll need: a pattern, a roll of cane, spline and driving and holding wedges.

Open-woven and close-woven cane are the two styles most frequently available to individual craftsmen, though some upholstery-supply houses sell others. Close-woven cane comes in 18-in. widths and costs about $7 a running foot. Open-woven cane comes 12 in. to 24 in. wide, in 2-in. increments, and costs from $5 to $10 a running foot. Spline, the strips used to hold the cane in the grooves, was once available in hickory and reed, but now only reed spline is available. It is classified as light (3/16 in. wide), medium (1/4 in. wide) and heavy (5/16 in. wide).

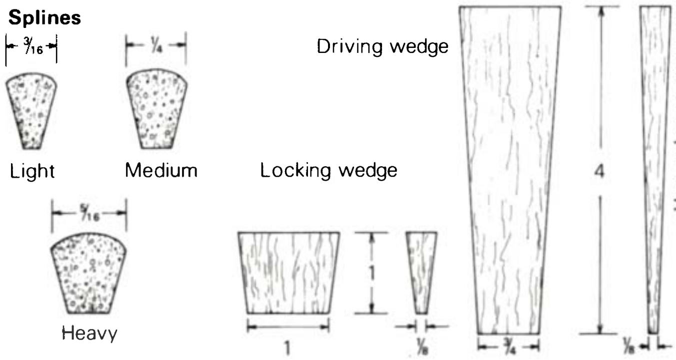
To begin, remove the old cane and clean the groove of glue, cane and spline. If the seat frame has a series of small holes drilled around the opening, you'll need to hand-weave individual strands of cane—a different process from what is described here. You could rout a groove 1/4 in. back from the holes, but I think it's easier to learn to hand-weave. Check the groove for size. It should measure 3/16 in. across by 1/4 in. deep. Sometimes the groove is 1/4 in. or 5/16 in. wide, usually an indication that the frame has been recaned several times—cleaning the groove of old spline and cane widens it. Buy spline in the size closest to the width of the empty groove.

Draw a pattern of the shape of the opening you wish to cover, allowing at least 1/2 in. beyond the groove. Transfer this pattern shape onto the cane webbing, cut it out and soak it in warm water. I have seen formulas for soaking solution: usually 1 1/2 tablespoons of glycerine per gallon of water. I haven't had great success with this because glycerine absorbs water from the air, and in an area such as the damp, river-valley town where I work, it makes the cane feel sticky. If your area is drier than mine try it, but test a patch first.

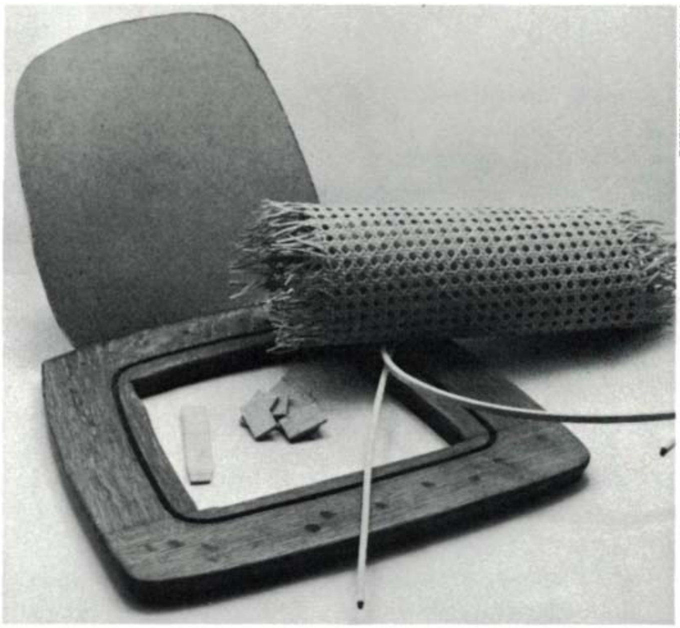
Establish the amount of spline needed and soak it along with the cane. Don't be afraid of damaging it—soak it at least an hour, longer if you prefer. The more pliable it is, the easier it is to work. The cane and spline will become not limp, but pliable enough so that when bent over on itself the fibers will not fracture. While the cane is soaking, seal the frame with sanding sealer so the wood is water-repellent—the cane is wet when you insert it into the groove. Next, make a number of hardwood locking wedges and a driving wedge.

Lay out the soaked cane over the opening with its shiny side up and align the weave parallel to the groove most prominent in design, usually the front groove. Woven cane has two sides—a glossy side and a dull side. The shiny surface is the bark of the rattan cane and is the side you wish to display to wear or view.

Pull out the weavers (horizontal members of the weaving) that run over the groove. You don't have to do this all at once but only where you intend to start. With the driving wedge and a mallet, force the cane with light taps into the groove, and lock it in place with the small wedges. Sponge the cane down from time to time to keep it pliable—sponge the dull side, because the shiny side isn't absorbent. To keep the cane flat and parallel to the groove, begin in the center of the



Illustrations: Christopher Clapp



Photos: G.A. Michaud

Materials: Pattern, cane, spline, driving wedge and locking wedges.

EDITOR'S NOTE: Three sources of cane and caning supplies are: Cane and Basket Supply Co., 1283 S. Cochran, Los Angeles, Calif. 90019; Inter-Mares Trading Co., 1064 Route 109, Lindenhurst, N.Y. 11757; and H.H. Perkins and Co., P.O. Box AC, Amity Station, Woodbridge, Conn. 06525.

frame and work out toward the corners evenly on each side. Continue right around the frame, moving from the front to the back, then to each side in turn. The edges of the cane will project up beyond the groove: Cut them off using a mallet and chisel at the outer edge in the bottom of the groove, pulling out the locking wedges as you go. A sharp chisel is a must, for the cane is pliable, stringy and tough.

Traditionally, once the trimming was complete, hot hide glue was run into the groove. For that you have to be fast. I find that aliphatic-resin glue (such as Titebond) works well and gives enough time to force in the spline, the next and final step. Plan where you want the spline joint. Begin there and force it into the groove, wedging the cane in place. Since the spline is soaked and is pliable, it will compress and make room for the cane that shares the same space. Do not expect driving in the spline to take up any great amount of slack in the seat—the seat is drawn taut in the wedging process. Drive the spline down until the crown is just visible, no lower than the frame surface. This way the crown will protect the bent edge of the cane from wear. Use a padding block in driving down the spline and not the face of the mallet, or the spline will be wavy and dimpled. I have read instructions for inserting dry spline into a groove that has untrimmed cane jutting out in order to tighten up slack in the seat. The results are disappointing. The crown of the spline may flatten out or split. In addition, the spline can't be driven all the way into the groove because the cane, while pliable, can not be compressed to the extent of being invisible. Trimming is also much more difficult because you must cut into the spline and can damage the crown.

When you get around to the back again, lap the spline over itself and cut it with a sharp chisel. Wedge the ends into place. Sponge off the excess glue and allow the cane to dry, about a day. The cane will shrink and tighten, so much so that when tapped it will ring.

Soaking raises whiskers in the cane. A light sanding with fine paper will remove most of them; snip the larger ones with scissors. Another method is to burn off the hairs with a torch, but the possibility of scorching the surface makes this method risky.

If you wish, the cane can be coated. Lacquer sanding sealer plus a lacquer top coat of whatever sheen will work well and change the natural color little. To add color, use a water stain on the damp cane—carefully. Cracks in the cane will accept more dye and the seat will have uneven color. Other methods, such as coloring the top coat or rubbing in a pigmented stain on dry cane, all give different results. Test a sample first. In my experience, oil and varnish finishes are too dark and uneven. Of course, you can always choose not to finish it at all.

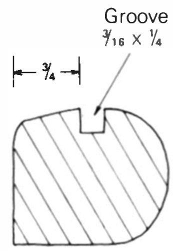
Making a caned headboard — My headboard, an ellipse with a major axis of 60 in. and a minor axis of 22 in., is made of elm laminated to a thickness of 1½ in., but ash, hickory and oak would work well, too. The ellipse is formed in two halves about 4 ft. long and joined by a simple scarf joint. Forming the headboard frame in two halves allows for different-width bedsteads and simplifies mold-building to a single all-purpose half. Just trim and join to the appropriate size.

After deciding on the design, I cut hardwood mold blocks 1½ in. thick shaped to the interior curve of the ellipse, and bolt them to a ¾-in. thick plywood base. I then cut follow-up blocks 1½ in. thick. Laminating itself is straightforward. I slice the elm a little over ⅛ in. thick—I prefer to slice my own veneer rather than use the thinner commercial veneers. Although laminating thin veneers may result in sturdier construction, thicker veneers require fewer laminations and create a finished form that appears bent from solid stock. A band saw fitted out with a hard-edge (not silver-steel) blade is ideal for this work because it cuts a narrow kerf and therefore wastes less stock. On a 14-in. saw I use a ⅜-in., four-tooth-per-inch blade with buttress tooth design. The problem with using these blades is that they come only in bulk-packaged lengths. Some mail-order houses (like Woodcraft Supply Corp.) will cut and weld band-saw blades to size, but a toolmaker who will weld blades to your specifications will give you the greatest selection.

Slice the laminate strips and keep them in order as they come off the plank; a touch with the hand plane and they're ready for gluing. I use an aliphatic-resin glue because of its color, strength and fast cycle time. Coat both sides of each strip using a small, short-haired paint roller and rub the strips together. When the pack is glued up (in this case 13 strips) lay it between 1½-in. wide steel straps and clamp into the mold. Straps keep the fibers from breaking out around sharp bends, smooth out imperfections in the mold, and even out follow-block clamping pressure. I recommend spring steel, but low-carbon steel can be used successfully if all the kinks are flattened out. Paint the steel because the interaction between glue and steel and wood will leave a stain—with aliphatic-resin glues it is usually deep blue-black. Allowing 30 minutes from the beginning of clamp time to mold release is not unreasonable in a warm shop. Then restrain the piece for about 24 hours, wrapping it with string or clamping it around a spare piece of mold, to minimize springback. If you're not in a rush, let the piece sit in the mold under clamp pressure, and little if any springback will occur.

Once the halves are molded, I join them with a simple, long, slender scarf joint. The resulting ellipse is planed flat so the router, used to cut the groove, will ride on a level base.

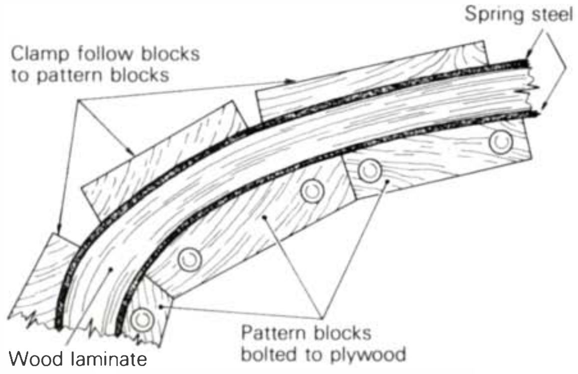
The usual placement of the groove for the cane is ½ in. back from the interior edge of the frame. In the ellipse headboard, the groove is set back ¾ in. Bevel the surface from the groove to the inside edge so the cane stretches free of the frame. In new construction I prefer the 3⁄16-in. spline for a delicate look, but no matter what size spline you choose, sink the groove ¼ in. deep.

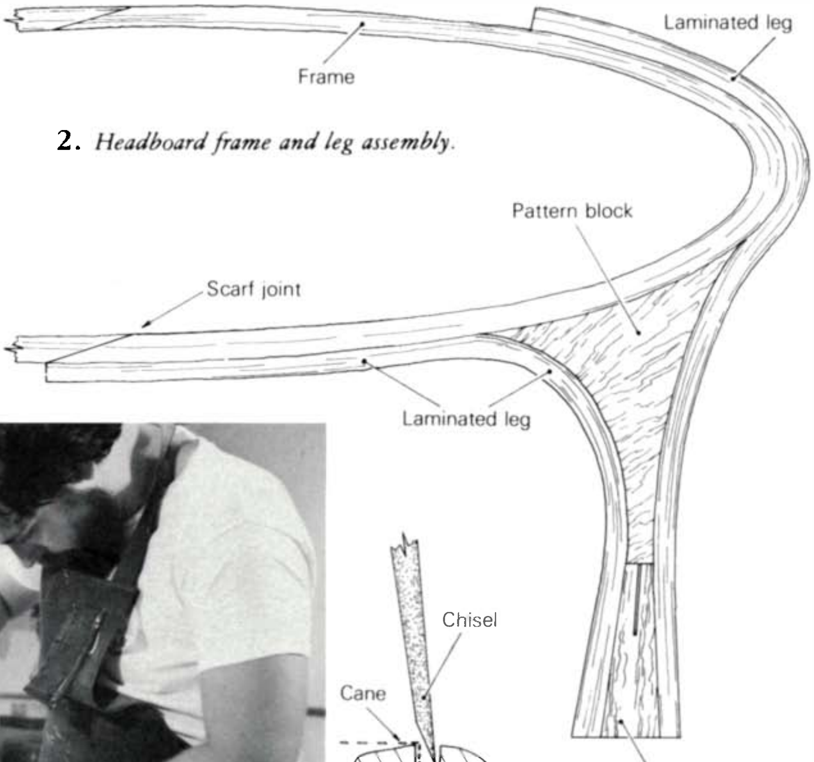


Now laminate the frame legs in the same manner as before, but this time the ellipse frame becomes part of the mold. Fasten the frame down around interior pattern leg blocks, one set for each side. The lower part of each leg is solid lumber and is both form and screw-in block for the bed rails. There is always a gamble with springback and each leg can take an independent set, but this is not too important and won't affect the strength of the finished product.

Once dry, shape the final form of the headboard. Since the overall form is curvilinear, I complete it with generous radii. A spokeshave and hand plane, unlike power sanders, which tend to dig in and are somewhat hard to control on light work, allow control and smooth out any dips. A 9-in. bench plane works well on long convex surfaces. I use three types of spokeshave: a flat-bottom straight blade, a convex-bottom

1. *Headboard mold.*





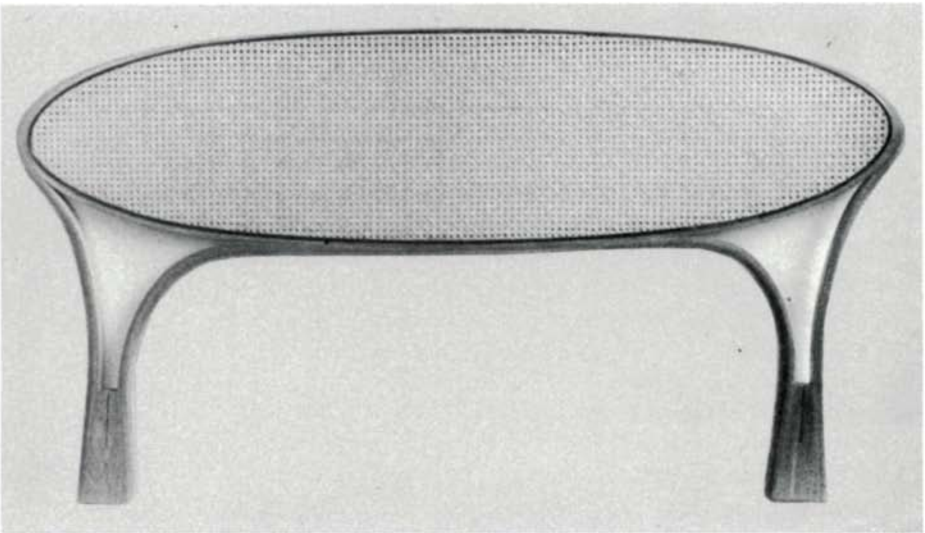
2. *Headboard frame and leg assembly.*

3. *The cane is forced into the groove and held in place with a locking wedge.*

Trim cane ends by chiseling at outer edge of groove bottom.

4. *Straggling edges are trimmed, as in the photo at left and the drawing above.*

5. *The spline is wedged into the headboard.*



6. *The completed headboard, of laminated elm, is 60 in. by 36 in.*

straight blade and a flat-bottom concave blade. Sand lightly with 150 garnet paper, then with 220.

Finishing is next. I use a lacquer system. The normal sequence is grain-raising, sanding with 220 garnet paper, staining, sealing, filling if necessary, then the top coat. Always seal the frame before inserting the damp cane. The sealer keeps stain from bleeding into the cane and water from the damp cane from soaking into the frame.

The spline shown in the headboard is stained black with an alcohol-soluble aniline dye, which when set won't bleed. Mix the strength needed and soak the spline until it is saturated with dye, then remove excess solution and dry. Resoak the spline in warm water to soften it, and it's ready to insert.

After cane and spline are installed and dried in the frame, complete finishing. I spray another coat of sealer over all and sand when dry. I only rub out the frame—rubbing out the cane is neither practical nor necessary. □

Gerry Michaud, 38, is assistant professor of industrial design at the University of Cincinnati.

Making a Basket from a Tree

Splints from black ash, in the Shaker tradition

by Martha Wetherbee

The completed basket is 12 in. by 9½ in. by 5 in., excluding the handle.

In my shop at Shaker Village in Canterbury, N.H., I make wooden baskets the way they were made 100 years ago. I make cheese baskets, egg baskets and laundry baskets. I reproduce Shaker kitten heads, cat heads, hexagons and chip baskets, also measures of all sizes from ¼ pint to ½ bushel. Openwork baskets with pegged wooden swivel handles swing from the ceiling on Shaker pegs. Most are filled with onions, garlic and shallots drying. I make other types, including the old-style basket that I stamp in color with potato prints. All are constructed without nails, staples, tacks or glue. The three surviving Shaker sisters at the Canterbury community, now in their 80s, remember very little about the basketmaking industry that died during their childhood. I have been reassembling the facts about the old craft so that my baskets will continue in the Shaker tradition as simple, functional products of the highest possible quality.

Choosing a tree — Baskets made in New England are usually made from black ash, also known as brown ash. This tree is particularly suitable for basketmaking; its yearly growth rings can be loosened by pounding them with a sledge. Strips of separated ring can be pulled from the log and woven into baskets, chair backs or seats because they bend easily without splintering or cracking. When finished smoothly they can be used to panel frames in cabinet doors or room dividers.

Black ash is an unattractive tree that seldom grows straight. Its butt is short with branches beginning eight or ten feet up. The branches are scrawny and crooked, and the top of the tree bends downward as though it were dying. Few live longer than 80 years, and few are cut commercially. Years ago black ash was known as the basket tree.

Healthy black ash trees grow beside good-sized free-flowing streams. Once I cut a tree by a stream that had at one time flowed briskly, but five years before had been dammed and rerouted by beavers. As the flow of water declined, so did the health of the black ash. Its annual rings were extremely difficult to separate when pounded.

The ideal basket log is a 10-ft. knot-free black ash butt about 12 in. in diameter. For the beginner a 6-ft. length, 6 in. to 8 in. in diameter will do. I don't recommend using a tree less than 5 in. in diameter. When I began making baskets I used whatever logs I could find—some of them crooked and knotty. The rings separated quite well, but many of the splints had to be rejected because they tore around a knot or were too curved. A few knots the size of a penny can be worked around.

When you find your tree, contact the landowner and tell him he has a basket tree growing in his wetland; a basket for the tree is usually an agreeable trade. When I select a tree for my next-year's baskets I feel that I am giving it a second chance in life—the opportunity to be converted into 50 baskets that will be cared for, admired and used for many more years than the tree would live.

Pounding apart the rings — Cut an ash in spring, the Indians say; there is a good deal of water in the tree and the sap has loosened the bark. Irwin, a full-blooded Penobscot Indian living in Indian Town, Maine, told me that years ago his father would start out early in the morning to search for a black ash. He would cut it and pound the splints from the entire log in that day. In the evening he would return with great bundles of splints on his shoulders. For me it takes 10 days of rigorous pounding, eight hours each day, to pound apart one log.

Although the Indians traditionally cut black ash in the springtime, I have had success all year round. A tree cut in any season should separate easily if pounded within a week of being felled. A log that cannot be pounded immediately or one that still has lots of good splint on it should be submerged in water to keep it from drying out, though soaking for more than a year may rot the inside.

I recommend using the back of an ax for pounding. Grind the edges of the end round to avoid sharp corners that might perforate the splints. The back end of a splitting maul, a hatchet or a sledge hammer might also be used.

Set the log on the ground or in *V*-grooves cut in the ends of two stout stumps. Shave off the bark with a drawknife. Pound a section 2 in. or 3 in. wide along the log from one end to the other. Strike with the same force you would use to split cordwood. Allow each impact to overlap the one before it.

The first few layers below the bark, which include the cambium and some of the youngest sapwood, will need a good deal more strenuous beating than deeper layers. Don't become discouraged if the growth rings don't cooperate. The farther you get inside the log, the easier they will separate. These first layers are too brittle for splints and tear easily. Sometimes it is easier to shave these layers off with a drawknife. It may take as long as two hours for one person to get the outer portion off the log. You will know when you have arrived at good splint wood by the strength and flexibility of the material. Now the careful work begins.

Give the end of the log some extra tapping to begin separating the splint. You will be able to lift the outer ring with your fingers and pull off a strip that is 2 in. or 3 in. wide, though wider strips are possible if enough of the log has been pounded. Continue pounding and stripping the entire circumference of the log before starting the next layer. Sometimes more than one growth ring can be lifted at a time, de-

Photos: Richard Starr; Illustrations: Christopher Clapp

pending on the wood and the force of the blow. I have taken as many as six layers of splint up at one time. If you have difficulty getting layers to separate just keep pounding, being sure not to miss a spot. You can't skip around; there are no shortcuts to making good splint.

The thickness of the annual rings will vary according to favorable or difficult growing conditions during the year they were formed. I have found no differences in working qualities between heartwood and sapwood, though heartwood splints, which come from deeper in the tree, are darker in color.

Occasionally annual rings won't separate from one another. Such layers may look pithier than the others on the end grain of the log. Remove these rings with a drawknife and resume pounding on good layers. I once acquired a log discarded by another basketmaker who'd encountered sticky layers halfway through. I took it home and submerged it in a pond, weighing it down with logs. A month later I cleared the sticky section by shaving and pounding for an hour. The splints below this section pounded with ease. There were 40 good years left in the log, which made 25 baskets.

Preparing the splints — Sort splints according to their thickness. I once wove a large laundry basket using thin splints, and a heavy load of laundry permanently ballooned out the sides. Make the basket from heavy splints if you expect it to carry heavy loads.

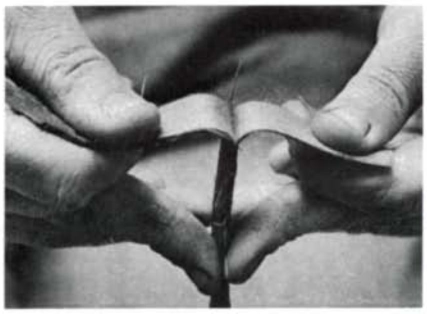
Cut the splints with heavy scissors to proper width and length for the style of basket you choose to make. The Indians built their own stripping tools by embedding a clock spring with sharpened edges in a block of wood. A leatherworker's tool made for cutting strapping works well and costs about $8.

All wood grows in annual rings, and each ring has two layers: earlywood, which grows rapidly in the spring, and latewood, which is formed more slowly in the summer. Black ash is a ring-porous hardwood, which means that the earlywood layers contain many large, sap-conducting tubes called vessels. There are fewer vessels in the latewood and they are much smaller. Because of this structure, earlywood is more coarse and less dense than latewood. When ash is pounded, the earlywood collapses and comes apart.

Black ash basket splints, as they come off the log, are composed of smooth, strong latewood with a stringy coating of earlywood on their outer surfaces. Growth rings can be used as basket splints in their natural state, but you can split thick layers into thinner pieces. When you do this, you get two splints, each with a smooth surface of latewood on one side. Very thick splints can be split into thirds or quarters, yielding interior splints that are satiny on both sides. The advantage of

Black ash (Fraxinus nigra), *also known as brown ash, splits easily, and therefore is a perfect basket tree. It is found in Northern wet areas and is 40 ft. to 80 ft. tall. Its pinnate, elliptic leaves number seven to eleven, its bark is shaggy and its buds are dark brown. At upper right, Wetherbee pounds a black ash log that has been soaking for a year, which is why it appears so dark. Note the overlapping impact marks. Right, she peels off an outer-ring strip.*

To get thin splints, score halfway through a strip near an end (above), bend it back (top right) and peel the halves apart (right). To correct runout, or unequal thickness, increase the tightness of the bend of the thicker half at the point of splitting. The split will move toward the thicker side. At left, Wetherbee uses a splitter she learned of from a Maine Indian basketmaker. The split end of the splint is pushed through an opening in the apex of the inverted V. The sides of the splitter can be used as fulcrums to bend the splint over to prevent runout.



splitting is twofold: You get smooth surfaces and, if you care to conserve material, several splints from one. Mixing satiny splints with the coarse, as the Shakers did, can create textures extraordinarily pleasing to the eye and to the touch. Rough splint surfaces may be scraped smooth. I use a paint scraper or a drawknife to remove the fuzzy outer layer.

Weaving the body of the basket — Weaving the basket is not difficult or time-consuming. In fact, most of the time in basketmaking is spent selecting the ash, pounding it and carving handles and rims. Some baskets have round bottoms, others are square or rectangular. I will describe how to weave a basic, rectangular market basket about 12 in. long, 9½ in. wide and 5 in. deep. The only tools you will need are a work table, scissors and a bucket of water.

The vertical members of the basket are thick splints called uprights. This basket will need 7 splints that are 25 in. long, ½ in. wide by 1/16 in. thick and 11 splints the same width and thickness but 22 in. long. (Baskets with handles must have an odd number of uprights so the handle sits centered on an upright.) The horizontal members of the basket are called weavers. You'll need 32 weavers about 41 in. long and about ¼ in. wide by 1/32 in. thick.

Soak the uprights until they are pliable—up to 30 minutes. Weave them into a tight mat about 9½ in. by 6½ in., with the long splints running in one direction and the short in the other. The tightness of the mat is limited by the thickness of the splint; little square openings will remain between the strips. Soak the weavers until they are workable. The first weaver helps to hold the bottom mat of the basket together. Weave it around the mat, over and under. The ends of the weaver will overlap, and this overlap should cross two consecutive uprights.

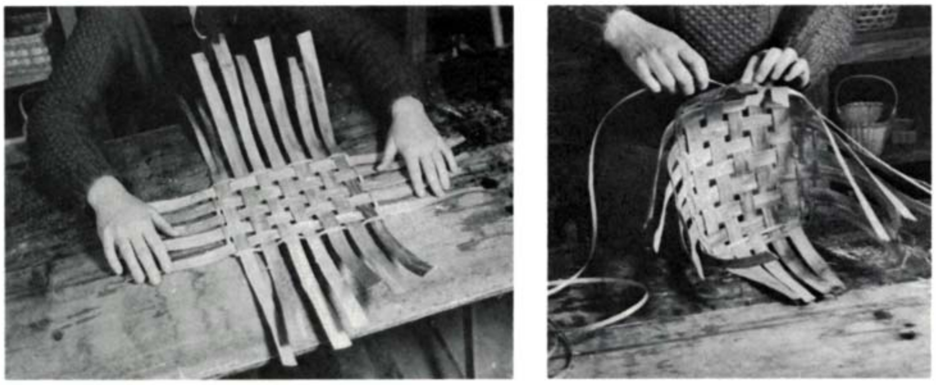
When wet, the sides of a basket can be bent to whatever shape you desire. Making sure the uprights are pliable, bend all the uprights upward and then inward toward the center of the basket. As you add courses of weavers you must continue to persuade the side splints to take the shape of the basket. As the rows accumulate, the uprights begin to stay in position without help.

Each weaver should begin and end under a different pair of uprights from its neighbors so that the overlaps are staggered around the basket. With all the weavers in place, the wet basket should be about 6½ in. high. Set the basket in a sunny window to dry for at least two weeks. You will find that the basket has become loose because the splints have shrunk in width as they lost moisture. Tighten the basket by pushing the weavers toward the bottom, one row at a time. With scissors, cut the uprights that end inside the top weaver flush with the top of the basket. Trim the outside uprights to form points a couple of inches above the edge of the basket. Invert the basket and immerse the projecting uprights in a shallow sinkful of water for a few minutes to soften them. Tuck them down into the weavers on the inside of the basket. The body of the basket is now finished and ready to be rimmed.

Making rims and handles — For me the most exciting part of making a basket is carving and shaping wood for rims and handles. I use white ash or hickory, trees fairly easy to find in New Hampshire, for the inner rim and handle. White oak, red oak or brown ash could also be used. For the outer rim, because it has little structural value, I use a heavy piece of ash splint rather than split and shave wood.

Choosing a good tree is important. If you select the right one, your handles will bend with ease; if not, they are likely to break. The perfect tree for handles is healthy, knot-free and 3 in. to 8 in. in diameter at chest height. The bark of a healthy tree looks young, tight and vibrant. It is best to use the wood as soon as it is cut, though a log will remain fresh for up to a month if kept whole. Once split up, the wood becomes too dry to use for basket parts in less than a week. I go into the woods in the morning to select a tree and usually have made four or five handles and rims before the afternoon has passed.

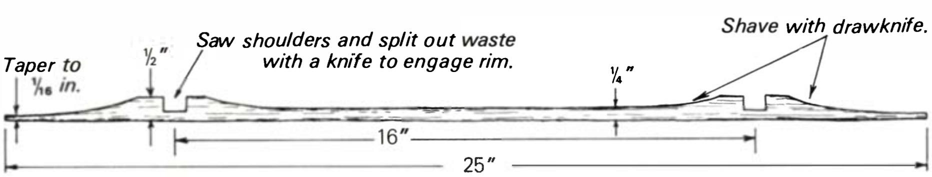
The length of the log you'll need is determined by the size of the basket to be rimmed. For our basket the rim is 40 in.



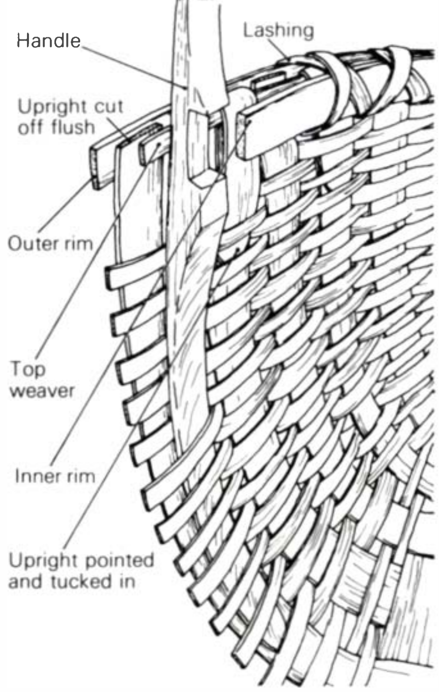
After the uprights have been woven into a mat, left, weave a weaver around it, right, and bend the uprights up and in. Successive courses of weavers begin to hold the uprights in shape to form the sides of the basket. The handle (figure 1) is shaped on a shaving horse with a drawknife, notched and attached to the basket (figure 2).

1. Basket handle before bending

Not to scale



2. Basket construction



and the handle needs 25 in., so cut a section about 40 in. long from the butt of the tree. Split the log into quarters with a sledge and a wedge until you can split the pieces further with a froe and a wooden maul. The closer the piece is to the size of the handle and rim, the less time you will spend shaving it out with the drawknife. The best part of the wood for bending is the sapwood closest to the bark. Try to split out a section that is 1 in. to 1½ in. square or pie-shaped, but a 2-in. piece will do if splitting gets difficult.

To make the inner rim, clamp the stick in the shaving horse (*Fine Woodworking*, Sept. '78) with the bark side down. Holding the drawknife bevel side down, shave wood off the heartwood side of the stick, a single growth ring at a time. The drawknife can shave away lots of wood quickly, so be cautious. Your aim is to obtain a stick ½ in. wide and ⅛ in. thick. Follow the growth rings as closely as possible to maintain continuous grain. Working just inside the bark is easiest because the bark side of the stick is true to the grain. Hold the stick at arm's length and sight along its edge. The piece must be uniformly thick to make a smooth and even bend. When the stick is almost down to size, turn it over and shave off the bark and cambium layers, trimming the stick to its final thickness. When the piece is perfect, chamfer the edges with the drawknife, then use a hand knife to round the edges of the rim.

Green wood cannot be bent abruptly; it must be coaxed to take a new shape. With the sapwood side of the stick on the outside of the curve, begin at the center of the stick and work outward, bending the stick at 2-in. intervals. I use the end of the shaving horse as a fulcrum when I begin to bend and later hold the wood in my thumb and forefingers. With repeated coaxing, being more forceful each time, the stick will loosen up. When the shape is nearly round, form it into a complete circle and hold the overlapping ends together with two spring clamps. Now you can form the rim into an oval, matching it to the shape and size of the inside top of the basket.

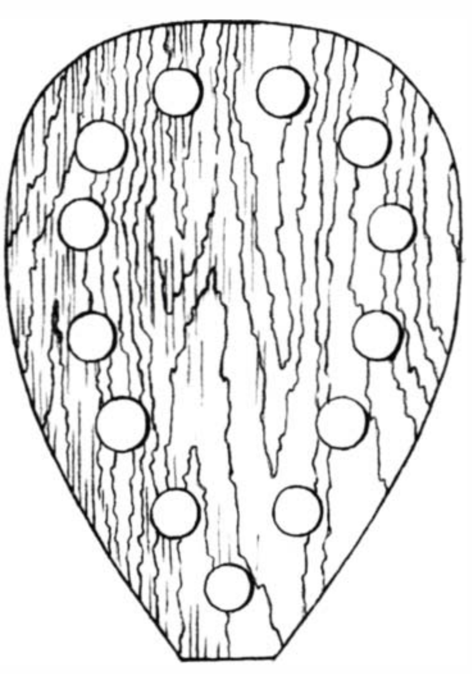
If at any stage of the bending you discover sections of the rim that need to be shaved thinner to bend properly, don't be afraid to unbend the rim and put it back on the shaving horse; green wood will return to its bent shape easily. When you are satisifed with the shape of your rim, return it to the shaving horse and taper the ends in thickness so that no lump forms where they overlap.

Carving the handle is similar to shaping the rim. Start with a piece about 25 in. long and shave it into a ½-in.-square section. The arch of the handle is 16 in. long, with 4½-in. ends that project into the basket. Center the 16-in. measurement on the heartwood side of the stick. Shave away this section until its thickness is a uniform ¼ in. Chamfer the edges of this underside surface with the drawknife and round the chamfers. Leave the top surface of the handle flat. Taper the ends of the handle to about 1/16-in. thickness, as shown in figure 1.

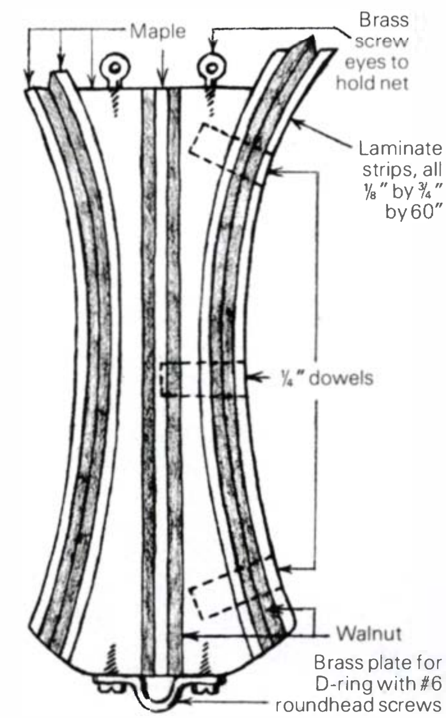
Coax the handle to its bent shape as you did the rim. When you are satisfied with the curve, tie the ends of the handle together with wire or string and let it dry overnight. After drying, the once supple wood retains its form and no longer feels workable. To cut the notches to fit the rim, clamp the handle in the shaving bench. Use a fine-tooth saw to cut two slots to accommodate the width and thickness of the rim. Split out the waste with a knife.

The basket is finished by attaching the rims and handle to the body with spring clamps. Prepare the lashing from thin splint cut to 3/16-in. widths. Slide one end of the lashing splint down along an upright, fold it up and tuck it under a couple of weavers. Then bring the lashing up over the rim and down between two uprights. Wind the entire basket in one direction and tuck the end of the lashing into the body of the basket. This basket has a second lashing wound the other way around the rim, over the first lashing, creating a crisscross pattern and adding strength. The rim and handle form a rigid framework. The woven body flexes to resist shock. In combination, they make a durable and attractive vessel. □

Martha Wetherbee, 30, of Sanbornton, N.H., is a former elementary-school teacher who turned to basketmaking four years ago.



Net form
(holes are for clamps)



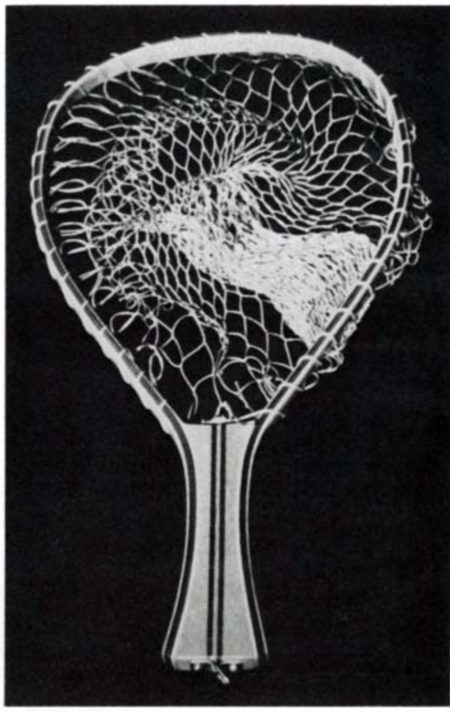


Photo: Jonathan Knight

Laminated Fishing Net

A generous hoop pursues the noble trout

by Jonathan Knight

I am a recreational woodworker and don't have the expertise that many of the contributors to this magazine demonstrate. As a consolation, however, I do not have to produce in order to sustain myself, and this leisurely consideration of my projects lets me refine my ideas without time constraints. One simple project I have enjoyed is the fishing net shown here. It was a challenging design problem that bears dividends in all too infrequent use on the stream. I have made four or five of these nets now, for myself and a few good friends. The first was made five years ago and has seen seasonal use since with no ill effects or structural problems. It easily handled my largest trout, a four-pounder, and has bumped along many a stream clipped to my fishing vest.

The size of the hoop is generous, to match my optimism in pursuing the noble trout. The laminated hoop is constructed around a waxed plywood form, and composed of four ⅛-in. hardwood strips—two of walnut and two of curly maple. I cut them long enough to encompass the form plus the handle, usually 5 ft., and plane them. Then I bandsaw the two matching maple pieces for the handle and smooth them with spokeshave and files. The width of the walnut and maple spacing strips for the handle is important—the total width of the handle must just equal the throat of the hoop form, for a strong glue bond.

To assemble the net, I apply Weldwood plastic resin glue to all mating surfaces of the hoop strips, which are arranged with alternating grain in order to maximize stability. I use an extra maple strip as a caul to distribute the clamp pressure and to avoid marring the hoop. I begin clamping at the middle of the hoop and work around the sides until the hoop is fully secured. Then I apply glue to all the inner surfaces of the inner strips that join the handle, and with some fiddling and fussing I clamp the handle into position as well. Here precise cutting of the spacer strips pays off, because too little width will not permit adequate clamp pressure at the critical junction of the hoop and handle, and a poor gluing job will, of course, cause delamination.

After the glue has set for 24 hours, I remove the clamps and do preliminary shaping with a plane and spokeshave while the hoop is still around the plywood form. In this way I can remove excess wood and glue in a symmetrical fashion. A few blows with a mallet remove the form from the hoop, and I final-shape with spokeshave and scrapers. Then I reinforce the handle/hoop bond with ¼-in. maple dowels, three on each side of the handle.

I finish with five or six coats of Flecto Humicure catalyzed exterior finish, sanding between coats. It is a most durable finish. Then I attach the net with nylon cord around the hoop and anchor it at the throat with small brass screw-eyes inserted before finishing. A brass *D*-ring and mounting plate at the handle butt complete the net. □

Jonathan Knight practices orthopedic surgery in Seattle, Wash. An avid woodworker, he has recently completed a laminated oak couch and a lapstrake cradle along the lines of a Viking boat.

Illustrations: Mathilde Anderson

Knockdown Tabletops

Dovetails, not hardware, pin top to base

by Kenneth Rower

For storage or shipment it is often advantageous for a tabletop to be quickly removable, while in daily service the top should be fastened securely enough for one person to be able to shift the table within a room. Here are two construction systems that require no hardware—one for tables with apron frames together with a variation for pedestal frames, and the other for trestle frames.

Apron frame — This method uses dovetail pins cut at the tops of the legs and dovetail housings with escapements chopped across the grain of the underside of the top. To assemble, drop the top over the pins and push it across the frame to lock the pins in their housings. To disassemble, push the top from the opposite side until the pins register in their escapements, and lift the top away. Properly dimensioned, the system is invisible when locked up (figure 1).

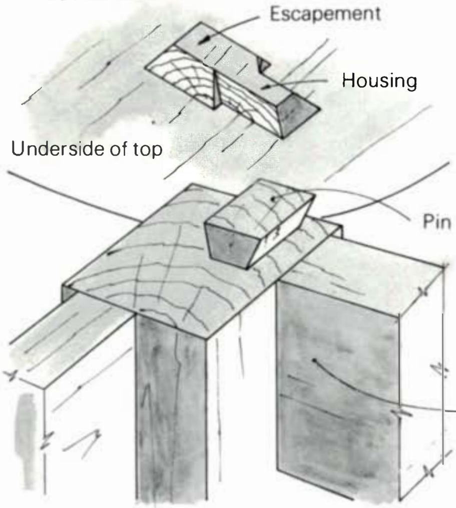
When sawing the legs, leave extra length at the top end equal to about half the thickness of the tabletop, and when laying out the rail mortises do not omit the customary allowance above the top of the mortise—about ¾ in. for a 4½-in. rail. Square up the top of each leg and take all measurements from there. Build the frame and assemble dry, leaving the rails strong to be trimmed later. Sketch plans and elevations of the leg tops, bearing in mind that all four pins must be offset in the same direction, and that if the system is to be concealed the pin length must be a bit less than half the leg thickness, an allowance being made for seasonal change in the width of the top. Later in the construction, when the frame has been fitted to housings, the escapements will be lengthened as well to accommodate this variation. For frames of ordinary size, about 30 in. across, divide the leg top into two pin lengths plus ⅛ in. at each end (figure 2), then lay out the pins using a mortise gauge for the side and end lines, and a small adjustable bevel, set to a beveled guide block (about 78°), for the slopes. Gauge the shoulder lines from the end. Make the four cuts outlining the pins, then saw the shoulders. Trim with a sharp chisel, testing the work with the guide block. Finish all work on the frame except polishing.

Build the top and trim it sufficiently to center the frame. Scribe the outline of the pins on the underside of the top to mark their position when locked up (figure 3), but note that the outline is of the crown of the pin rather than its root, which is actually wanted in this space. Mark near each outline the direction the frame will travel when unlocking. Pencil in a benchmark on one leg and nearby on the underside of the top to register the location, and remove the frame.

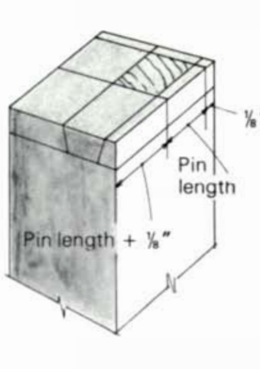
Lay out the escapements by extending the scribed sidelines in the proper direction a distance equal to the pin length, and connect the new lines with an end line. Find the centerline along the length of this double box. Measure the width at the root of each dovetail pin and transfer it to the layout of the housing, employing the centerline. If the measurements vary from pin to pin, transfer one at a time. Cut the escapements, first boring out with a Forstner or other short-pointed bit, then chopping square. There is no advantage and some danger in going any more than a trifle deeper than the height of the pin. Test the frame in the escapements to be sure that the shoulders of the legs lie flush with the underside of the top. Level as necessary. Now remove the frame and lay out the slopes of the housings, using the adjustable bevel set to the guide block. Bore out, then with a dovetail saw rough out the slope, keeping a little strong of the line. Chop out the waste, again keeping away from the line. Clamp the guide block at the line and trim with a narrow paring chisel, the final cuts to be taken with the chisel right against the block (figure 3).

Lay the frame in the escapements and see that the pins are

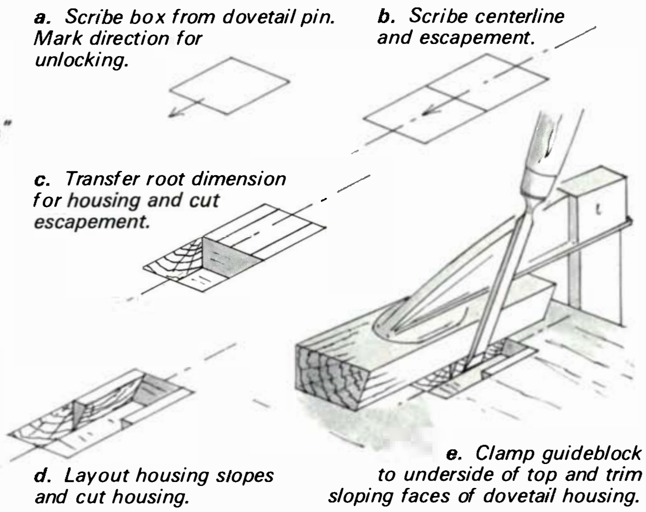
1. Dovetail pin and housing system for apron-frame tables



2. Pin layout



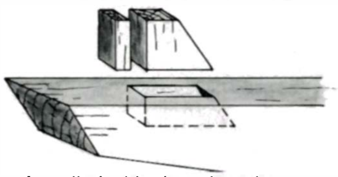
3. Layout and cutting of dovetail housing and escapement



likely to enter the housings. Then remove the frame and chamfer the leading corners of the pins. Replace and push (or pull). Considerable force may be necessary the first few times—waxing the pins is helpful. However, a driving fit means too much interference. Usually one joint will cause the trouble, or two that are not in parallel across the frame. There will be enough flex in the frame so that tapping at each joint will tell which one is binding. If you trim away too much during adjustments, a piece of veneer or cedar cigar wrapper (.009 in. thick) can be glued into the housing. When all is well, remove the frame and stamp a benchmark into the top of one pin and inside the corresponding escapement. At this point consider the probable shrinkage and expansion of the tabletop, and lengthen the escapements accordingly. Round off all the points and corners of the pins and the entry corners of the housings, as in service the top drops down over the pins, somewhat by feel. Then the near pair of legs can be gripped and the top pushed home with chest or waist.

Pedestal frame — As the arms of a pedestal frame do not offer the appropriate grain for cutting pins, separate pins must be fashioned and joined to the arms. Make up pin blanks of rectangular section, but with one sloping face in the length, then mortise in with a shim to drive the blank against a correspondingly undercut end of the mortise. Saw the slopes once the blank is glued and trimmed.

Dovetail pin for pedestal table



Install pin blank and wedge in pedestal arm, then shape pin.

A blank could be fitted up through the underside of the arm and then wedged below, but shrinkage in the depth of the arm would leave the pin standing proud and the joint loose. The best orientation is for one set of arms to be perpendicular to the grain of the top, the other parallel, with room left in the housings perpendicular to the grain for tabletop expansion and contraction. If you orient the arms at 45° to the grain of the top, the system works but the housings won't be as strong.

Trestle frame — In a knockdown trestle frame consisting of two trestles, a stretcher, and two draw-wedges, the action of the wedges in drawing the trestles tight against the stretcher shoulders can be exploited to clamp the tabletop to the frame. The system consists of a barefaced dovetail cleat formed by extending the post tenon up through each trestle arm, and corresponding housings cut into the underside of the top where it bears on the arms (figure 4).

When cutting the posts, allow for bringing the tenon through the arm, plus an amount equal to about one-half of the thickness of the tabletop, and square the end of the post. Cut the mortise-and-tenon joint, assemble dry, and mark the tenon where the top edge of the arm crosses the cheeks. Remove the post and using a dovetail plane or a wide paring chisel, cut the slope on the inner face (with respect to the middle of the table) of the tenon. The shoulder should be a little behind the line to allow for shrinkage in the depth of the arm (figure 5). Build the rest of the frame.

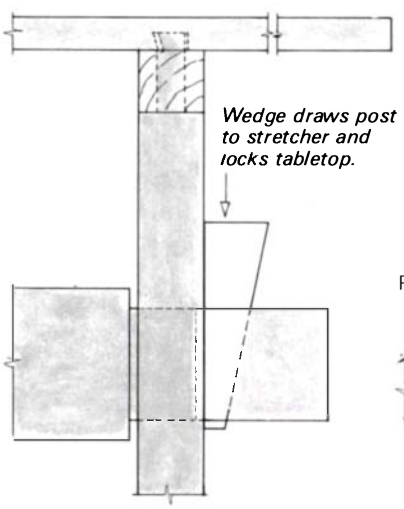
Make the top and trim to size. Make up a beveled guide block as before though long enough to be clamped from the tabletop edges, and if the underside of the tabletop is not already flat, plane flats where it will bear on the trestle arms. The flats must be parallel, in plane (check with winding sticks) and wide enough to register the guide block.

Invert the assembled frame and center it on the underside of the top. Scribe the outlines of the cleats and remove the frame, benchmarking one end of the system. The outlines mark the location of the cleat crowns, not their roots. With a steel tape, measure the inside distance from root to root of the cleats, add 1/32 in. (more for a very long table) to provide compression to the system, and transfer to the layout of the housings. Draw another line outside the housings to allow the cleats to enter the housings before locking up (figure 6).

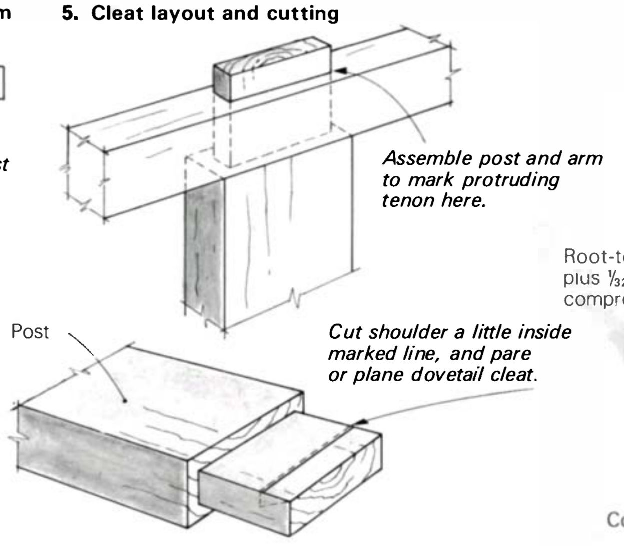
Bore and chop out the housings, keeping clear of the sloped faces. Then clamp the guide block in place and chisel back the sloped faces. Leave a little clearance at the bottom of the housings. Round off the entry corners of the housings and the points and corners of the cleats. To assemble, fit the trestles loosely to the stretcher, spacing them out from the shoulders an amount about equal to the swell in the cleat. The top should now drop easily over the cleats. Drive home the wedges to lock up the trestles and the top. Should the system loosen, tighten it by trimming the shoulders at one end of the stretcher, or by installing a shim in one housing. □

Kenneth Rower, 37, makes furniture in Newbury, Vt.

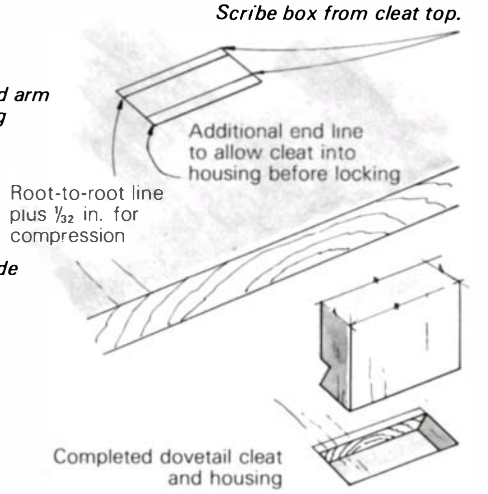
4. Dovetail cleat and housing system for draw-wedged trestle table



5. Cleat layout and cutting



6. Housing layout for dovetail cleats



Orientable

Another knockdown design

by Curtis Erpelding

Fir, maple and walnut, 60 in. by 36 in. by 30 in.

The process by which a piece assembles itself intrigues me. Most of my designs incorporate a knockdown feature to emphasize and perpetuate the act of assembly. There is a pleasing gestalt to how a few components, only so many pieces by themselves, transform into a table or chair, and easily disassemble for moving or storage. Stacked and sculptural furniture seems too solid and final in comparison.

Knockdown design assumes easy fastening. The less hardware involved, the purer the design. I cut the compound-angled *V* in the end of the through stretcher tenons with a radial arm saw. A slight tap on the correspondingly tapered wedge that fits through this slot draws the stretcher against the cross member (figure 1). For a more secure fit I routed a *V*-shaped dado into the back of the cross member and chamfered the tenon on both sides to seat into it. But not exactly—the *V* of the stretcher is slightly fatter than the dado in the cross member so it mates ever more tightly.

The top is standard breadboard construction. It is free to contract and expand and easy to remove. Cleats screwed to the underside of the tabletop center it when they're placed to one side of the stretchers. The cleats and stretchers are through-mortised and drawn tightly together by folding wedges whose opposing ends curve. When the top expands, the right cleats are free to move with the tabletop and a gap opens between cleat and stretcher (at the single arrow in figure 2). With contraction the left cleats are free to move and a gap opens between cleats and stretchers on the left side of the table (double arrow). As the seasons change, the top may position itself up to ½ in. off center, but it will stay flat and intact.

In evolving this table (it had two prototypes, one in fir and one in maple), I added a drawer of walnut and maple, hung under the top by its slide—a bit of whimsy. Instead of the usual square groove, I worked hollows in the drawer and matching rounds with planes. The two slides are connected at the back and the whole unit slips into the stretcher via bridle joints. The slides and the top edges of the drawer are flush with the bottom of the tabletop, which supports the unit.

I chose fir for the table itself because its graphic grain is right for subtle curves and crisp edges. There's a certain delight in working what most people consider a common utility wood. I hand-planed all surfaces, including the top; I had only a 4-in. jointer and no thickness planer. All curves—first bandsawn—I worked with a spokeshave. The realized curve of the legs, though based on the Fibonacci series, comes from tool, hand and eye. I don't use templates or calipers. □

Curtis Erpelding, 29, has recently become a resident woodworker at Oregon School of Arts and Crafts.

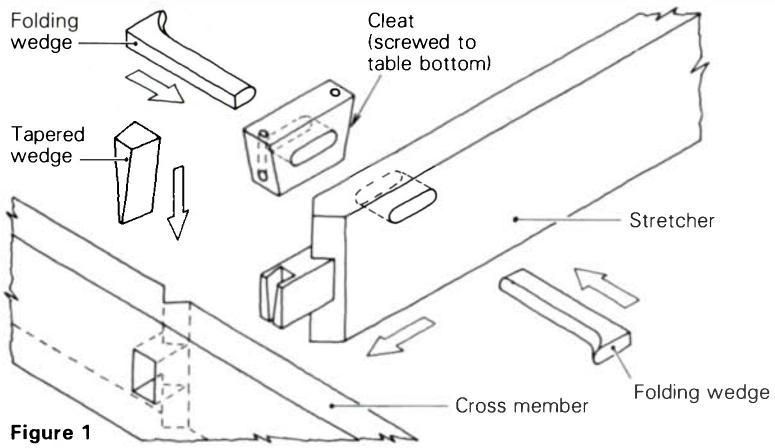
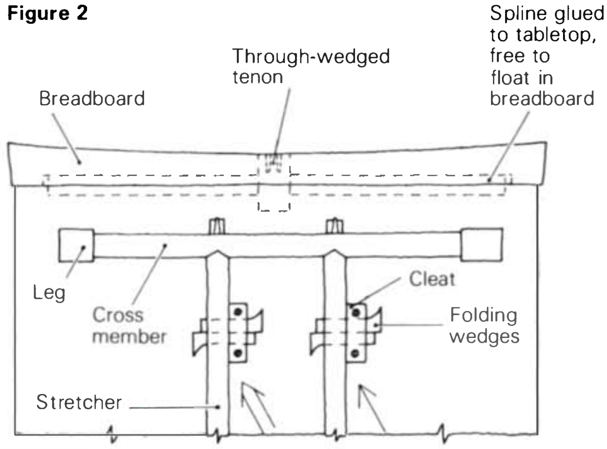
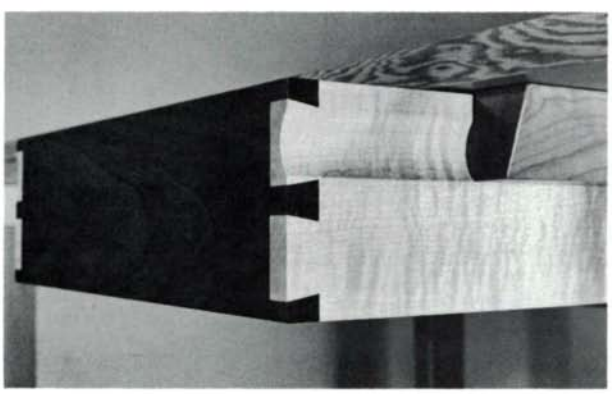
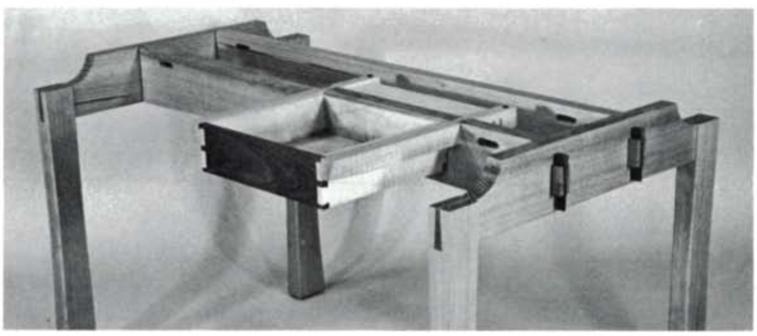


Figure 1

Figure 2





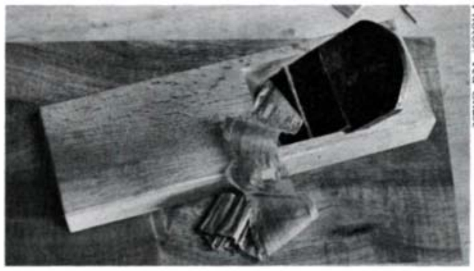


The name 'Orientable' suggests both the orientation of parts into a table and the Oriental influence on the design.

Japanese Planes

The preparation and use of *kanna*

by Ted Chase



Photos: Ted Chase

Woodworkers, both amateur and professional, have been hearing lately about Japanese tools. Ads mention "superior edge qualities," pulling instead of pushing, and assorted other exotic advantages. Interested people who have purchased a Japanese tool may have brought it to the shop, used it for a while and gone back to work with their original tools. Others have found that the tools they bought "didn't work" at all. As with all fine tools, knowing how to care for and prepare them is essential for premium performance.

A brief history — Probably the most striking thing about traditional Japanese woodworking is that much of it is done in a sitting position. The earliest of Japanese tools, the *chona*, or adze, was used long before the introduction of the ripsaw (late 14th century) to rough-surface lumber that had been split with wedge and/or chisel. The adze handle was wood and the blade socket was of primitive and thin metal. A person's full, standing force behind this tool would break the socket—thus the seated position. Nor was this unusual to the lifestyle. Japanese homes have long been designed for multiple-purpose living with minimal furniture; sitting on the floor has been the typical posture for work and for eating. Woodworking was similar. Because few woodworkers had large, permanent shops, a great number of master carpenters, carvers and apprentices would be gathered for a commission by an emperor, feudal lord or military leader. These artisans would set up shop at the construction site, so putting the work on the ground eliminated the need for a workbench. Since less power was applied to the work, it required no mechanical clamps or vises. Because the adze was used across the grain rather than along the length of the piece, the stroke was shorter and a worker could keep one hand free to hold or position the piece. Both feet were available as clamps and weights. Even today, Japanese craftsmen prefer to work sitting down. And where workbenches are used, they're much lower than Western benches, and without vises. The worker planes against a bench stop. Because the bench is low, he can place a foot or leg up on it to hold down the work.

It wasn't until the late 1300s that Japanese blacksmithing and iron manufacturing improved significantly. Along with the refinement of military weapons and ceremonial swords came the introduction of the ripsaw. Lumber cut with these saws could be surfaced more smoothly with a new tool introduced from China via Korea. Its blade, stronger than the *chona*, was set in a block of wood that was moved over the length of the piece to yield a smooth, flat surface. These planes, as used in China and Korea, were designed to be pushed, not pulled. The early imports had a dowel or piece of wood used as a handle, extending through either side. However, these handles soon disappeared, and the craftsman pulled the plane over the work from a seated position.

There have been numerous explanations for the reluctance of the Japanese to adopt the push stroke. Earlier tools and the lifestyle had established deep precedents. Pull-type crosscut saws were used as early as 800 A.D. Given the state of the blacksmith's art at this time, thin blades did not have the stiffness to be pushed through the wood. Perhaps the pull stroke in carpentry goes back to the earliest farming methods, characterized by pulling the hoe rather than plowing through the soil. Consider too that the most common and cherished building materials were straight-grained cedar and cypress; saws and other tools do cut these better on the pull stroke.

Japanese planes have changed little over the centuries. Unlike Western planes, which began in wood and matured to metal (and now are back to wood), the block of solid wood, usually oak, is still the basic modern Japanese plane. The only major refinement came in the late 1800s with the introduction of the subblade, or chipbreaker, positioned a fraction back from the tip of the primary blade.

A *kanna* is simpler than the standard metal block plane. It has no handle, no adjusting mechanism, no screws and levers—just a solid block of wood with two blades wedged in behind a pin that runs the width of the body. The design has been the same for 400 years. Its components are the *kanna no ha,* the plane iron, and the *dai,* the body.

The *ura* face — Most Japanese cutting blades, whether used in planes, chisels, gouges or spokeshaves, are different from Western blades. The standard Western blade is a solid piece of high-carbon steel. The steel of a Japanese blade is a laminated composition of high-carbon and low-carbon steel. The angled or beveled side, *omote,* is never double-beveled. And the other side, *ura* (the flat side of the Western tool), has a hollow ground. The laminated composition and hollow-ground shape offer a number of advantages. The actual cutting edge is the high-carbon steel and the rest of the blade is softer, more pliable steel, which can absorb shock when planing a board with knots or irregular grain patterns; the blade has less tendency to skip or chatter as the plane hits an irregular point. Another advantage is that the hollow-ground section of the *ura* side does not require regular attention. Because there is less surface area, it offers less resistance as it is guided over a board or grinding stone, so keeping this side flat and sharp is easy.

The first procedure in the preparation and care of any Japanese tool with this kind of blade is to obtain a completely flat surface on the *ura* side. Instead of a grinding stone, a *kanaban,* or "iron board," is used in conjunction with a series of grinding powders beginning with *kongosha,* a coarse material from sandstone. The other two powders are residual

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Ted Chase, who now makes furniture in Concord, Calif., spent a year in Japan studying with master craftsman Kennosuke Hayakawa.

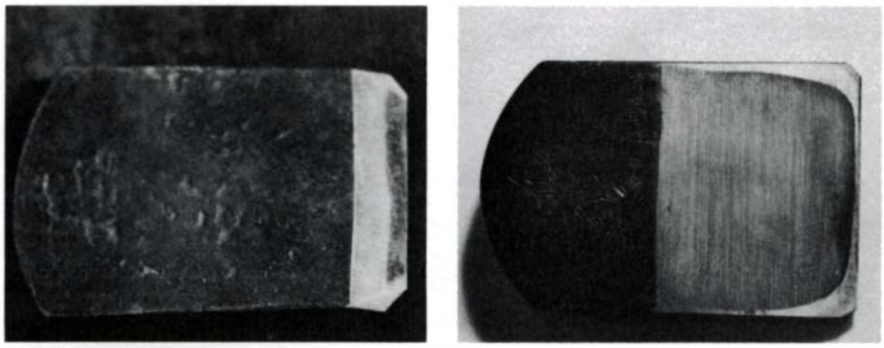
grinding material that comes from the medium and fine grinding stones. A pinch of *kongosha* is dropped on the iron board with a bit of water and the flat surface of the blade is ground back and forth, yielding a streaked surface. When the streaks are uniform over the face, wash the board and continue with a pinch of the second grinding powder, residue from the medium stone, and a bit of water. This yields a finer, but still streaked, surface. When the streaks are uniform, wash the board again and continue with a pinch of the third grinding powder, from the finishing stone, and some more water. The final step is to put only a drop of water on the board and work the blade face over the board until it is completely dry. Continue to work the blade on the dry surface until there is a completely unstreaked mirror finish on the *ura* face. This is the "basic face" because it is prepared first, after which it remains relatively untended.

The *omote* face — The next step is to sharpen the beveled side of the blade, the *omote* face, on the medium stone. The *omote* face is a bit more difficult to prepare than the basic face, because only the angled part of the blade is held against the stone so it is easy for the blade to twist or roll. The medium stone is also used with water, not oil, and kept clean when not in use by being submerged in water, usually standing on one end. When sharpening, add enough water to provide an easy, but not resistance-free, movement across the stone. As you sharpen, water and stone material will accumulate at both ends of the stone. Save this as the second powder for the iron-board treatment of the *ura* face. As you sharpen the bevel, a burr will develop on the cutting edge, felt from the *ura* side. When it spans the entire cutting edge, change stones and work with the finishing stone. Grind only the *omote* face on the medium stone, never the *ura* side.

Begin on the finishing stone by working the *omote* face in the same manner as on the medium stone.* Then turn the blade over and work the *ura* face over the stone as done on the iron board to begin to remove the burr. Return to the *omote* face and work, then back to the *ura.* The ratio of working the *omote* to working the *ura* is about 10 strokes to 2. Continue until the burr is gone from the *ura* and a mirror surface appears on the *omote.*

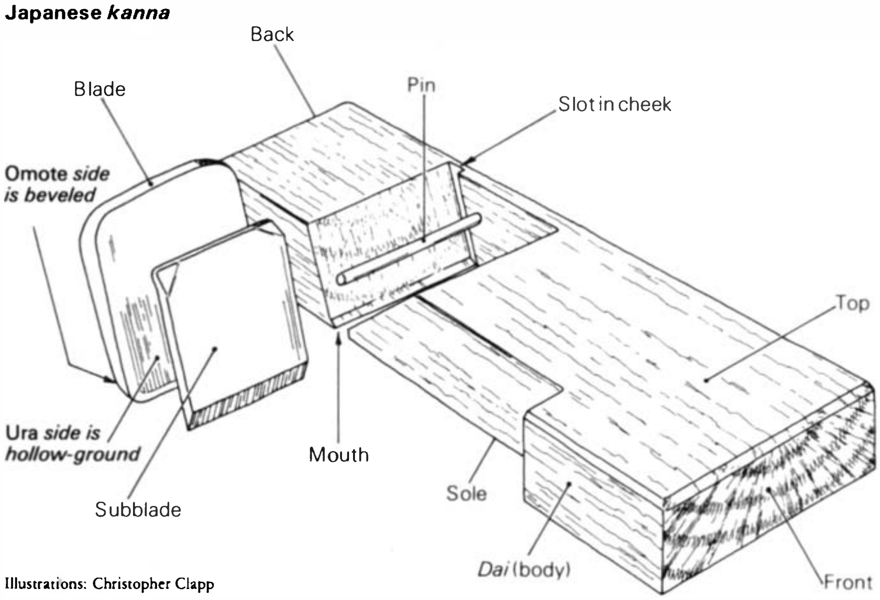
Obviously you should keep your iron board and stones completely flat. Sharpening thin blades that do not cover the entire surface of the board or stones can change their shapes. To keep them flat, sharpen on different areas of the board or stone, covering its full length. Check the surface regularly and, as needed, rub together two wet stone faces, of different

*The medium stone is usually synthetic. The finishing stone comes in both synthetic and natural stones. I use the King deluxe 1000 (available from Woodline/The Japan Woodworker, 1004 Central Ave., Alameda, Calif. 94501, for $9). I have both synthetic ($15 to $25) and natural ($50 to $5,000) finishing stones and find the synthetic adequate for the average worker. However, as one's techniques become more refined, the natural stone is, subtly, much better.

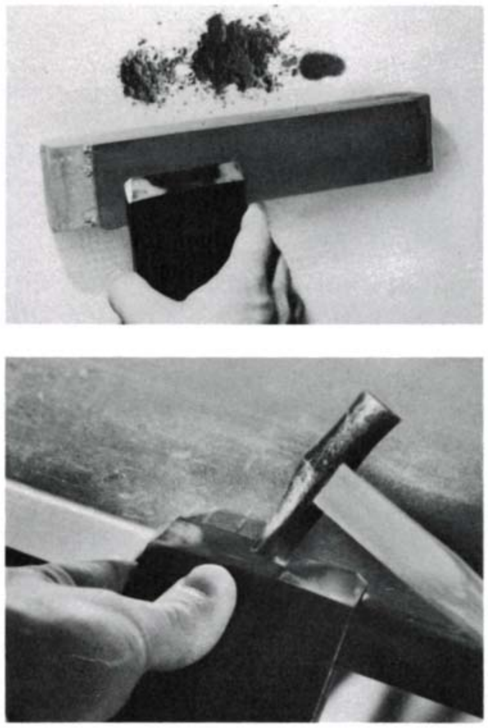


Omote, *or beveled side of a* kanna *blade, left, reveals laminated composition: high-carbon steel at the edge; softer, shock-absorbing low-carbon steel for the rest of this side, including the back of the bevel, which appears lightest in this photo. The* ura, *or basic face, right, is hollow-ground.*

Japanese *kanna*



Illustrations: Christopher Clapp



A kanaban, *or iron board, sharpens the* ura. *A series of grinding powders pictured at top—* kongosha, *right (a sandstone grit), and second and third grinding-stone residues, center and left— are mixed with water on the* kanaban *and the blade ground back and forth over it to bring up a mirror finish. Bottom, because of the low-carbon steel in the blade laminate, the hollow ground on the* ura *can be pushed out by tapping the bevel on the* omote *with the pointed edge of a hammer while the blade rests on the corner of a hard metal surface. This is done when, after repeated sharpenings, the edge has been ground back into the* ura *hollow.*

or of the same grit. This can also be done with two iron boards, with water in between.

Refinishing the *ura* — It would appear that when the *omote* has been sharpened and resharpened down to the hollow itself, the cutting surface has run out. When the front edge can no longer be worked or sharpened, the hollow-ground surface of the *ura* must be pushed out, providing more surface area for the basic face. Because of its low-carbon-steel composition, you can tap the *omote* face with the pointed edge of a hammer to push the *ura* face out.

Hold the *ura* face tightly against an anvil or the edge of a heavy metal work surface. With the blade at a 45° angle to the edge of the anvil and using the pointed edge of a hammer, gently tap the *omote* face along a line across the whole face. The line, actually a series of indentations, must be made two-thirds of the way down from the tip of the blade. Steady, firm taps are necessary, spaced right next to each other in an even line. Later, with proficiency, it will be possible to tap the line halfway down from the tip. This takes less time but more skill. An improperly placed tap can seriously damage the blade. Use gentle, yet firm and evenly placed, taps. Too much force can crack the blade.

This completed, return the blade to the iron board and, using the second powder, begin to rework the basic face. If the front edge does not yet yield enough high-carbon steel, return to the anvil and begin again. This process cannot be hurried, and you may have to repeat it a number of times.

A good blade made of high-quality metal can last a lifetime if it is treated with care and respect. Many old Japanese craftsmen are proud of their *chibi,* or shortened blades, reshaped and sharpened through many years of work.

Usually, the first 15 mm of a new blade does not produce the finest-quality edge and cut, not because the steel is different from the rest of the blade, but rather because through a process of sharpening, finishing, shaping and refinishing, the blade is tamed, custom-fitted to the craftsman. And in some ways, the blade tames the worker as well: The particular composition of each blade is different, so through use and care, a worker will come to understand what is expected of him. Over a period of many years a craftsman will be able to determine which planes to use for rough work and which for finish work, which for soft woods and which for hard.

Using a finely tuned blade becomes an experience in feeling, or "tasting" with one's hands. The taste is different for each person, depending on the style of work, and comes only with experience. But, by watching a good craftsman at work, one can see the plane cutting smoothly over any angle of grain. Then, if the blade tastes like it is not cutting (not passing smoothly over the wood), a sensitive and patient worker will stop, return to the medium stone and resharpen the blade. This takes place many times during the course of a day whenever the blade is not cutting the way it should feel.

The *dai* — I have been told of legendary master carpenters who could sharpen their plane blades so keenly and prepare the *dai* (the plane body) so finely that if they placed the *kanna* on one end of a board and tilted the board, the plane would cut by itself as it slid down the board. Carpenters' mythology, perhaps, but it sets a standard of excellence that these craftsmen are constantly trying to achieve.

Preparation of the *dai* is essential to proper tool care and functioning. Because all Japanese planes are made of solid wood and affected by changes in temperature and humidity, *dai* preparation becomes an ongoing technique for the life of the plane. Improper *dai* preparation probably causes the most problems for those Western woodworkers who buy a Japanese plane and find it useless from the start or after the first change in the weather.

Usually the blade of a new *kanna* does not fit down completely into the mouth and extend out enough to cut. This is sometimes because the seasoning process continues after the *kanna* is manufactured. The first procedure is to correct the groove in the *dai* for the blade to fit snugly, yet deeply enough to cut. In *kanna* with both a blade and a subblade, to allow adequate room to work on the groove, remove the pin that holds the subblade against the main blade. Place the *dai* on its left edge and grasp the pin tightly with pliers. Tap the pliers firmly with a hammer. When the pin protrudes from the hole in the side of the *dai,* pull it out with the pliers.

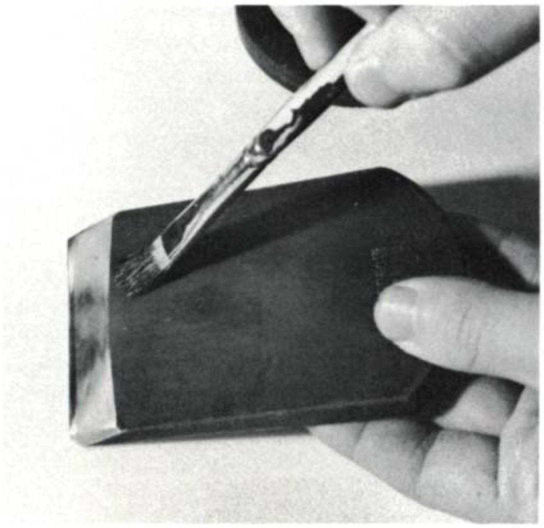
Now using a short-bristle brush, paint ink on three sides of the main blade. Do not ink the *ura* face or the cutting bevel itself. Chinese calligraphy ink is best. Before the ink dries, place the *omote* face against the angled groove of the *dai* and push in by hand. Gently tap the top end of the blade down further, using a metal hammer with a convex face or a wooden mallet. The tapping should become increasingly firm until the blade fits in the groove. Listen, and when the sound is "solid" (a higher-pitched tap) the blade is snug. To remove the blade, tap the end of the *dai* (behind the blade) firmly with the hammer until the sound indicates the blade is loose. Tap the upper corner-edge of the end of the *dai* on either side of the midpoint, first one side then the other, back and forth. Be sure to tap the corner edge squarely so as not to chip the *dai.* By placing the thumb of the hand holding the *dai* against the blade, you can exert pressure outward with the taps of the hammer, which will also prevent the blade from shooting out of the *dai,* and onto the floor or your foot.

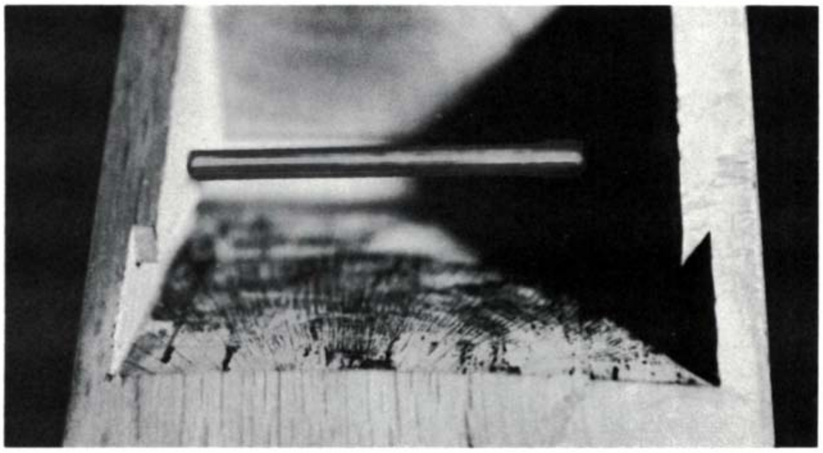
With the blade removed, you can chisel away the ink impressions left on the tight parts of the groove and refit the blade to sit deeper in the *dai.* Chiseling should remove only a thin amount of wood, almost like a powder, and the process of inking and refitting the blades is repeated many times. Chisel only on the wide face that touches the beveled side of the blade and along the sides where the blade fits into the groove; do not chisel the top of these side grooves.

When refitting the blade, don't force it any deeper than it can go with gentle to moderate tapping. Again, listen to the taps. When you begin to sight the blade along the sole of the *dai* just protruding from the mouth, the process is complete. It will take time, especially when the plane is new. After that it won't be necessary to refit unless the temperature or humidity changes significantly or the seasoning process is still extremely active. Then minor inking can be done.

The process sounds complicated and time-consuming, but it is necessary and, with practice, easy. It might happen that too much of the groove has been chiseled. In this case, glue a piece of paper on the wide part of the groove that supports the *omote* side of the blade.

The sole — Sometimes planes are used on their sides, planing, for example, on a shooting board. The Japanese *kanna* is tipped on its right side for this. The sole and right side of the plane therefore must be square. Planing the side might be





Paint the lower face and the two edges of the blade with ink, left, and while the ink is still wet, tap the blade in to register the high points in the groove. When the blade is tapped out, ink remains on the areas to be pared down, above.

necessary. Be careful when chiseling the groove to fit the blade. After many years you may weaken the right side with excessive chiseling, so favor it.

The next step in preparing the *kanna* for use is to make the sole completely flat. The best method for doing this uses a special plane called a *dainaoshi,* whose single blade, set at 90° in the *dai,* scrapes fine, powder-like shavings from the sole of the *kanna.* It is possible to use a wide chisel in the same way. (In fact it is necessary to correct the sole of the *dainaoshi* itself in this way.)

By holding a straightedge across the sole of the *dai* in front of a light and tilting it slightly, you can watch for light to shine through underneath and illuminate the high and low spots across the surface of the sole. Hold the straightedge in many different positions: along the width, length and diagonal. Move it slowly and mark the high spots with a pencil.

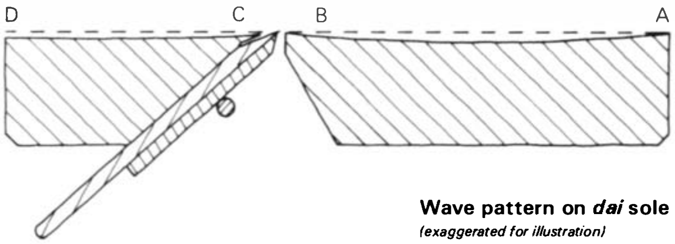
Now take the *dainaoshi* (or a chisel) and begin removing the pencil marks, and with them a thin shaving of the sole. Be sure to plane evenly so as not to create extremely low or twisting spots. It is sometimes wise to plane across the *dai* from one side and then turn the *dai* around so planing can go across from the opposite side. This will ensure even planing. Always plane across the *dai,* not lengthwise. You can, however, turn the *dainaoshi* at different angles to the sole of the other *kanna* to smooth the planing action. After removing the pencil marks, again check for flatness with the straightedge and mark new pencil lines for the next shaving. Repeat until you've rendered the *dai* completely flat.

Some books, both English and Japanese, suggest using coarse abrasive paper to sand down the sole of the *dai* to flatness. However, this method is not advisable. The grit from the paper can lodge itself in the sole of the *kanna* and can mar the surface of the lumber being finished. It can also transfer grit into the lumber and then chip the blade as the *kanna* makes its next pass. Further, any other method of treating the sole after sandpaper has been used risks damaging the tool used for the second refinishing.

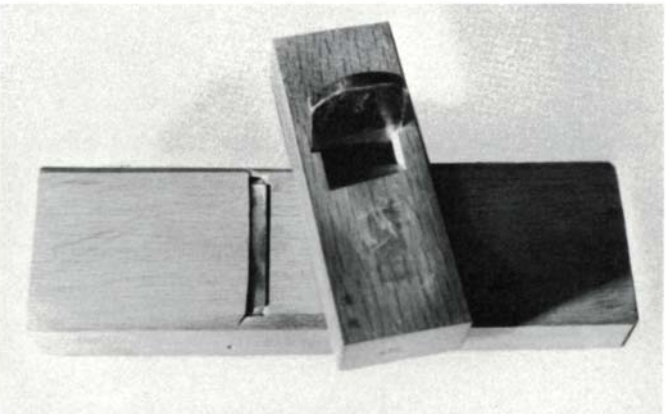
Depending upon the climatic conditions of the shop and the seasoning qualities of the *dai,* secondary *dai* refinishing with the *dainaoshi* will be necessary at various times. Again, the feel of the cut is the best way to tell whether you should check the sole for changes in flatness. For the *dainaoshi* and finger planes, a flat sole will suffice for smooth cutting. However, large-body *kanna* require further treatment to create a "wave" pattern on the sole that facilitates accurate and smooth cutting. Locate four points on the sole of the plane: Point *A* is the front of the *dai.* Point *B* is the part of the sole just in front of the mouth, or opening for the blade. Point *C* is that part of the sole just behind the mouth. And point *D* refers to the opposite end or back.

With the *dainaoshi,* plane the sole between points *A* and *B,* taking care to keep those two points the same height. The area between should be approximately 1/64 in. lower. Now, working back from point *C*, plane *C* just a fraction lower than *B* and continue to plane the sole out toward the back to about 1/32 in. lower than *A* and *B*. By eliminating the surface area between points *A* and *B* you reduce the surface of the *kanna* in contact with the wood. Further, the area between points *C* and *D* is a fraction lower than point *B* or the blade would be lifted off the wood and would not cut, or would cut erratically. The figures given are basic rules of thumb for relative

Not to scale



Wave pattern on *dai* sole
(exaggerated for illustration)



Dainaoshi *(planes whose blades are set at 90° to produce a scraping cut for truing plane soles) are used always across, never along, the length of the sole. Larger plane soles are planed not flat but in a wave pattern to reduce friction.*

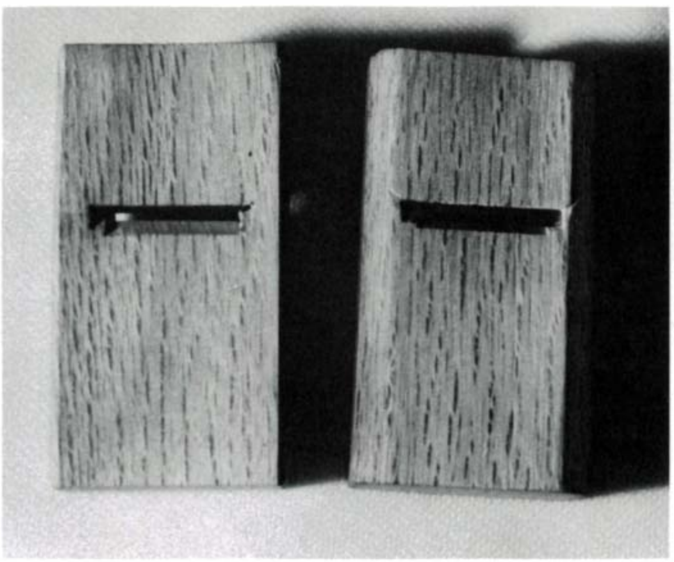
highs and lows for all points. The best-prepared *kanna* would use fractions of these fractions, and the quality of the cut would be unmatched.

When preparing the sole with *dainaoshi* or chisel be sure to back the blade out of the mouth area, but keep the blade just snug enough in the groove to warrant removal with a hammer, not a hand. This will exert force on the sole behind the mouth so the highs and lows one measures during correction will be the same as when the blade is in the cutting position. Otherwise, the blade might force the area behind the mouth higher than point *B*.

Even after many, many years of seasoning, a *dai* may still need correcting. Again it becomes an experience in feeling to determine when the *dai* is not cutting or moving across the wood efficiently. By examining the sole for shiny spots, you can sometimes detect the high spots without a straightedge. However, this is a preliminary step and should be followed up with the techniques presented here to correct and prepare the *dai* for further use.

Once you've prepared the sole of the *kanna* with a *dainaoshi,* a few minor adjustments must be made for the final finish. A newly purchased plane has a bevel running the length of the *dai* on either side of the sole. After fitting the blade in the *dai,* you'll find these bevels do not reach the mouth. To eliminate unnecessary contact between sole and work surface, increase the size of the two bevels right up to the mouth area. Then chisel a cut at either side of the mouth, angled back toward the end of the *dai* and out onto the beveled sides. This angled cut acts as an escapement for fine shavings that would otherwise become clogged in the mouth. Finally, on the upper edge of the mouth, or the edge closest to the back of the *dai,* chisel a thin 45° bevel across the entire edge. This bevel can reflect light and silhouette the blade as one sights it down the length of the *dai,* facilitating easy and proper gauging of the blade depth.

These procedures may sound complicated. One might ask, "Why not the marvels of modern metal planes?" However, if you are interested in using a Japanese plane and you can complete these steps, you'll be rewarded with an unparalleled cutting tool that will become easier to operate and to maintain as you work with it. Consider the greater sensitivity of a wooden *kanna* over a metal plane; the pull stroke keeps the work between *kanna* and body. In a short time you'll develop a different sense of control over your work. Another advantage of Japanese planes is that because they are made of solid wood with no moving parts, they can be modified and adapted to fit an infinite variety of shapes and surfaces.



Kanna *newly purchased, left, and after complete preparation of the sole, right. The large bevels that run the length of the sole decrease the surface area, the notches at the sides of the mouth are for fine-shavings clearance and the chamfer along the back edge of the mouth is for reflecting light to sight proper blade depth.*

Choosing your *kanna* — The usual manner of making and buying *kanna* in Japan is for a craftsman to purchase one from a master *kanna* maker or from a shop that sells *kanna* made by others. Then he either uses it as is or changes it to suit his needs. The process of making a *kanna* can involve both hand and machine work to a greater or lesser degree, depending on the tool's quality and cost.

I was introduced to a man who makes *kanna* in the Nagoya area of Japan. He and his son run a small tool and hardware shop. They would first cut and square pieces of wood to approximate size using a table saw and a jointer. This wood is then stored anywhere from 2 to 25 years. Much concern and respect are shown for the seasoning process. Better-quality *kanna* are seasoned longest and made by hand. The groove is cut either entirely by hand or with a mortising machine and then finished by hand. The *kanna* master usually buys a variety of blades from different sources, again at varying quality and cost. He builds the *dai* to fit its chosen blade. An expensive *kanna* will have a *dai* seasoned 25 years, and will be made completely by hand, including the blade. It will cost about $250.

Japanese *kanna* can be purchased in a variety of standard sizes. The standard ones are mostly flat-soled. However, it is possible to find tool shops that also sell *kanna* with shaped soles for specialized planing. Finger planes are usually bought in the standard shape and the *dai* recut to fit the job at hand.

Here are some hints on what to look for in a *kanna.* Check the end grain of the *dai;* it should be running horizontally, not vertically as in Western planes. The rays will run vertically and should be well-defined. Check to see that the mouth of the *dai* is not too large and that the escapement angle for the shavings is sharp. There should be no gaps along the groove where the blade fits into the *dai.* To check for this, hold the *kanna* up to a light source and check for light in the groove between blade and *dai.* Test whether the blade fits tightly in the groove. If the *dai* has two blades, it will have a pin to wedge the blades together. Check the positioning of the pin. If the *dai* has been expanding and contracting in the shop, the pin may be pushed through or near the opening of the hole. A tight-fitting blade and evidence of pin movement indicate a better plane; the *dai* has been around for a while, so it is older and therefore more seasoned. Another important thing to check is that the *ura* side of the blade(s) is well shaped and has a well-defined concave face.

The processes involved in preparing and maintaining Japanese *kanna* are rigorous at first. The attention to detail on such seemingly simple tools is, without a doubt, not for everyone. However, for a craftsman who is willing to put mental, as well as physical, effort into preparing and caring for these planes, the rewards can be profound. The craftsman becomes so intimate with his *kanna* that it is, indeed, an extension of his hands, putting him in touch with the process of making, as well as with the end result. □

Making a Modern Wooden Plane

Nuts and bolts adjuster controls depth

by Karl Dittmer

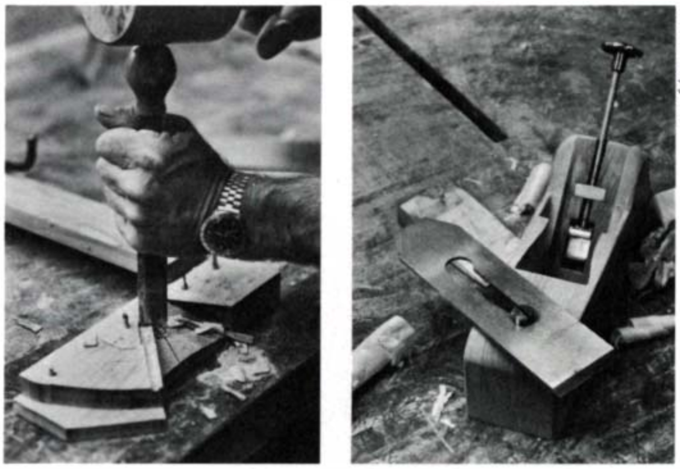
When I yearned for a quality wooden try plane, I took one look at the price and decided to build one using rock maple. Modern glues are trustworthy, so I elected to build it in four layers, using two ¾-in. pieces for the inner layers and ½-in. pieces for the outer. This made it a simple matter to cut the throat area, usually a chore.

The result was quite successful, except that the old-fashioned wedge system proved a bit coarse, particularly when trying to back off the blade for that final light cut. After some thought, I came up with an acceptable depth adjustment that engages the head of the screw attaching the plane iron to the chipbreaker. I have eliminated free play through careful fitting and now have a precise, uncomplicated adjustment mechanism that is almost as smooth and accurate as the one on a Primus plane I acquired during an extravagant moment. Lateral adjustments are made by forcing the top of the plane iron to one side. Come sharpening time, the homegrown mechanism shines because the iron comes out without any of that Primus-type hassle.

The modernized try plane worked so well, I bought more irons and turned out a few more planes. All are a pleasure to use and construction is simple, thanks to being able to work on the throat area before each is assembled. I make my throats small, then after the sole is finished, file them to fit. Don't despair if you get the throat too big. A thin shim epoxied under the plane iron near the throat opening will cure it.

Most of my planes have the iron at 45°; smoothing planes should be at around 50°. Dimensions were determined by the width of the plane iron and what I felt would be appropriate for my style. If you are not certain just how long to make your plane, make it oversize, then cut it off later. □

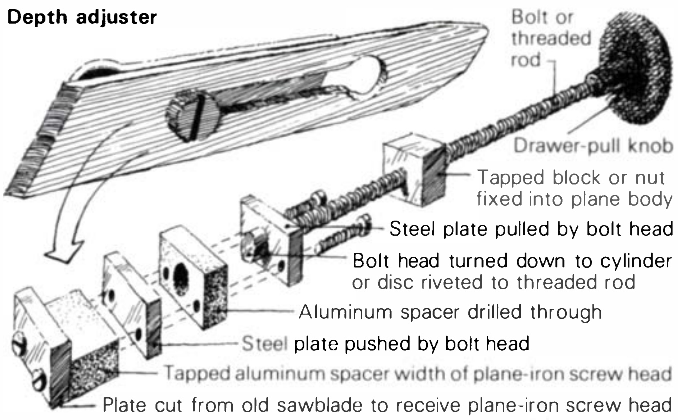
Karl Dittmer builds furniture in El Reno, Okla. For more on making planes, see Fine Woodworking, *Winter '75.*

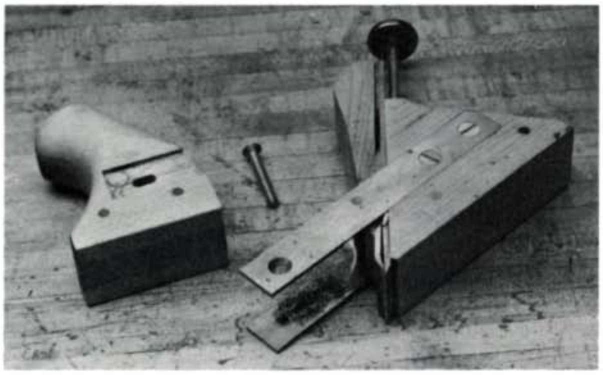


Photos: Ray Jones

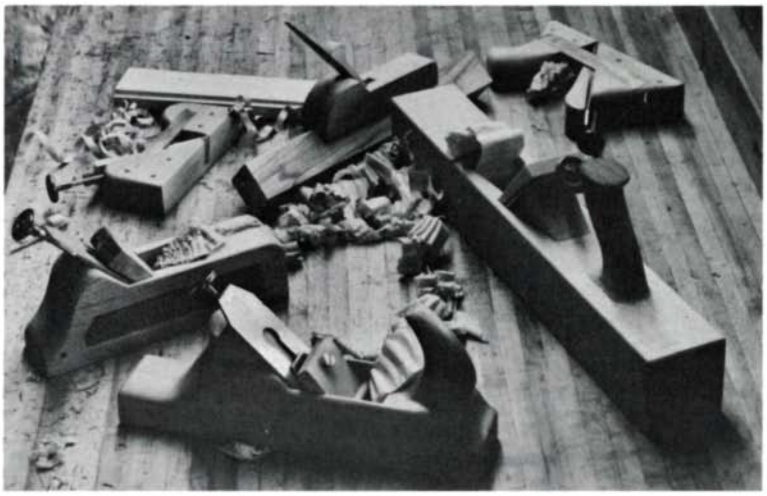
Jack plane, right, with depth adjuster and glued-up body is easy to build; most of the throat area can be sawn before assembly. For stability, grain in adjoining pieces of wood is alternated. The adjustment screw, threaded through a brass block mortised into the plane body, is bound to a sliding carriage that fits the plane-iron screw. After the center laminates are sawn, left, they are positioned on the side pieces using steel pins. The sides are cut with a saw and chisel to taper in toward the mouth. Here Dittmer cuts a mortise to accept the depth-adjustment mechanism.

Depth adjuster





Gentleman's plane, disassembled above, is even easier to make than the all-wood-bodied planes. It uses the same adjusting mechanism, but has steel side straps and a pin to hold the wedge and plane iron in. With the toe removed (which reveals its mouth-adjustment capability) and an alternate, shorter set of side straps, it could be used as a bullnose plane.



Some of Dittmer's handmade planes.

French Polishing

Elbow grease and shellac build a fine finish

by Clinton R. Howell

By today's standards, French polishing is not economical for the commercial woodworker. It is virtually all sensitivity of touch, and it takes years to understand the nuances of technique, from knowing the precise amount of lubricating oil to put on a surface to sensing when the job requires a higher room temperature. It also takes time—the finish is built up of many thin layers of shellac. The maker of fine, one-piece-at-a-time furniture should not overlook French polishing, however, because of the warmth it gives a new piece and the patina it develops with time. The finish is also relatively easy to rebuild if it becomes marred, and can be applied over almost any existing finish. I have French-polished over oil-based varnishes, polyurethanes and acid-catalyzed lacquers with good results.

History — The development of French polishing is not well documented, nor is the first person to develop a good shellac for furniture known. The first mention of shellac in England can be found in *A Treatise of Japanning and Varnishing* (1688), by John Stalker and George Parker. Stalker and Parker treat shellac and the people who used it ("varnish dawbers") with disdain, but do admit that shellac was "commonly used by those that imploy themselves in varnishing ordinary woods, as Olive, Walnut, and the like." I believe that here they were acknowledging the nascent craft of French polishing and that their disregard for these varnish daubers might have been nothing more than a xenophobic reaction to the introduction of a new craft to England by immigrants.

The man who taught me how to polish, Herbert Burrell, of London, has been polishing for 45 years, and he also feels that alcohol-soluble finishes were used in England earlier than 1830, when French polishing is commonly thought to have been introduced. The difficulty is in establishing what is an unretouched surface, and whether that surface was originally French-polished. Burrell admits this is almost impossible to ascertain.

Formula — French polishes are generally shellac-based, though I have found formulas that include seedlac, sandarac, mastic and other resins. Stalker and Parker's formula of a gallon of spirit to 1½ lb. of shellac flakes is identical to one I found in the *Cyclopedia of Useful Arts* (1884), but I prefer to mix 2½ lb. of flakes with a gallon of ethyl alcohol. Both isopropyl and methyl alcohol will work, but to keep the solution free from water, use as pure an alcohol as possible.

I've used orange shellac, but the orange color does come through. Some people prefer this but I don't, except on light woods like pine and maple, to which the orange shellac imparts a warm yellow tone. Bleached or white shellac has a short shelf life and I seldom use it. A shellac that works well for me is Angelo Blond from William Zinsser Co., 39 Belmont Dr., Somerset, N.J. 08873 (sold in minimum quantities of 10 lb.). I have not found an adequate ready-made American polish, though several are available in England.

Surface preparation — The most important step in French polishing is preparing the surface; you want the grain to lie flat. Shortcuts invariably lead to difficulties down the line, but if you use a water stain before finishing, save time by wetting the grain before staining. Use about as much water as you'll be using to stain. Allow the wood to dry about an hour or so, lightly sand and then stain. This is usually all that is needed to keep the grain flat.

Putting a sealer coat of polish on the wood is the first step in French polishing. The sealer will prevent the filler from working loose as the wood expands and contracts over time, as well as the discoloration that can occur when filler is applied directly to the wood. You can apply the sealer coat with a hardened fad (the piece of cotton wadding that makes up the inside of the rubber) or a brush. Don't use fresh cotton wadding because bits of it will come loose and stick to the surface of the wood. If you use a brush, thin the polish to avoid leaving brushmarks and lines.

Moisten the fad with polish—you want it to be about as wet as a squeezed-out teabag, not so wet that it drips. Move the fad in broad, sweeping strokes until the entire surface is covered with polish, then allow it to stand for 30 minutes.

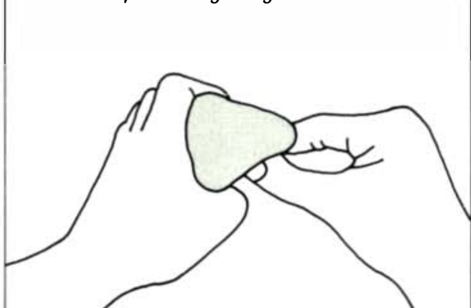
The second step is filling the pores of the wood. While pumice was widely used in other countries, plaster (the hardware-store variety) to which color has been added is the traditional English filler. Improper plastering shows up as white flecks in the grain on antiques. For a dining table I'd use about half a cup of plaster and half a teaspoon of powdered color (available from Behlen Bros., Box 698, Amsterdam, N.Y. 12010). You'll have to experiment to find the right color for the piece you're finishing: As an example, for mahogany filler I might mix rose pink, yellow, orange and a touch of brown. Be conservative with the amount of color at first—what looks pale in the bowl will darken when wet.

Moisten a piece of burlap in water, dip it into the colored plaster, and apply with a circular motion. Lean down hard on the burlap—you want to force the filler into the pores of the wood. Wipe off excess plaster before it hardens. When the plaster has dried sufficiently, usually in three to four hours, remove the residue with a worn piece of wet-and-dry paper and linseed oil, then wipe the surface clean.

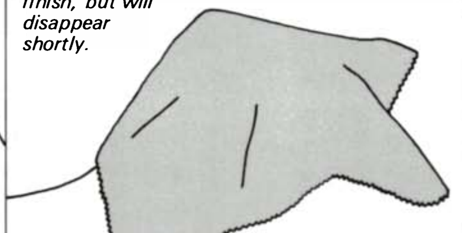
The next step is evening out the tone of the wood—in polishing, this takes the most skill. A good finish will allow the eye to travel smoothly over the surface of the piece without

EDITOR'S NOTE: *A Treatise of Japanning and Varnishing* (1688) by Stalker and Parker was reprinted by Alec Tiranti, Ltd., London, in 1960. It is often available in libraries or through inter-library loan, or your bookseller can order a copy for you.

1. *Hold cotton wadding between thumb and forefinger. The amount of wadding depends on the size of the job.*

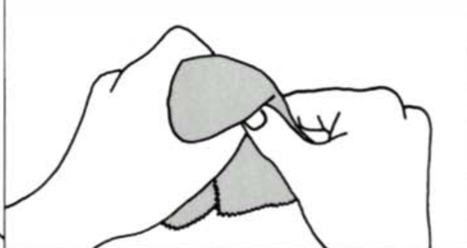


2. *Form the wadding into a pearlike shape with a firm point for getting into corners.*

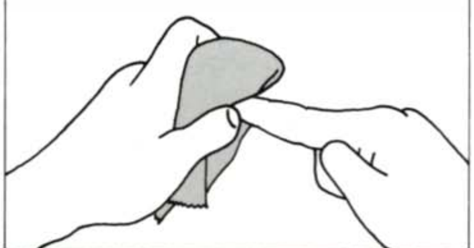


3. *Cover the wadding with soft cotton cloth. The cloth should neither be so fine that it inhibits polish from penetrating it, nor so coarse that it leaves large fiber marks. Some fiber marks will always show immediately upon applying finish, but will disappear shortly.*

4. *Flatten the wadding so the rubber does not become sausage-like, and to keep as much rubber on the polishing surface as possible.*

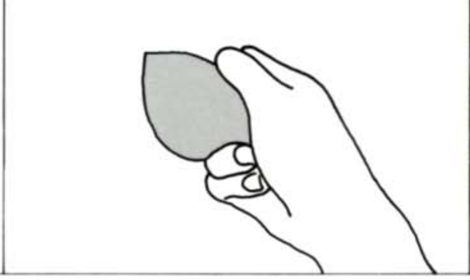


5. *Pull the cloth against the wadding and make sure one flat edge leads out to a point.*



6. *Secure the second edge. Like the first edge, it will allow work within constricted areas.*

7. *Firmly secure the cloth, to keep it from wrinkling and causing streaks.*



8. *The finished rubber.*

The rubber disassembled after use—cotton wadding is at left, the cotton cloth at right.

Illustrations: David C. Howell

being jarred by splashes of bright color here and there. I use alcohol stains in two colors, black and Bismark brown (a red). Mix these colors well with about one part polish (for a binder) and three parts alcohol. In a year's worth of polishing I have used about half a pint each of brown and black—the equivalent of a teaspoon of stain in powder form. Black and Bismark brown can be adapted for use on almost any wood. However, colors such as chrysodine (another red) for maple, and green (good for making a red mahogany brown) are useful.

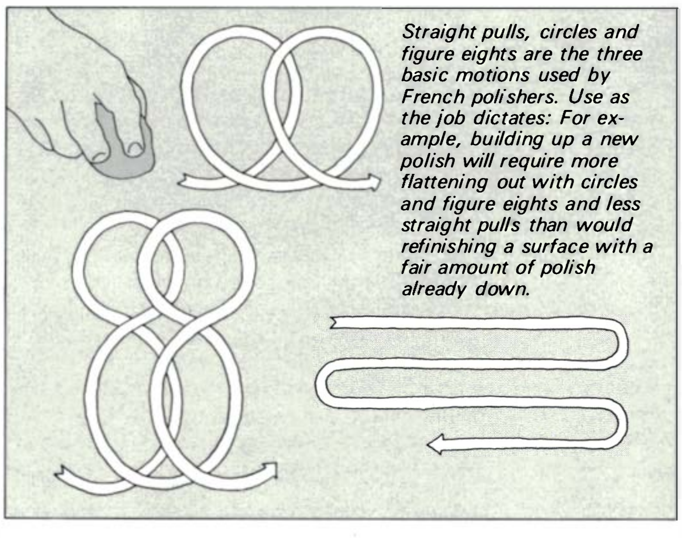
Always apply these colors patiently with a brush or hardened fad, depending on the size of the area being colored. Many thin coats are harder to detect than one thick one. Exercise caution when recharging the brush or fad with color. If the tool is too wet, drips will form marks on the surface, which then must be completely cleaned off with alcohol. It is disheartening when the job is nearly finished and an entire area must be reworked because of carelessness.

After staining, sealing, filling and coloring, the surface will look so beautifully flat and even that the novice will be tempted to stop. In truth, the work is just beginning.

Making a rubber — The rubber, unlike a brush, will apply the finish in flat layers, and is the principal tool in French polishing. It is wrapped into a pearlike shape to get into tight corners—the drawings above show how.

The medium-soft, all-cotton cloth that covers the wadding should be pulled together so that it will not wrinkle during use. Should streaks occur during polishing, examine and correct the rubber, then resume work. The streaks will disappear. Learning how to construct a proper rubber takes time and patience, but once it is mastered you will see that all other shapes are clumsy in comparison. I keep my rubbers and fads in airtight containers between jobs so they won't go hard, but if they do get a little stiff, pour in some alcohol.

Applying the finish — The best way to put on a high gloss is to work for three hours, leave off for a day, rub the finish down with worn, fine sandpaper and a bit of linseed oil, and



Straight pulls, circles and figure eights are the three basic motions used by French polishers. Use as the job dictates: For example, building up a new polish will require more flattening out with circles and figure eights and less straight pulls than would refinishing a surface with a fair amount of polish already down.

start anew. This was how pianos were finished before the advent of sprays, and the surface that resulted was phenomenally lustrous and durable. However, this was often done over a period of 60 days—certainly not economical today.

To get your layers of polish to lie flat, apply the polish with firm, steady pressure using the three basic motions shown on the previous page: straight pulls, circles and figure eights. If you were to do nothing but straight pulls, ridges would develop and mistakes, such as streaks, would be harder to eliminate. Generally, until this becomes second nature, it is best to do five or six straight pulls to each set of circles and figure eights. Never rub in a circle exceeding 8 in. in diameter, to avoid leaning too hard on the rubber. Both the figure-eight and the circular motions form whips in the polish, and these are difficult to remove when the rubber has been pressed down with too much force. Bearing down too heavily can also cause the polish to pick up previous layers.

Work as drily as you can while getting used to the surface. Too much polish too quickly will look good for a minute, but with subsequent rubbing the rubber will stick and pick up the polish. The way to keep the rubber under control is to charge the fad with polish a little at a time, removing the cotton cloth each time you do so. When the fad is charged, remake the rubber and squeeze out excess polish through the point of the rubber. When you accidentally put too much polish on the surface, let it dry for 10 to 15 minutes and then work straight over the streak, rubbing hard. You might need to add a drop of linseed oil to the rubber for lubrication.

Though oil keeps the rubber from sticking, the novice will find the use of oil difficult to master. Oil can fool you into thinking you have put a beautiful finish down, when in fact there is still plenty of oil to be removed. One way to tell is to blow on the surface—if it clouds there is too much oil. Leaving on excess oil will cause the polish either to crackle or go white. Sometimes this happens in a week, sometimes in a year, but eventually it will happen.

In England the traditional oil is raw linseed, though lemon oil can also be used. If you need it (and often no oil whatsoever is needed), apply about half a drop to the rubber, or flick a bit on the wood with a finger. The total amount of oil I used recently on a dining table was approximately a quarter-teaspoonful. If you put too much on you can either draw a rubber that is charged sparingly with alcohol across the surface with straight strokes, or work the oil out with the polish by rubbing (the dried oil will accumulate on the sides of the rubber). When the surface is free of oil, the rubber will begin to stick slightly, and you'll hear a faint squeak as you draw the rubber along.

French-polish whole surfaces at a time, such as an entire leaf of a dining table or the top of a sideboard, otherwise the surface will have ridges. Large surfaces are the easiest to polish because the "skin" in one area is drying while you're polishing another area. The hardest surfaces to polish are the smallest ones—it's tempting to polish incessantly, but work with deliberation and try not to speed up the routine. You will know when the job is finished when the surface is lustrous and free of streaks, specks and ridges.

As the polisher works, a residue of material will build up on the hands, but cleanup need not be a problem. A generous amount of baking soda dissolved in a container of warm water cleans well and is also reusable. Keep the solution in a pot and simply reheat it when you put down your rubber for the day. □

Clinton Howell is a furniture conservator and publisher of the Antique Furniture Newsletter, *which costs $12 for 6 issues and can be obtained by writing to 445 Bedford Center Rd., Bedford Hills, N.Y. 10507.*

Seedlac Varnish

by Sidney Greenstein

When you combine seedlac, the hardened secretions of the *Laccifer lacca* insect, with alcohol, you get a magnificent spirit varnish that was used for centuries past and is still used today by people in the know. Unfortunately, there are still too few people in the know, and seedlac is often left out of otherwise comprehensive literature about finishes, such as Don Newell's article, "Finishing Materials" *(Fine Woodworking,* July '79). Seedlac is scraped off the twigs of trees; if it is melted down the result is shellac, but this heating and refining process robs the seedlac of many valuable properties.

Seedlac varnish is pale amber in color and unlike shellac, does not tend toward opacity. Seedlac is also highly scuff and water-resistant and dries fast. You can apply it over any traditional water or alcohol stain, or tint the varnish itself with alcohol-soluble colors.

Seedlac varnish boasts a long, honorable history. The first definite reference in Indian writings to the use of lac resin occurs in 1590 A.D., in the *Ain-e-Akbari*, the official records of Akbar, the Mogul emperor. Details of using lac resin in "lacquering" and polishing wood in public buildings are given. One of the earliest references in the English language is to be found in *A Treatise of Japanning and Varnishing* by Stalker and Parker, printed in London in 1688.

While we can only guess at the actual processes involved, we do know that the incomparable Japanese lacquered furniture of the 16th, 17th and 18th centuries had seedlac as its base. The fine finishes we associate with 18th and 19th-century French and English furniture are also seedlac-based. The finishes of the old Italian violinmakers of Cremona are also thought to be seedlac, either wholly or in part. Violinmakers today are divided on the question of whether oil or spirit varnish is best. Those who choose the latter opt for seedlac and would never entertain the idea of shellac on a fine violin.

Tons of seedlac are imported yearly from India for uses in the paint, textile and medical industries. Until recently, modest amounts were available to artisans and small users. These sources are now drying up—the tendency nowadays among conglomerates is to discontinue special (and slow-moving) items. Harpsichord makers William and Nora Smith (1530 Sunset Cliffs Blvd., San Diego, Calif. 92107) import seedlac in 200-lb. lots, and usually have the material on hand to sell in small lots.

To shellac adherents I say: Forgo both ready-mixed products and those you make from buttons and/or flakes, and substitute seedlac. You will obtain a superior material that can be brushed, sprayed or French-polished to produce a coating of much greater transparency, faster drying time and greater water resistance than shellac. □

Sidney Greenstein, 71, lives in San Diego, Calif.

Shaper Cutters and Fences

For accuracy and flexibility, make your own

by Earl J. Beck

My machine woodworking efforts started in 1934 with making a shaper from two old auto brake drums, using a plan from *Popular Science*. I have for 19 years been using variations of my own design of a single-cutter shaper collar, using mostly freehand-ground cutters, with great success, speed and safety. I got to grinding the cutters in a curious way. I was fortunate in finding a number of old cabinet planes, some of which were molding planes. I wanted to use the nice shape in one of these, but did not want to limit myself to a straight or slightly convex edge, so I ground my first cutter to match the plane iron. When I returned to the plane for the straight cuts, the grain proved difficult and the plane badly tore out the wood. As the shaper cutter didn't, I finished the job with it. I like my collection of beautiful old hand tools, but I love that shaper.

The shaper has many advantages over other tools to do the same work. Now if you enjoy pushing a carving chisel through a complex, knotty, ornery piece of wood for hours on end, fine. I like to do that myself once in a while. But more important to me is the rapid, precise contouring of wood to produce parts that fit together without a lot of hand-finishing, allowing me all the time I want for hand-detailing and removing all traces of machine work. I use a band saw, jointer and shaper, and of these only the shaper is indispensable.

Shaper and router cutters — While the shaper is my tool of choice, there are applications for the portable high-speed router for which I have been unable to adapt a shaper. So I will precede my discussion of shaper cutters with a discussion of router cutters—many of the principles are the same.

A router may be the best choice where the workpiece is large and awkward. It may also be the only machine alternative for the shaping of compound-curved stock—the contouring, for instance, of fancy chair frames that would otherwise be handcarved. To reduce handwork in making a double-wide copy of a French Provincial chair, I made a cutter for the router like the one in figure 1. I could have ground a standard cutter to shape, but I chose to braze a tungsten-carbide metal-cutting chip to a ¼-in. aircraft-quality bolt, rounding the hex head in a lathe (you could also do this by hand-grinding) and slotting it to receive the chip. The important thing with a single-edged cutter (the only type most of us want to fool with, in the absence of sophisticated precision grinders) is to have the dummy side—used only for balance—short enough that it doesn't tear up what the sharp cutter side does. So place the chip slightly off-center and sharpen the slightly longer side. Once when I did not have a large enough chip, I placed a smaller chip more than a little off-center, with no obvious disadvantage or vibration.

Being able to fashion your own cutter gives you the option of producing the same contour in different ways. A conventional ogee cutter looks like the one at *A* in figure 2. The same shape can be produced by *B*, with the advantage that the tool marks are in line with the grain and consequently easier to remove.

While there is no great point in using carbide steel rather than high-speed metal-cutting steel unless you plan to use your cutters continually on abrasive wood or you desire a permanent cutting edge, the carbide can be brazed and heated with impunity (MAPP torches are satisfactory), as overheating does not anneal them. Carbides are inherently hard and unlike tool steels do not depend on quench-hardening. Also, carbide tool bits come in shapes and sizes about right for the job, and don't require extensive sawing or grinding. If you decide to silver-solder tool steels (brazing will probably be too hot), you'll find either *T* or *M*-series high-speed steels will be harder than necessary for wood cutting. If available, the higher numbers in the *M*-series—*M15* or *M33*—will be least susceptible to annealing during silver-soldering.

If you choose carbide, you'll need a silicon-carbide grind-

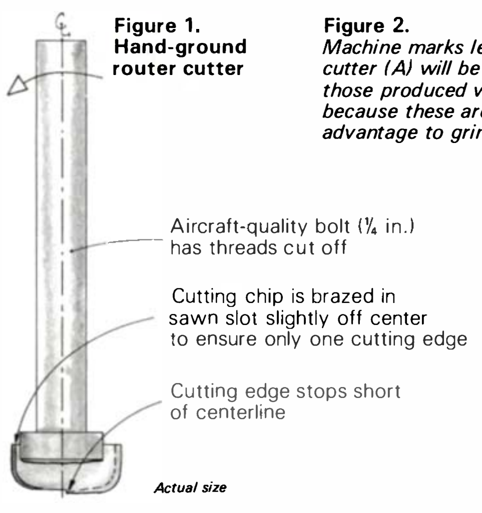


Figure 1. Hand-ground router cutter

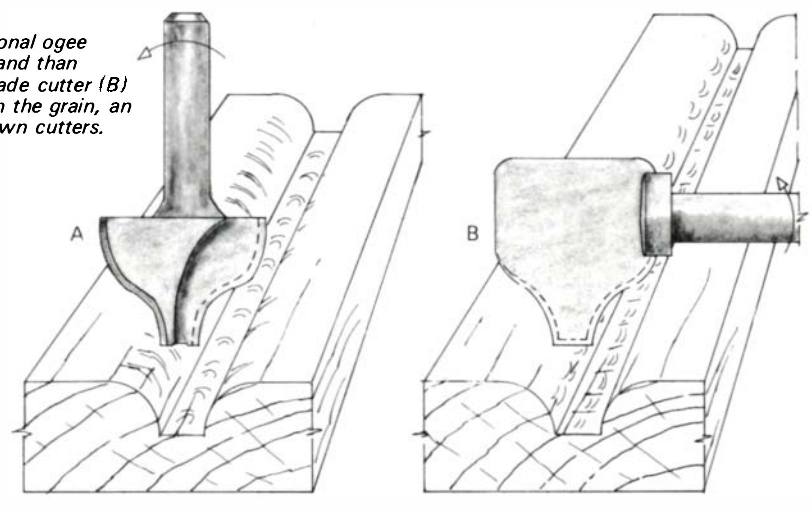


Figure 2. *Machine marks left by traditional ogee cutter (A) will be harder to sand than those produced with homemade cutter (B) because these are in line with the grain, an advantage to grinding your own cutters.*

ing wheel; aluminum-oxide grinding wheels are too soft. You can use the soft, green silicon-carbide recommended for this purpose, but I prefer a harder, vitrified wheel made for lapidary. The vitrified wheel is more likely to overheat and while that won't harm a brazed chip, it might melt the silver solder. It is my impression in freehand grinding, where the cutter is not rigidly held, that the vitrified wheel produces a slightly sharper edge.

Tool geometry and sharpening — I have two single-cutter shaper collar systems (figure 3)—to attempt to grind multiple cutters is impractical as it's difficult (if not impossible) to grind two or more cutters to exactly the same shape. The system *A* cutter consists of two collars separated by a post, which balances the cutter sandwiched opposite it. System *B* consists of a small cutter held in a slot in a solid-steel disc with an allen screw. For cutters up to about ⅝ in. wide at the cutting edge, system *B* is my method of choice. The small cutters are heat-treated easily with a small torch, and easily annealed for reshaping. The disc may be any useful size—for small cuts I have had success with a disc 1½ in. to 2 in. in diameter. An advantage of system *B* is that the holding disc usually doesn't interfere with the wood guide (discussed later), which may then fit closely and all but totally shield the cutter.

Through grinding cutters I attempt to achieve a wood surface that may be sanded easily, has no trace of casehardening (burnishing of the surface), and minimum or no tear-out. This combination is probably impossible, which is why production woodworking involves so much sanding. If you examine all but the finest of new furniture, you'll see that sanding frequently has been substituted for high-speed machining, giving the finished piece a buttery, rounded appearance with excessive radii on corners. Woodworkers who try to speed things up with an abrasive flap wheel know the effect.

For every wood, moisture content, machine and speed there is an optimum combination of rake (cutting) and relief (clearance) angles, as shown in figure 4. The desirability of, and in production work the need for, a definite rake angle is a persuasive argument for the shaper instead of the router. The rake angles of the router cutters I have seem to vary all over the place—as do their cutting capabilities. All seem to depend on the machine's high speed to compensate for a lack of attention to detail.

Over the cutting length of a shaper knife from top to bottom, the radius (r_1 and r_2 in figure 4) varies significantly, and thus so do the cutting and relief angles. On straight blades such as used in jointers and planers, you can grind a small second bevel on the face of the knives for a smaller cutting angle. This back-beveling gives more of a scraping than a lifting action, and virtually eliminates tear-out (see *Fine Woodworking*, Nov. '79, p. 34). This tactic is not viable for shaper

Figure 3.
Two single-cutter shaper systems

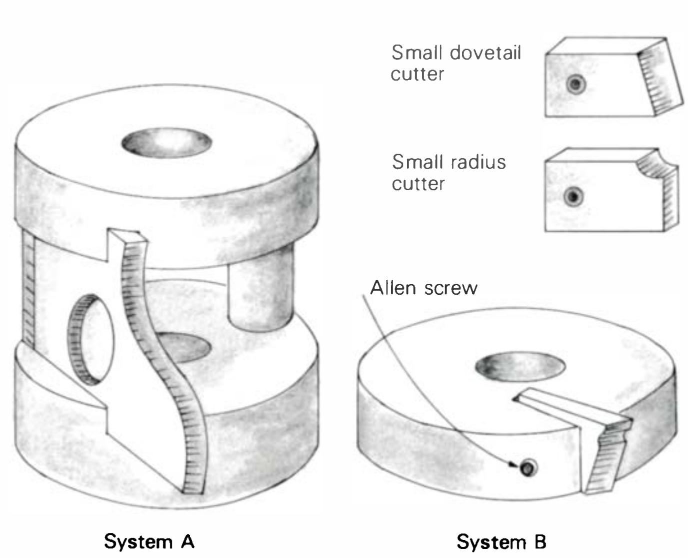
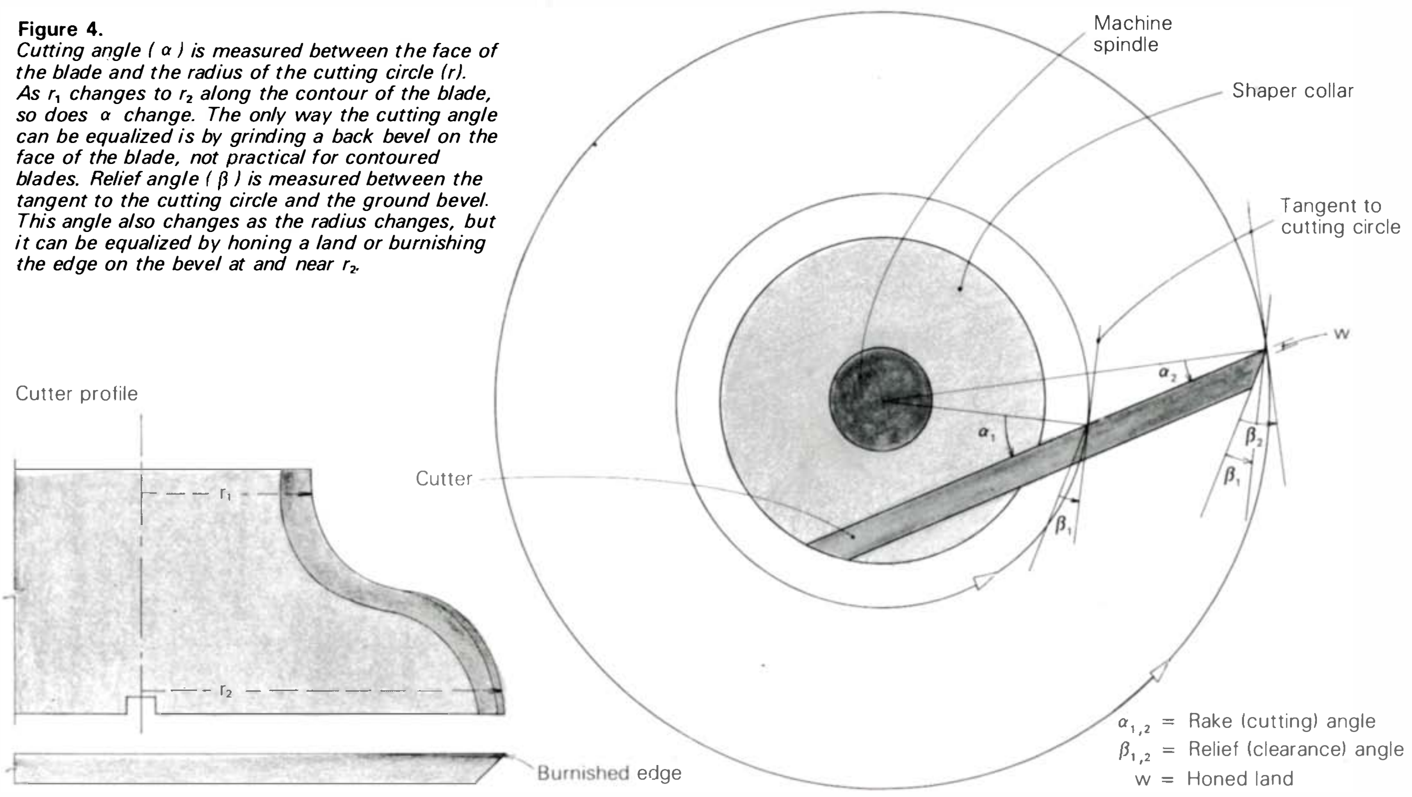


Figure 4.
Cutting angle (α) is measured between the face of the blade and the radius of the cutting circle (r). As r_1 changes to r_2 along the contour of the blade, so does α change. The only way the cutting angle can be equalized is by grinding a back bevel on the face of the blade, not practical for contoured blades. Relief angle (β) is measured between the tangent to the cutting circle and the ground bevel. This angle also changes as the radius changes, but it can be equalized by honing a land or burnishing the edge on the bevel at and near r_2.



blades, which are contoured, and so for optimum results you must make an adjustment of another sort: Relieve the extreme edge at and near r_2. Grind initially to the correct angle at r_1 in one pass, then grind a small land, w, at the outer edge of r_2, at the same angle. As an alternative, you could burnish the leading edge of the cutter at the largest radius (as when finishing the edges of hand scrapers), but only if the cutter is not too hard. For a fully hardened cutter, hone the end to produce a land of width w.

The small land on the cutter (which can form through wear as well as by grinding) suppresses tear-out by forcing down the wood fibers just behind the sharp cutting edge. The trade-off, however, is zones that are casehardened. These zones may not be visible, but they are all too apparent during finishing, when they cause the stain to blotch. How casehardening occurs is exaggerated for illustration in figure 5, where both the width of the land, and the travel of the workpiece while the cutter is in the cut are much too large for the real world. However, the depth of cut, another variable that influences the finished surface, is pictured in the detail typically. To achieve the best cut with minimal tear-out and casehardening, try a combination of shallow cuts, slow feed and a slight land on the cutter.

The criteria by which a skilled amateur or small-shop professional judges cutter performance are probably quite different from the criteria used in a high-speed mill producing planed, structural lumber. For one thing, softwood lumber is usually planed wet, and it is the after-dry appearance that the customer observes. Casehardening is irrelevant in structural lumber since the wood will not be stained, and may even be preferred for the smooth, slick finish it imparts. On the other hand, the small-shop woodworker generally seeks two types of surfaces—one to be glued and the other to be finished. If you're gluing, precision is all-important in obtaining the best possible fit. Despite some reports to the contrary, I believe roughing up the surface first with sandpaper gives a better glue bond. Now suppose you have a jointer with an optimum cutting edge. The trailing edge of the cutting bevel causes casehardening. Because the wood is kneaded, however slightly, sanding is difficult and in some woods almost impossible. For gluing, it's usually better to accept a little tear-out, which will disappear under clamping pressure.

The more important type of machined surface for most of us is the one that is shaped, sanded and finished. My idea of a good surface is one from which I am able to remove the cutter marks with a pass or two of medium-grit (say, 100) sandpaper. Again, in this case, a bit of tear-out would be preferable to a bit of casehardening. If the shaped surface is to be painted rather than finished with a clear stain, however, I would opt for a bit of casehardening.

To avoid excessive hand-finishing, I keep cutting edges sharp, with a slight burr and no excessive fine honing. This is a good reason for using high-speed steel cutters instead of tungsten carbide—my tests show that even with the greatest care, grinding tungsten carbide leaves little if any burr.

The shaper and its basic tooling — Just why does the shaper work better than the router, where it can be used? First, the shaper has a larger radius of cut, important in a surface to be sanded. The router partly compensates for this with its high speed, but unless its cutter is very sharp, not enough. Second, the shaper cutter can be honed with a rough stone or ground on a medium-grade aluminum-oxide wheel to produce a slightly torn finish, which is optimum. Third, except for certain unfortunate types of cuts—usually a result of poor cutter design—the shaper is safe. Figure 6 (next page) shows what I believe to be an important feature of shaper use—you can submerge the cuts, and the workpiece being machined protects you from flying debris. That the work, if it leaves the table, moves away, rather than toward the cutter, and thus is less easily ruined, is a bonus.

I use a spindle shaper with a ½-in. diameter shaft. These

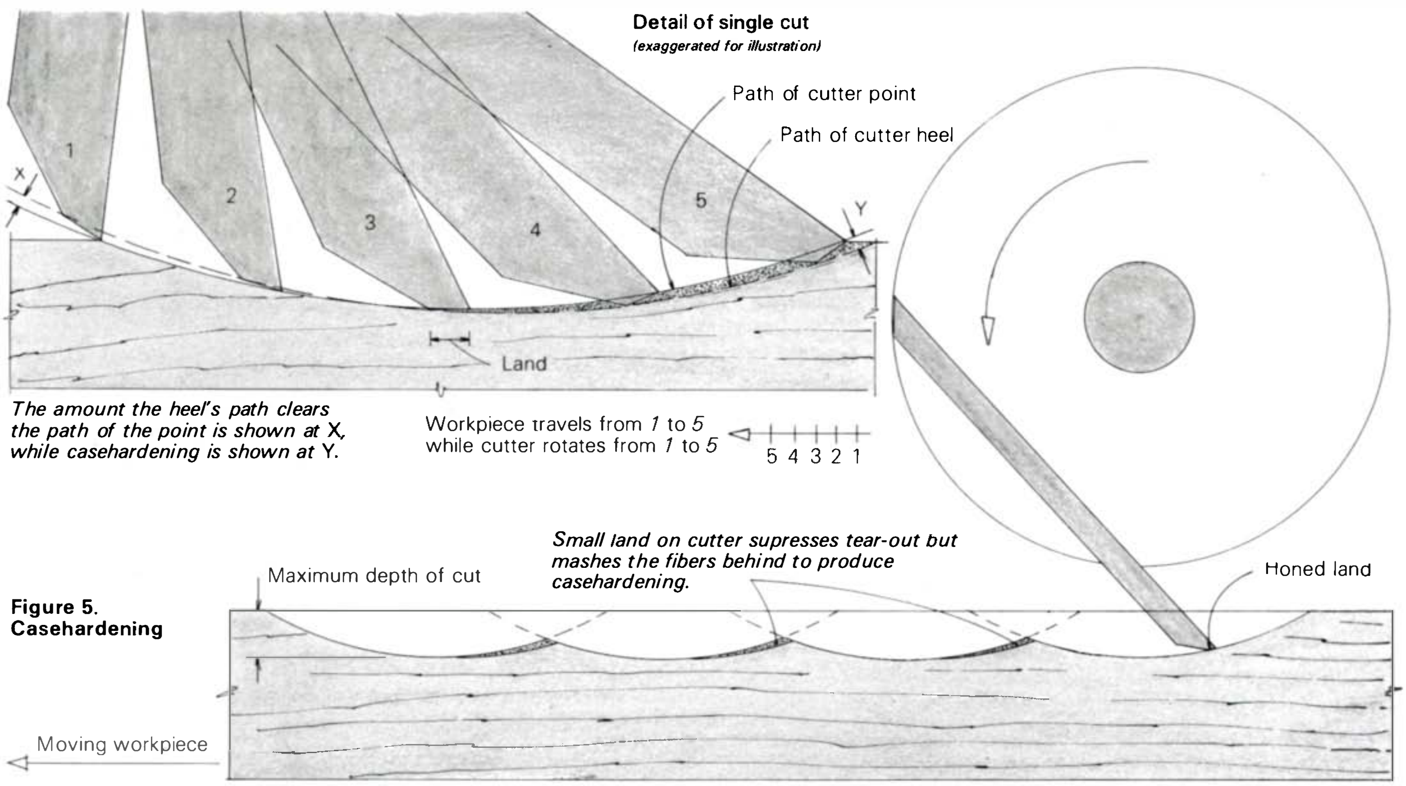
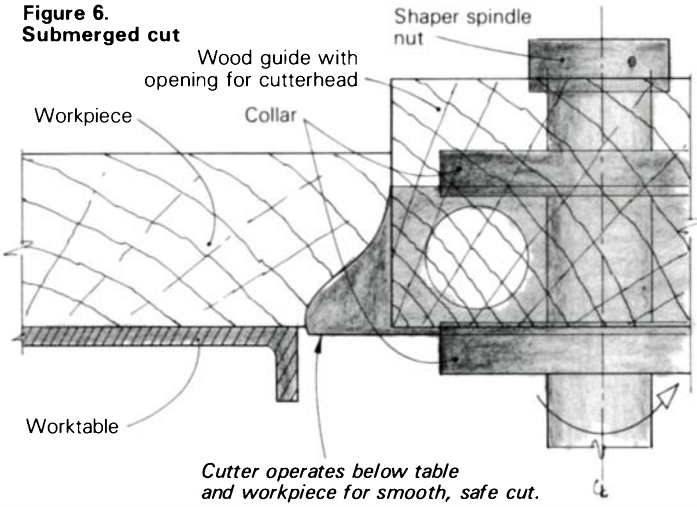


Figure 5. Casehardening

Figure 6.
Submerged cut



machines are usually belt-driven by a motor mounted below the table. Some models have direct-drive motors, but these lack flexibility and I don't recommend them. They're also unduly noisy because of the high speed they must achieve. A good shaper should have a fairly heavy table (I prefer ground cast iron) at a comfortable height, with hold-down-bolt holes, an adjustable bearing carrier to elevate and lower the cutter, and well-made auxiliary components (such as spanner nuts and spacers).

I built my ½-in. spindle shaper, and anyone could duplicate it for about $1,500, using local foundries and machine shops. A logical adaptation might be made with low-cost conversion parts for a ½-in. drill press. Don't do it: The only thing I know of that is more dangerous is the myriad of cutoff items that accumulate on shop floors. If you want a good, nice-looking shaper and don't want to make one, buy Sears' model 2392N (97 lb.) at $209.95. Buy a few cutters, but mostly grind your own. They'll be sharper and work better.

If you're planning to buy a shaper, try to buy it without the fence, at lesser cost—I have a nice factory-built adjustable fence that I simply never use, preferring instead the wooden work guide shown in figure 7. The guide is fashioned from a piece of scrap wood about ¾ in. thick, with an opening for the cutter. When I want to renew the working edge and know so a day or two in advance, I glue a strip of hardwood to the old edge, leaving a space above the surface of the table for chip clearance.

I also like to use another technique for submerged cuts—especially simple with system *B*, but usually practical in any case with a little trimming of the hardwood strip. I clamp the guide down lightly, with the cutter inside, and then move the guide in while running the machine, to allow the cutter to cut its own opening, a little oversize. I relieve the second edge with a skew chisel to provide good entry without hang-up. For vertical clearance, I place two scraps of thin cardboard under the guide after the cut is made, and run the guide into the cutter again. If I can't use a submerged cut because of cutter design or the nature of the cut, and am going to make a lot of cuts, then I build a guard that completely covers the cutter. In this case it is important to shape the guard so chips can be carried away from the work. Chips that circulate around the cutterhead can cause small but noticeable depressions in the finished surface. Even in the open-topped fence, a chip ramp is a good idea.

I regulate the depth of the cut with a cam adjuster attached to the work guide; it requires minimum (for me) tooling and is ideal. As discussed earlier in this article, tear-out and casehardening can be minimized by making a series of light cuts rather than one heavy cut. The cam adjuster facilitates this by allowing incrementally fine cuts without having to stop the machine or reposition the workpiece. In use, you place the fence over the hold-down bolts through the appropriate holes (there is a choice, allowing gross adjustment) and roughly set the depth of cut, shifting the fence in the hold-down-bolt slot. Set the hold-down knobs loosely and move the cam lever to fine-tune the depth of cut. This care is justified only for finished surfaces; for glue joints only accu-

Figure 7. Adjustable wooden work guide

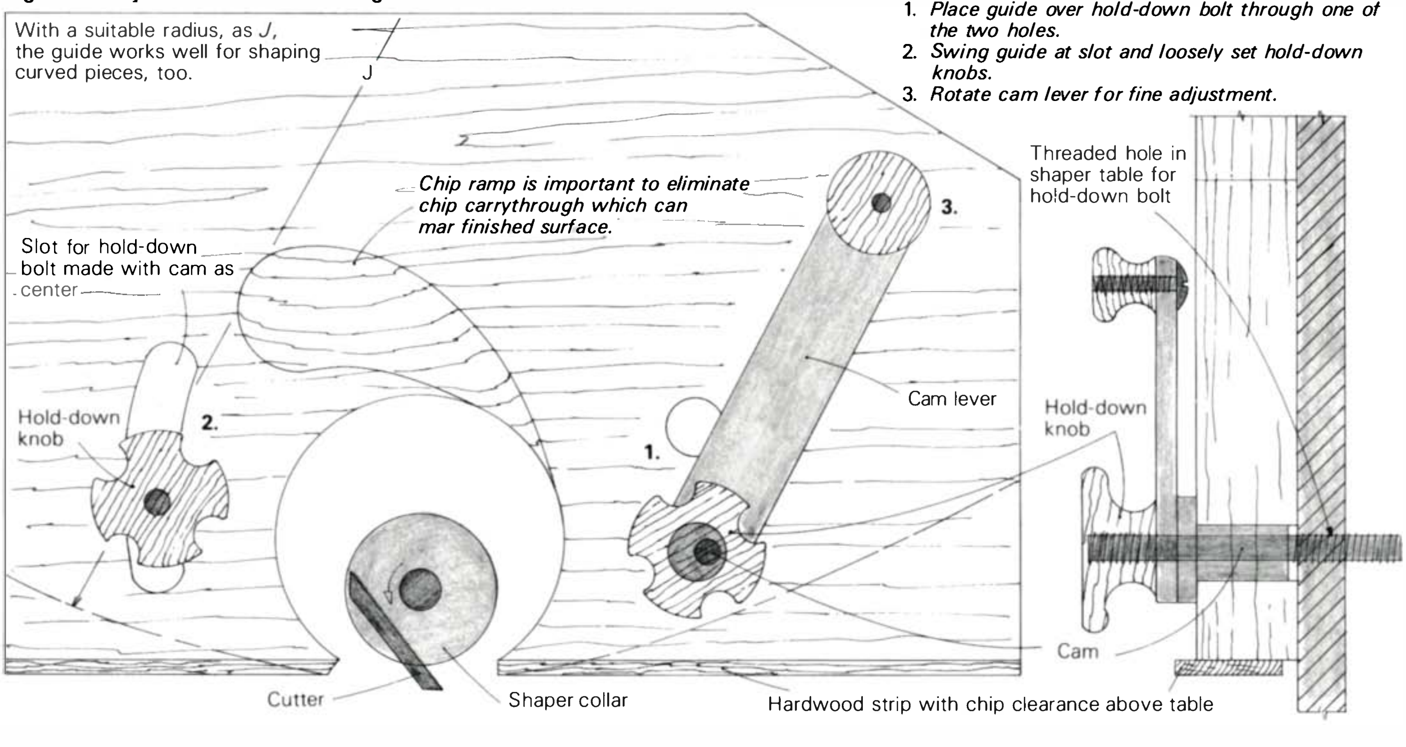
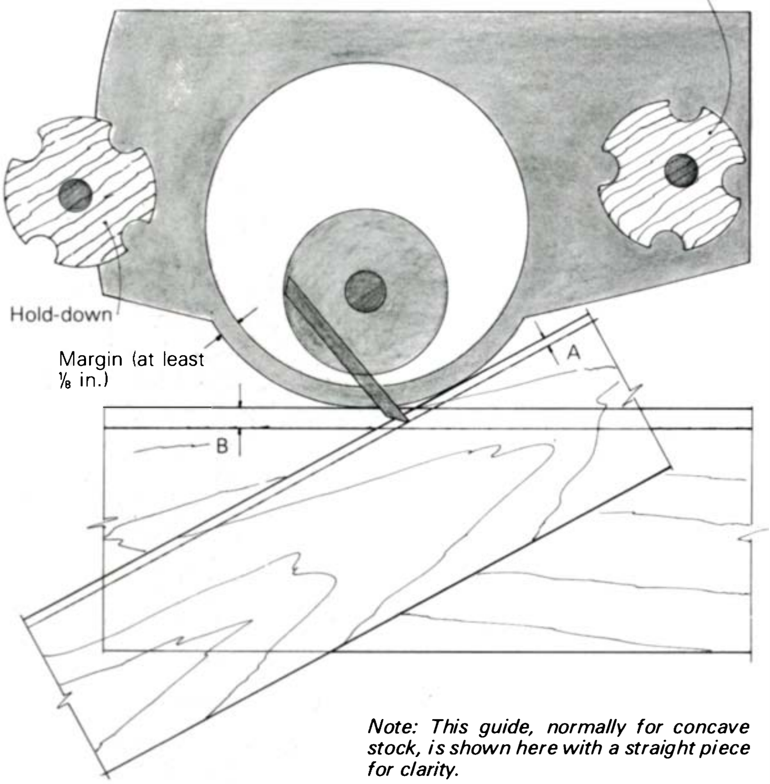


Figure 8.
Metal guide for concave cuts can be mounted below the cutter, as shown here, or on spacer blocks above the cutter.



Note: This guide, normally for concave stock, is shown here with a straight piece for clarity.

Figure 9. Contour guide

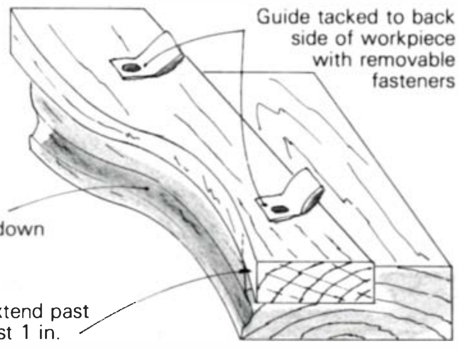
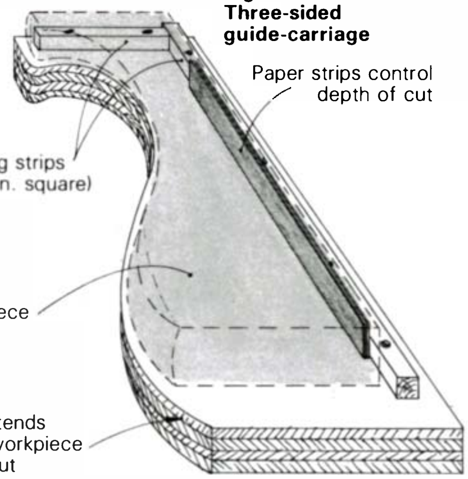


Figure 10. Three-sided guide-carriage



racy is necessary, and in other cases, say, for tongue-and-groove joints, heavy cuts are usually adequate.

More shaper guides — The straight guide is the safest, most accurate and simplest way to ensure a near-perfect cut in a shaper. Unfortunately, it is useful only for straight or convex work. Where molding of concave stock is desired, it is standard practice to run the work past the cutter, holding it either against a ball-bearing rubbing collar attached to the cutter or a steel rubbing collar inset in a well in the table opening (see "Furniture from Photographs," *Fine Woodworking*, July '79). In either case, the cut is started by holding the work against a hold-down stud to avoid having the cutter toss the work back at you—a tricky and dangerous maneuver. There is no rapid, simple way to adjust depth of cut in either of these two methods, and the inset collar tends to interfere with the positioning of the cutter.

The guide shown in figure 8 can be positioned either above the cutter using spacer blocks or bolted to the table and adjusted with the hold-down, cam, or both. It is a useful alternative to the guides discussed above: It provides friction without the rubbing post, a nuisance on certain pieces with small radii, and you can control the depth of cut—change it without turning off the shaper or adjusting the guide—by changing the angle at which the workpiece approaches the cutter. The first shallow cuts, as at *A* in figure 8, are made with the work tangent to the guide at a point to the right or left of center. Final cuts, as at *B*, are made with the work tangent to the center point.

All three types of guides do share certain problems, however. Unless the work is held in a shaped guide that has a surface elevator built in, as in figure 10, you may need a plywood surface elevator. Also, if a template is attached to the workpiece in order to get a precise shape, it's usually necessary to make the pattern slightly different from the shape of the finished piece because the cutting radius and ball-bearing or insert radius are not the same, as anyone with experience in router control using rubbing collars knows.

You can make the concave-cut guide in figure 8 on a metal or wood lathe of aluminum (⅛ in. to ¼ in. thick) or on a metal lathe of steel (⅛ in. thick)—the size of the opening is irrelevant. You could also cut the guide on a drill press using a fly cutter. In any case, for durability it is best to leave a margin around the hole at least ⅛ in. wide.

Where only one side of a workpiece is to be shaped, you can tack a guide to the back side of the workpiece, as in figure 9. Make sure you carefully cut and sand the guide, as imperfections there will be transferred to the work. The guide should be at least 1 in. longer than the workpiece, in order to enter and leave the cut under full control, with the workpiece held at the correct distance. The workpiece should be sawn about 1/16 in. oversize on the edge to be shaped. Make the guide of any material, depending on the number of times it is to be used—pine for short runs, metal for long runs. I find it useful to keep on hand a supply of pine and hardwood planed to about 5/16 in. I never throw a guide away, although occasionally I get in a hurry and rework one.

Figure 10 shows an alternative to tacking the guide piece to the work. In this case the part to be formed had both faces finished, so I made a three-sided carrier to hold the workpiece. Because I had not developed the cam adjuster at the time, I used paper strips to adjust the depth of cut. □

Earl Beck, of Ventura, Calif., is a semi-retired research engineer and lifelong woodworker who generally builds rather than buys his tools.

Plans for a Pigeonhole Desk

Design suggests the best woods

by Simon Watts

This folding desk is one of the more complicated pieces, in terms of joinery, made in my shop. The folding front flap is only to make the piece more compact and to give easy access to the drawers. It does not conceal the pigeonholes, as does a conventional roll-top or slant-top desk. I've made nine over the past 14 years, each one a little different from the last. The drawings and photos show the final version, and there are no more changes I want to make to this particular design. It has been made in teak, mahogany, cherry, walnut and padauk but not in any blond woods such as oak or ash.

The matter of choosing an appropriate wood for a particular design is difficult, but not as subjective as it appears to be. Leaving aside questions of cost and availability, there are certain criteria that always apply. Most obviously, the wood chosen has to have the right mechanical properties for its particular function—which may mean using more than one species in the same piece of furniture. Years ago chairs were commonly made out of three different woods: pine for the seat, since it could be easily carved; maple for the legs and rungs, which was ideal for turning; and oak for the back, because of its bending properties. One also needs to think of the suitability of the wood to the tools and construction techniques and the climate to which the finished piece will be exposed. For example, if there is to be a lot of hand-dovetailing, oak is a miserable material because its coarse grain makes it difficult to cut cleanly; if there is a lot of machining and you don't have carbide cutters, you should avoid teak; climates where there are great fluctuations in humidity demand a stable wood such as mahogany.

Stability, ease of working, durability, strength, hardness and resistance to decay—all these have to be considered, but often this still leaves considerable possibilities. Why is it that certain designs look better in one wood than another? Part of the answer lies in the color and texture of the wood. All woods have grain patterns, which range from the almost invisible, as in holly and ebony, to the inescapable, as in red oak. If you use an aggressively grained wood to make a piece like this desk, which is characterized by simplicity and careful proportions, the result is visually confusing. It may be striking and dramatic, but it is not anything a sensible person would want to live with. My general rule is, the smaller the surfaces and the finer the detailing, the more restrained the color and figure should be, but, like any rule, mine can be disregarded by the true genius with triumphant results.

Another point to consider is the hardware that will be used and how it will look. Certain combinations are more pleasing than others: polished brass with walnut or mahogany, wrought iron and oak, stainless steel and rosewood. Similarly, if more than one wood is used, it is important that they enhance each other and that both be subordinated to the overall design. A colleague of mine once made a small oval vanity table, the surface of which was veneered with alternating strips of ash and ebony. Superbly executed, the result was a visual nightmare; but a large table in ash, with a thin edging or inlay of ebony or rosewood, could be both striking and tasteful. If the contrast between the two materials is too subtle, there will be an irritating doubt as to whether, in fact, there is more than one wood and you will get what a teacher of mine called "the monotony of faint variation."

There is also the matter of tradition and historical precedent. A furniture-maker is not bound by these considerations but should be aware of them. This desk has some close relatives in the past at a time when walnut and mahogany were much in vogue, and this may explain why these two woods are my favorites for this particular design.

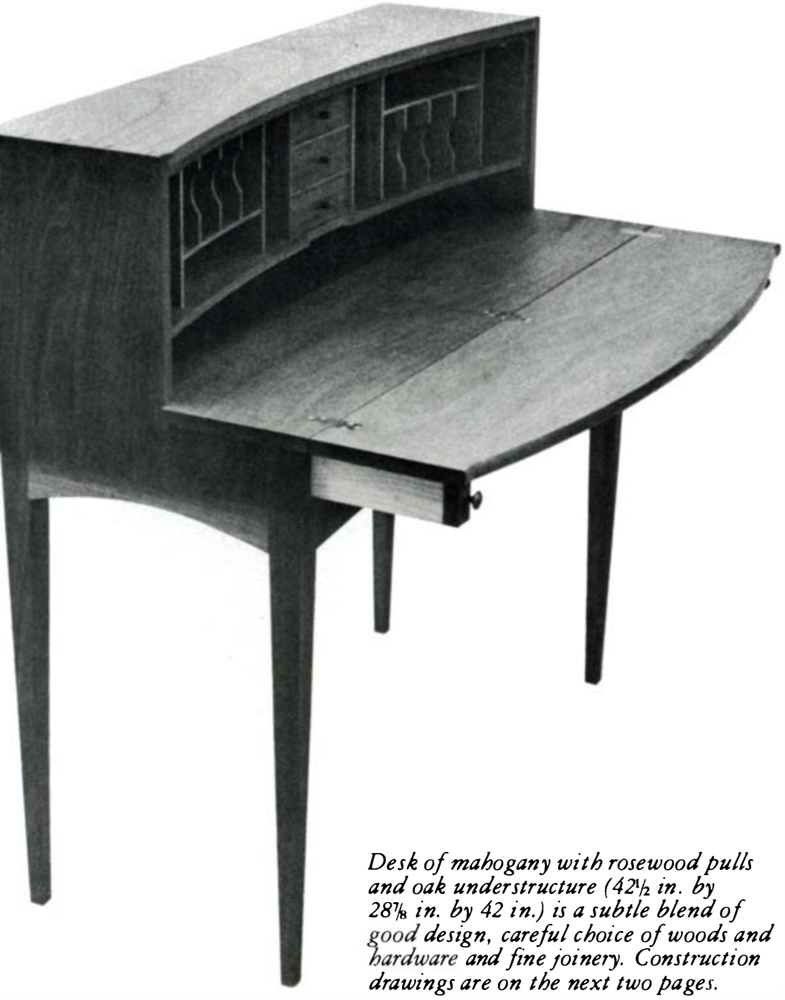
Some of my customers would want to select a wood not because it was appropriate for the design but because their living room was mostly cherry or oak and they thought that any additional furniture should be in the same wood. My argument is that it is not matching the wood and finish that makes two pieces of furniture good neighbors, but the less easily defined qualities of scale, simplicity and proportion.

Construction — This is a difficult piece of furniture to make, and I urge anyone who is not familiar with a specific technique to try it out first on scrap wood and avoid the frustration of spoiling good material. For example, if you have not made a haunched tenon before, make one, and if necessary, go on making it until you can do it with confidence. It is also prudent, when making a number of identical parts, to make up one or two extras—five legs instead of four, for example. Then, if you make a mistake on one piece, you won't have to repeat each step in its production. The extra piece, if not needed, can be kept as a pattern for future projects.

The time required to construct this piece will vary according to your experience and whether a planer or other machines are available. I would expect to spend about 120 hours in a well-equipped shop. At the end of this article I will discuss how to make up a materials list so that you can estimate the cost and order the right amount of lumber.

Assuming you have a pile of rough lumber, and the plans for this desk, a general cutting procedure would go as follows: Select the best boards for their width, figure, straightness and color. These will be used for the carcase and writing surface. Cut an inch off one end and examine it for checks. If it is clean mark off the length you want and add at least an inch, before cutting. Run the board, concave side down, over a jointer (or hand-plane it) until you have one flat surface.

Putting this flat surface *down*, run it through a thickness planer. Examine it after the first pass and, if it is chipping up, turn it end for end, still keeping the flat surface down. If you're going to glue up, plane to ⅛ in. oversize and, if your planer is wide enough, plane the whole assembly to the final thickness. Otherwise, plane to finished thickness, turning it



Desk of mahogany with rosewood pulls and oak understructure (42½ in. by 28⅞ in. by 42 in.) is a subtle blend of good design, careful choice of woods and hardware and fine joinery. Construction drawings are on the next two pages.

Photos: Richard Starr

end over end after each pass to avoid moisture imbalance that can cause cupping and to maintain grain direction through the knives.

Next, joint (or plane) the best edge and saw the board to width, allowing ⅛ in. to ¼ in. for cleaning up. With a knife, mark the ends to the exact length and cut off the waste.

The 10½-in. top should be one piece, but unless 18-in. boards are available the side pieces will have to be joined up, then dovetailed into the top, using a half pin at the corners as shown in the drawings on the next two pages. The front and back rails can be either one piece or laminated. They should be lap-dovetailed into the sides as shown. This whole assembly is called the carcase. Now rout the ¼-in. groove for the back panel around the inside of the back of the carcase, taking care to stop the groove in the side pieces so that it does not show from the top. The back panel can then be joined up and planed to its finished thickness of ⅜ in.

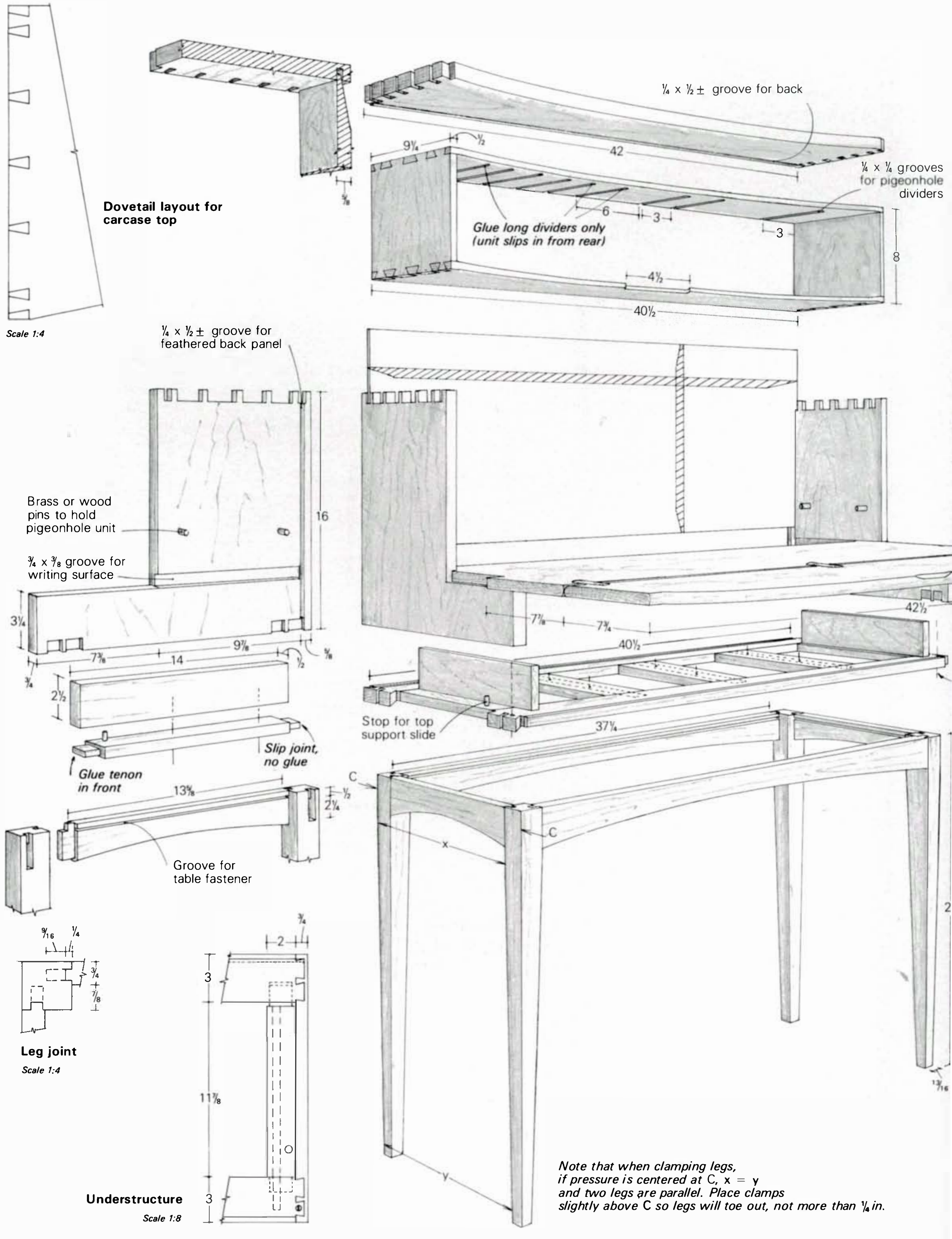
The grain of a rectangular panel should parallel the rectangles's long axis, to minimize seasonal change. If your wood is *recently* kiln-dried, you should allow between 7/32 in. and ⅜ in. per foot for expansion, or from ¼ in. to ½ in. for a 16-in. panel. The exact amount depends on the species. Teak and mahogany are at the lower end of the scale, beech and oak at the upper. There is practically no movement along the length of the panel, so it can be fitted quite snugly. With a plane, feather the panel to fit the groove after rough-cutting it to the approximate bevel on the table saw.

To make the understructure, tenon the five drawer supports into the front and back rails, but glue into only the front rail to accommodate seasonal changes in the carcase. Rout or saw a ¾-in. groove ⅜ in. deep in each side to hold the stationary piece of the desk top. Stop these grooves when they meet the back-panel groove, or they will show from the back. After sanding the inside surfaces, glue up the carcase and flush the dovetails off with a sharp plane.

I use Titebond (aliphatic resin) glue and plastic-resin glue such as Weldwood. Titebond sets up quickly (one to two hours) thus freeing up clamps and speeding the work. However, it has a short assembly time (five minutes or less), cannot be easily sanded off and deteriorates in ultraviolet light. It is subject to creep under stress and should not be used for heavy, bent laminations. Plastic resin permits longer assembly time (10 to 20 minutes), but takes at least six hours to set up at 70°F. Unlike Titebond, it is practically waterproof.

In general, I use resin glue for dovetails and any complicated joint requiring long assembly time and for joints exposed to sun and water. I use Titebond for small laminations and for simple joints that will not be heavily stressed.

It is convenient to make up the base now, to have something on which to set the carcase. The legs should be of the straightest stock you can find, for strength and for appearance. Rough-cut the taper on the band saw or table saw (don't use the jointer) and then clean it up with a plane. I like to plane the legs slightly convex, otherwise perspective makes them appear hollow. A haunched tenon attaches the legs to the aprons. The aprons are rounded on the underside and also have a slight curve—an important detail because it helps to keep the desk from looking too severe. After cutting



Dovetail layout for carcase top

Scale 1:4

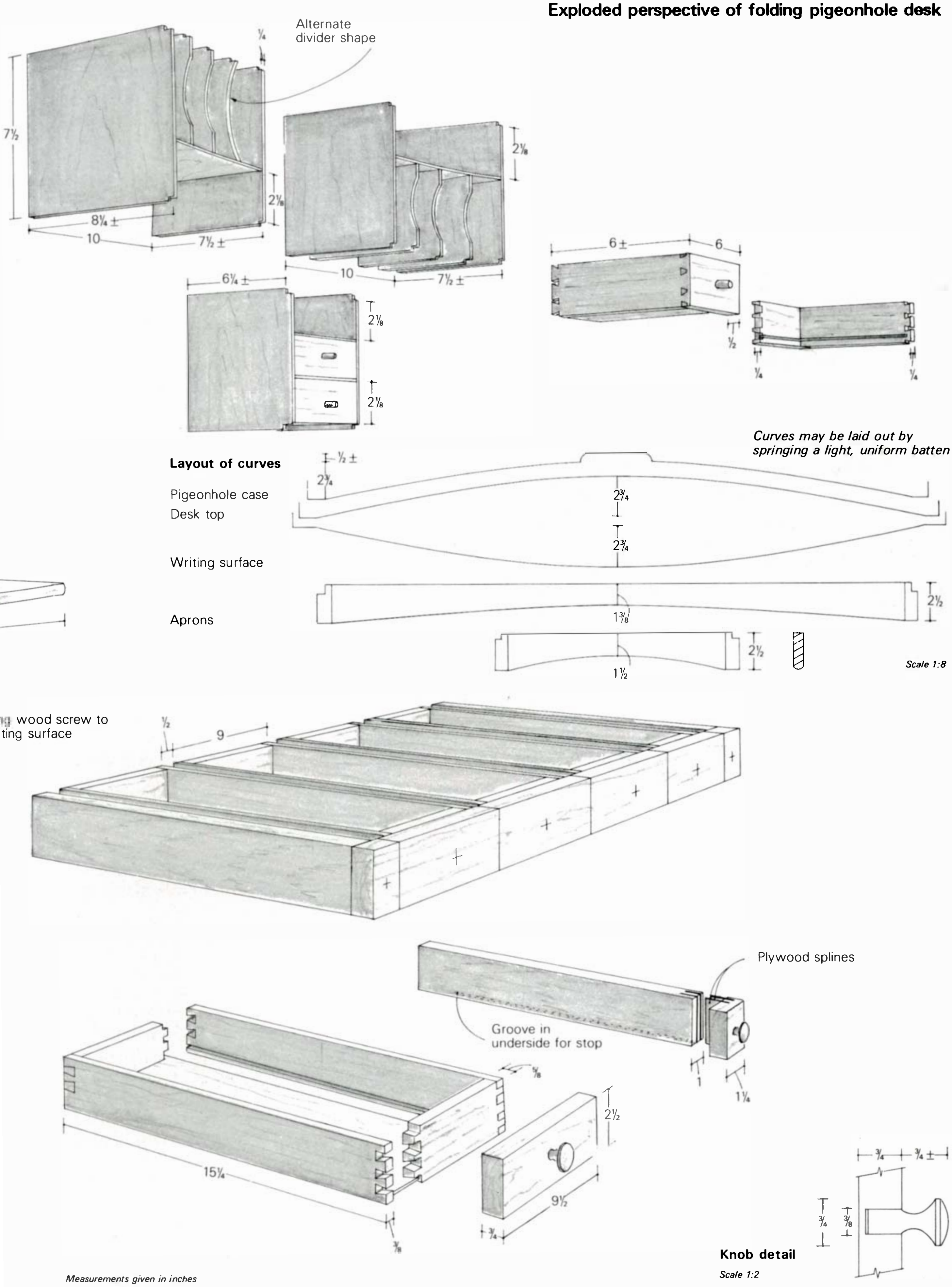
Leg joint

Scale 1:4

Understructure

Scale 1:8

Exploded perspective of folding pigeonhole desk



Measurements given in inches

the groove for the tabletop fasteners or buttons *(Fine Woodworking*, Sept. '79, pp. 63-64) you can glue up the base. Do this in two stages: two pairs of legs first, and then the whole assembly. Check with a tape to make sure the legs are parallel, as shown in the drawing. (They should actually toe out very slightly because perspective makes two verticals, when seen from above, appear to converge.)

Next select the stock for the writing surface, join it up and plane it to fit the ¾-in. groove. The stationary piece can be joined up out of ordinary stock but the front flap, like a table leaf, is not restrained by any structure or frame and should therefore be of vertical-grain stock and preferably one piece. Cut the stationary piece to size and slide it into the carcase until it stops against the sides. It should overhang the front by ½ in. and is kept in place by a single, long wood screw counterbored on each side. But don't fasten it yet; the top must be off to fit the slides and drawers—the next steps.

The slides that support the flap can be of maple or oak, faced with the same wood as the carcase. These facings are offset to act as stops when the slides are pushed all the way in, ½ in. short of the back panel; too close and carcase shrinkage would cause them to project. Attach the facing to the slides with plywood splines as shown in the drawing. Stop the slides in their extended position by putting a peg in the stationary part and a slot in the underside of the slide; the length of this slot determines how far out the slide will travel.

Now set the slides in place and measure the horizontal distance between them, subtracting 2½ in. for the five ½-in. dividers. Divide the remainder by four to get the exact width of each drawer. To avoid the difficulty of making drawers to fit precisely an existing opening, make the drawers first in the usual way (through dovetails at all four corners) and then fit them as follows: Cut some pieces of 3x5 index card. Place the slides, all the drawers and as many of the dividers as will fit. Then slip a piece of card into each gap, at the front and back. Remove, plane and test-fit the dividers until the assembly fits without forcing. Then clamp the dividers and screw them from the underside. (The drawer fronts, which will overhang the drawers, will be stopped against the front edge of the dividers, so not only must they be spaced accurately, but their front edges must be aligned.) When you remove the cards, the drawers will have the right clearance. Now cut out the false fronts and screw them to the drawers from the inside—don't use glue. Make these fronts slightly oversize so they can be trimmed to fit the openings and each other. I like to make the drawer fronts and the slide facings out of the same piece of wood, to give a consistent grain pattern.

The drawer fronts look better set back between ¹⁄₁₆ in. and ⅛ in. from the carcase front. To do this, block them out with one or two pieces of index card, plane or scrape them all off flush with the carcase and remove the card.

Turn the knobs or pulls out of a wood that contrasts with the carcase without being too extreme. For example, a walnut or cherry desk with rosewood pulls looks good, but ebony pulls on a maple desk draw one's attention, detracting from the overall appearance. If no lathe is available, you can carve pulls or substitute small brass knobs.

Cut the front flap as shown in the drawing and attach it to the stationary part using brass hinges, which have to be scribed and set into the writing surface. Rectangular hinges are easier to fit than the ones with semicircular ends. I strongly advise a trial fitting on a piece of scrap before cutting into the desk top.

The final step is to make the pigeonhole unit and fit it into the carcase. Dovetail the outside box together out of ½-in. stock and rout slots for the dividers. Cut a shoulder in the front edges of the dividers to cover the rounded end of the slot left by the router bit. Then slide them in from the back, gluing only the long, vertical ones. The small drawers are best lap-dovetailed but a simple rabbet joint, glued and nailed with panel pins, could be substituted.

Plane the sides of the pigeonhole unit to a slight taper so they fit snugly in the carcase. Then secure the whole assembly with four brass or wood pins as shown. You could make knobs for the small drawers from the same brass rod. All finishing should be done before the unit is fastened in place.

I usually finish with Watco, a synthetic oil that polymerizes on exposure to the air. I apply it at 24-hour intervals until the wood will absorb no more, wet-sanding with the grain, using 600-grit waterproof sandpaper for the final application. If this process is repeated every six months or so, an attractive patina develops. There is no need to oil the understructure because movement within and around it has been allowed in the construction. Wherever wood is sliding on wood I use a good-quality paste wax. This makes for a smooth action and reduces wear. The insides of the drawers are best waxed, too. It makes them easier to keep clean. □

Simon Watts is a contributing editor to this magazine.

Figuring your materials

When buying lumber wholesale, in quantity, you cannot specify the exact widths and lengths of the boards you want, nor, generally speaking, can you pick them out. Consequently you have to order more than you need—but at a lower price. Buying retail by the board is considerably more expensive, but you have less left over.

If you choose to make this desk in *Afzelia*, or some other exotic wood you don't plan to use again, then buying retail makes sense. If you decide to use a more common wood, such as walnut or cherry, which will be used for other projects, then you should buy wholesale at a better price and have the additional advantage of being able to select boards for their figure and color.

You figure the amount of lumber required by making a complete bill of materials. I follow the format given in the example below:

	Size (in.)	Area (sq. in.)	Area (sq. ft.)	No.	Total (sq. ft.)	Total (bd. ft.)
4/4 stock, walnut						
Aprons	2½ x 40	100	0.69	2	1.39	1.53
Drawer fronts	3¼ x 42	137	0.95	1	0.95	1.05
8/4 stock, walnut						
Legs	26 x 2 x 2	104	0.72	4	2.88	3.17

The last column is arrived at by multiplying the total in square feet by 1.1. You do this because when you buy a board foot, its actual size is 12 in. long by 11 in. to 11¼ in. wide; it shrinks that much across the grain from its cut-green width of 12 in. If you need 141 sq. ft., say, you will have to buy 141 x 12/11 (or approximately 1.1) = 155 bd. ft. A materials table like this one should be made for each different kind of wood and for each thickness. You must also allow for waste. If you buy FAS (first and seconds select), 20% is a commonly accepted figure. A lower grade will mean more waste. In addition to hardwood, you will need ⅛-in. plywood for drawer bottoms. You will also need tabletop fasteners (unless you make your own buttons), three brass hinges and some small pieces of hardwood for the knobs. *S.W.*

Repairing Wobbly and Broken Chairs

Two shops relate their methods

In the Q&A section of the May '79 issue, David J. Wood inquired as to methods of disassembling a chair that had been repaired with epoxy. George Frank pointed out quite correctly that a "sharp" blow is not really possible with a rubber mallet, and suggested instead the use of a steel hammer. We feel this will result in unacceptable damage to the surface. We have found that the following procedure works well for the five or so chairs a week that we rebuild in our shop.

If the joints are tight, drill the smallest possible hole directly into the bottom of the mortise and inject white vinegar. This will dissolve most glues and loosen others. While vinegar has no effect on epoxy, experience shows that joints repaired with epoxy are rarely cleaned out properly during the repair. The epoxy then is holding the old glue together rather than the wood. Dissolving the old glue effectively loosens the joint.

Knock the chair apart with a Computhane dead-blow hammer. These leave almost no mars and with even less rebound than a steel hammer deliver the better part of the force to the work. Stubborn joints sometimes require fixing one piece, say the rung, in a vise while the leg is knocked off with alternating blows to each side of the joint. This concentrates the energy on breaking the joint rather than moving the piece around the workbench.

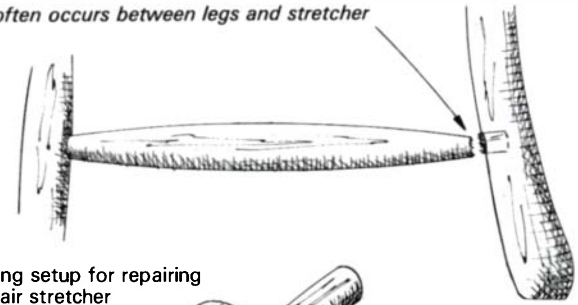
If this doesn't do it, leave the joint intact and fix the rest of the chair. We glue with cascamite after a careful cleaning of the joints. Its strength, long open and closed working time, good gap-filling qualities and low pressure requirements for a good set make it unbeatable for most chair repairs. Cascamite glue injected by syringe through a small hole drilled into the joint will strengthen the loose tenon that cannot be removed.

We do not use fox, or blind, wedges to spread tenons because we've seen them split seats and legs rather than be driven down into the tenon during regluing. A more consistent problem is that it is all but impossible to remove a fox-wedged (or, for that matter, a pinned) tenon if it gets loose again, and experience shows that tenons get loose in time whether wedged or not. Seasonal changes in humidity cause the tenon to expand, its confined fibers to be crushed, and the tenon to shrink smaller than it was before expansion. We often see amateur repairs with nails, screws or epoxy—all ineffective and problematic in themselves. The old-timers were right to assume they'd have to disassemble their chairs periodically and reglue them.

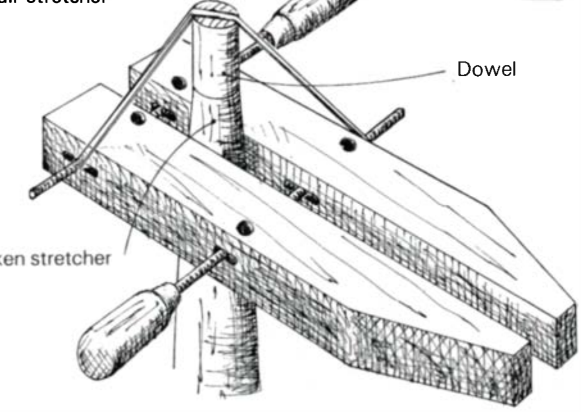
—Jane Clarke and George Danziger

When I am called upon to repair a chair leg, stretcher or arm support that has broken in the middle or toward one end, I use Albert Landry's scarf joint (Methods of Work, Jan. '79). However, many times a break will shear exactly at the joint line and perpendicular to the grain direction, especially on a chair stretcher (figure 1). In these cases I use a repair method that is easier than the scarf joint and nearly as strong. Also, if you are dealing with a chair in original paint or finish, little or no finish touchup is required.

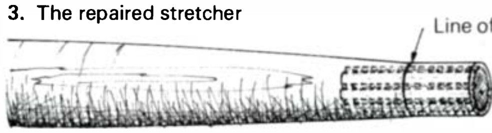
1. Break often occurs between legs and stretcher



2. Clamping setup for repairing broken chair stretcher



3. The repaired stretcher



First, file or saw the broken end perfectly square. Find a dowel the same diameter as the broken joint and cut off a piece the same length as the broken end, usually $\frac{3}{4}$ in. to 1 in. Butt-glue one end of this dowel to the broken member as follows: Take a small handscrew clamp and tighten the section between the threaded rods onto the broken member about an inch down from the top. Glue the end of the dowel to the end of the broken member, securing it by stretching a heavy rubber band between the threaded-rod ends of the clamp and up and over the end of the dowel (figure 2).

When the piece has dried, carefully drill through the dowel and into the old part of the broken piece with a drill $\frac{1}{8}$ in. to $\frac{3}{16}$ in. smaller than the dowel diameter. Glue a new section of smaller dowel into this hole (figure 3). Cut grooves into the sides of this dowel to allow air and excess glue to escape because the broken member's diameter is quite small and easy to split. The second dowel gives the joint all of its strength. Though it is $\frac{1}{8}$ in. to $\frac{3}{16}$ in. less in diameter than the original joint, in my experience it proves to be a sound repair.

—Robert C. Kinghorn

Clarke and Danziger's shop, The House Doctor, is in Leverett, Mass.; Robert Kinghorn repairs furniture in Excelsior, Minn.

400 craftsmen assess the state of the art

More than 400 woodworkers, some from as far as Florida, California and Hawaii, rolled into Purchase, N.Y., on the first Friday in October for a three-day conference called Wood '79: The State of the Art. By the time they went home Sunday afternoon, most were exhausted from talk and drink far into the night, but also exhilarated by the chance to show slides, meet colleagues, compare notes and swap techniques.

A show of hands indicated that the participants divided about evenly into four types: professional woodworkers, amateur craftsmen, students intending to enter the field, and teachers, most of whom maintain shops and build commission work on the side.

The event was organized around three panels, each of five or six people, who spoke to the whole group on the general topics of design, tools and techniques, and marketing. After each session, the panelists separated into smaller rooms for more detailed talk, more slides, and demonstrations.

Saturday night was set aside for a slide show of work by any of the conference participants. There was also a gallery exhibition of furniture and sculpture by the various speakers, plus a small trade show where a dozen firms demonstrated the type of hand tools and machines advertised in this magazine. The affair finished Sunday morning with a harrowing lecture on shop dangers and solvent safety by Dr. Michael McCann of the Center for Occupational Hazards.

The design panel opened the proceedings, but only two of its members directly addressed the topic at hand, the state of our art. Furniture sculptor Wendell Castle of Scottsville, N.Y., led off by contending that his ilk were ahead of painters and architects in creating post-modern art. On a more mundane level, *Fine Woodworking* editor John Kelsey offered observations of the current scene, based on the photographs of woodworking in *Design Book Two*. The other design panelists were Alan Friedman of Terre Haute, Ind., who discussed work by his students; Don McKinley of Sheridan College in Toronto, who revealed in slides how a talented designer discovers furniture forms by playing with bits of industrial scrap; and Bob Strini of Missoula, Mont., who explained why he twists wood like spaghetti into sculpture resembling cars entwined with trombones.

The techniques panel sampled a gamut of current work. Speakers and demonstrators included (and you can qualify most of them by their articles in back issues of *Fine Woodworking*): Dale Nish on how to harvest green wood for turning; Emil Milan on production carving with the band saw and various sanders; Bill Keyser on steam-bending; Castle on buying and modifying used machinery; Strini on the excellences of the hot glue gun; Tage Frid on carcase joinery and dovetailing; Jon Brooks on chain-saw-carving furniture from logs, stumps and roots; and Robert Whitley on making chairs.

The marketing panel included four owners of galleries that show one-of-a-kind furniture. The discussion, which centered on their relations with woodworkers, was leavened by business consultant Pat McGuire, who emphasized the importance of knowing your market. People spend more on furnishings during the first year after a move than during the next five years, McGuire said, and most families redecorate completely about one-and-a-half times in their lives. To obtain worthwhile furniture commissions, the trick is to catch people just before they move, and then to persuade them that good furniture is worth more than a vacation in Barbados.

The conference was organized by an ad-hoc committee that had been instigated by furniture maker Andy Willner of Thompson, Pa., during the 1978 Rhinebeck fair. As you might expect from this genesis, it emphasized sculptural furniture and the concerns of the high-style craftsman, to the detriment of traditional furniture, case goods, small-run production, business advice and hobby woodworking. As you also might expect, not everyone was happy with the program.

Still, the principal value of events like this is the opportunity to come out from under the sawdust and meet other woodworkers. There was considerable talk about the advantages that might be gained if woodworkers were to organize a guild, and the last word is that the Wood '79 staff intends to carry the ball—they've been attempting to work out the myriad details. Interested craftsmen should contact Ken Strickland at the Visual Arts Department, State University of New York College at Purchase, Purchase, N.Y. 10577.

Cut off your beard, safety expert warns

If you want to avoid inhaling toxic wood dusts and finishing solvents you really should cut off your beard.

That's the only way, according to Dr. Michael McCann, to fit a respirator to your face. McCann, director of the Center for Occupational Hazards and editor of the *Art Hazards Newsletter*, was speaking to about 200 woodworkers at the closing session of the Wood '79 conference. About half of his audience wore beards, and clutched their chins as McCann drove the point home: "How much is your beard really worth? If you insist on keeping it, there's one other thing you can do—rub vaseline into your beard so that your respirator can seal tightly."

Although McCann's text ranged over the hazards of crafts in general, for this audience he concentrated on solvents, finishes and wood dusts. Questions showed that these indeed were woodworkers' principal safety concerns; several production craftsmen said they had recently switched from modern finishes to boiled linseed oil to sidestep safety problems.

McCann pointed out that the degree of hazard must be ascertained in each particular situation, by judging the amount, length and frequency of exposure, the toxicity of the solvents in question and the possible synergistic reactions with each other and the worker's total body burden and individual susceptibility. The danger is that many chemicals are cumulative—one can suddenly become sick and stay sick as a result of long-term, apparently harmless, exposure.

One who works with solvents for eight hours a day and then quits faces much less risk than one who works for 15 or 16 hours at a stretch, since the body needs rest time to detoxify chemicals it has absorbed. Similarly, one who drinks, smokes and lives in the city may be perilously close to overloading the organs that purify the blood, and may become ill after only brief exposure, while his teetotaling country cousin will suffer no ill effects.

McCann noted that solvents enter the body not only by inhalation, but also through breaks in the skin and by ingestion. "It's surprising how much of a chemical can get into the system if you eat or smoke while working," he said. He also emphasized that finishing solvents are formulated to dissolve organic materials. Skin, eyes, rubber gloves and contact lenses are all organic. "Don't wear contact lenses while you are working, and if you splash solvent in your eyes, rinse them in running water for a full 15 minutes, then see a doctor to be sure."

McCann ranked solvents on a scale that ranges from "highly toxic," through "moderately toxic" to "slightly toxic." An "absolutely do not use" list includes benzene (a carcinogen), carbon disulfide and carbon tetrachloride, phenol, tetrachloroethane and trichloroethylene.

The "highly toxic" group includes solvents such as toluene, hexane and xylene, found in contact cement, spray glues and rubber-cement thinner, as well as in many penetrating oil finishes and lacquer thinners. Toluene was to blame for the glue-sniffing epidemic of a few years ago, and extensive exposure to hexane can cause permanent damage to the nervous system.

The label on the can usually does not say exactly what is inside, but the woodworker's clue to the presence of hexane is the phrase, "Petroleum distillates, extremely flammable." The label warning "highly flammable" or simply "flammable" applies to a different class of solvents.

The "moderately toxic" group includes some alcohols, ketones, cellosolve, acetate and turpentine—the last because it may cause a severe allergic reaction in some people, which can develop after years of repeated exposure without harm. Allergies can also develop suddenly from exposure to epoxy resins, formaldehyde, metal salts and a number of wood dusts, most of them tropical imports like cocobolo, iroko and African mahogany, but also including western red cedar. Also "moderately toxic" are the common petroleum distillates benzine (VMP naphtha), mineral spirits and kerosene.

McCann's "slightly toxic" list includes acetone (a surprise—it is usually thought more dangerous because of its pungent odor), ethyl alcohol and isopropyl alcohol.

The best precaution is to switch to another, less toxic solvent—if you can find out what is in the mix in the first place. If you have to use a toxic mixture, you should ventilate the shop in a way that doesn't draw contaminated air past your face (the fault of most canopy hoods) or recirculate it into the shop (the fault of many dust-collection systems). Be meticulous about shop housekeeping, change your clothes and wash with soap and water when you quit for the day.

McCann said that good ventilation systems are hard to design and require the advice of an industrial-ventilation engineer; an air-conditioning engineer who does not have expertise in toxic chemical ventilation will not do. In some small shop applications, a wet-dry industrial vacuum cleaner can be hooked up to individual machines to trap dust. But protection against solvents requires adequate ventilation or a proper respirator approved for the particular solvent by the National Institute of Occupational Safety and Health (NIOSH)—it will say so on the box. Avoid cheap, three-for-a-dollar dust filters; they only give a false sense of security.

One little-known hazard that is causing increasing concern in industry is the long-term exposure to formaldehyde, which can cause chronic bronchitis and allergic reactions. It is also a suspected carcinogen. Resorcinol glues and the glues used in particle board decompose under the heat of machining to produce formaldehyde.

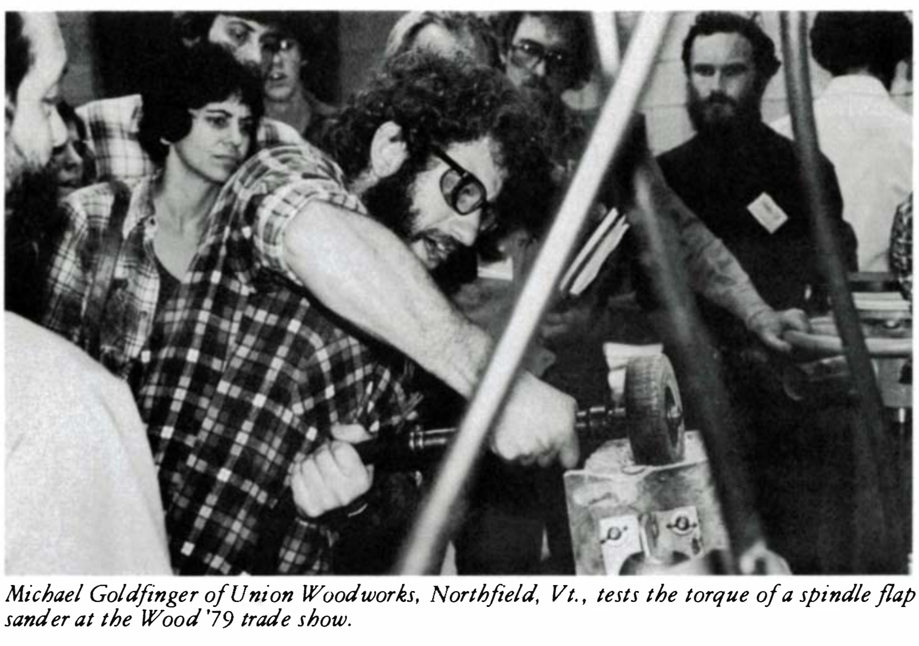
Another cause for alarm is the common wood preservative pentachlorophenol, which contains dioxin, the chemical blamed for birth defects in Italy and an ingredient in agent orange, the herbicide banned after the Vietnam War. There is no safe limit of exposure to dioxin.

McCann also warned that imported woods pose an unknown hazard in this regard, because nobody knows what the logs might have been treated with, before or after harvest.

He also warned against such hazards as noise and white fingers. The OSHA approved maximum allowance is 100 DB for a half-hour a day (or 90 DB for an 8-hour day), but a 14-in. radial arm saw puts out more than 120 DB (10 times the sonic energy) when crosscutting hardwood. "The rule of thumb is, if you have to raise your voice to be understood two or three feet away, you've got a hazard. Wear ear muffs (preferable to ear plugs) and take frequent breaks."

White fingers, or dead hand, is an occupational disease among loggers and others who use vibrating machines. It starts out as a numb tingling in the fingers, which goes away overnight, but long-term exposure can make the nerve damage permanent and extend it over the whole hand. Cold makes the problem worse, and McCann cited pneumatic tools because they exhaust a steady blast of chilled air. The precaution is good equipment designed to minimize vibration, frequent rests and warm gloves.

For a one-year subscription to McCann's *Art Hazards Newsletter,* send $10 to 5 Beekman St., New York, N.Y. 10038. McCann's office will also attempt to field questions by telephone at (212) 227-6220. *—J.K.*



Michael Goldfinger of Union Woodworks, Northfield, Vt., tests the torque of a spindle flap sander at the Wood '79 trade show.

by John Kelsey

ARNOLD MIKELSON 'Refined and diligent art'

Arnold Mikelson describes his carvings as "refined and diligent art." His house, surrounded by gardens, sits back from the road atop the bluff above the ocean in White Rock, B.C., Canada. Behind the house squat two *A*-frame buildings, the front one Mikelson's gallery, the rear his shop. Every day around dawn, there goes Mikelson, working steadily until late in the evening, 100 or more hours every week. For every hour carving, he guesses two are spent on overhead—sweeping, gardening, relieving his wife from minding the gallery. Even so, he makes 250 or more sculptures in a year, some duplicates of earlier work, but most of them new, always discovery. Often, he's actively working on one large piece and a dozen or more small ones, out of the several dozens that stand in various stages of completion around the shop. Says he, "If I do a large piece it's like a love affair with a beautiful woman, you can't find anyone to replace her. When I do a big piece I can't handle more than one, so I always have many little ones started also."

Mikelson figures he nets about $2 an hour for his labors, but still he is diligent enough to support his wife and four children by carving alone. "This is not for a young person," he says. "John Matthews, the English writer on carving, once said I was the best in the world, and I agree that I am probably among the best. If I make only $2 an hour, what can a young guy do? I could double my prices and probably still would sell them all, but I don't have the nerve to try it."

As for refinement, you will have to judge for yourself from the photos. As for art, ask Mikelson whether this is woodcarving, or craft, or sculpture. Be ready for an anecdotal excursion through art history: "This is not woodcarving. In the old country, woodcarving is like die-punching metal. My tools are the same, but if an old-time woodcarver makes a curved line, he uses a curved blade, and there's the curve, finished on the spot. My tools also have the curved blade, but none are used to determine the final shape; I do that, not the tools. In England I stopped in the studio at a cathedral, where a woodcarver was doing beading in a grape-and-vine motif. I say, 'Don't you ever get fed up with carving this same motif?' 'No,' he says, 'I've carved this pattern for the last 30 years.' The difference is design, and 90% of carvers don't design, they take someone else's design and copy it. Now, most people have the ability to learn to design, but the ability has to be developed from an early age."

Sharpening with the Mototool.

He is just warming up: "Art form develops by line flow, you can spot where a thing came from by the line. The renaissance line is the most powerful, signified by a fluid, shallow *S*-curve, which is what I use....I have no argument against modern art, most of it is pre-caveman anyway. My request is if a person looking at fine art does not understand what it means, the artist should be able to explain. Art is creation by a man, as opposed to discovery, nature's art, such as driftwood or the shapes made by waves and wind. That's not creation, but accidental discovery. If the artist can't explain it, it's a discovery—the artist has to know."

Mikelson was born in Latvia in 1922, the son of a cabinetmaker, fortunate in those days to be able to study painting and drawing, the essence of design. After the war, in England, he designed porcelain figurines for production, many of them birds. "Birds are a part of my life, so I don't have to stop to reason out their forms. The human female, horses, have to be done a tiny chip at a time; take too much off, you fail. I understand birds, and with my fantasy figures, you can take a 7-in. wrong cut and nobody knows the difference." Nonetheless, Mikelson also makes women, and fish, and a menagerie of animals. But always he returns to birds, both real and fanciful.

Mikelson's figures are all laminated from solid stock, so the lines of each element of the carving can work with the figure of the wood. His principal machines are the band saw, for roughing out the shapes, the belt sander, for making flat surfaces to glue together, and a small flexible shaft grinder carrying a 220 or 320-grit abrasive disc. "My secret," he grins. "I sharpen with it, first the belt sander to shape the edge, then the little grinder, then strop on leather and it's razor-sharp."

Hundreds upon hundreds of cardboard patterns festoon the rafters of the *A*-frame. "I draw the form, make the pattern, put it on the wood and arrange it so the grain can follow the lines of the carving. The patterns help me visualize, to develop full utilization of the lumber. Some of these have never been used, some I use over and over."

Once he roughs out the elements of the figure, he carves it in sections, and because of the way he works, the pieces may sit around the shop for a year or more before he glues them up. "If there is any movement, it has a chance to work itself out. Even a small bird is three pieces of wood glued up, no reason not to glue it." He uses white glue, thoroughly sizes the end grain, and if there are any dowels they are for locators only. The pieces never come apart, and one has to look hard for glue lines, so cunningly does he match the figure of the wood. Once a piece is together and the carving is completed across the glue lines, Mikelson finishes it with two to four coats of Benjamin Moore Imperial satin varnish.

Because he glues up his forms, Mikelson is usually able to carve with the grain, and to have the lines of the form follow the figure of the wood. He says, "The wood parts easily with the grain, much more difficult across the grain. So instead of cutting across the grain as most others do and making little chips, I make long shavings." He also prefers, whenever possible, to slice the wood with a knife. For example, most carvers would make the feathered wings and tails of Mikelson's birds with a *V*-tool. Says he, "I make a double cut, with the knife and chisel. With the knife, cut the side of the feather to a stop cut at the end. Then slice along with a skew or a straight blade. The surface comes from the tools, not from sandpaper or rifflers, although of course I use those too, but only when I have to." □

Photos: Staff

Typhon, son of Hera, satin walnut, $2,500.

Chelsea birds, satin walnut (eucalyptus), $3,500.

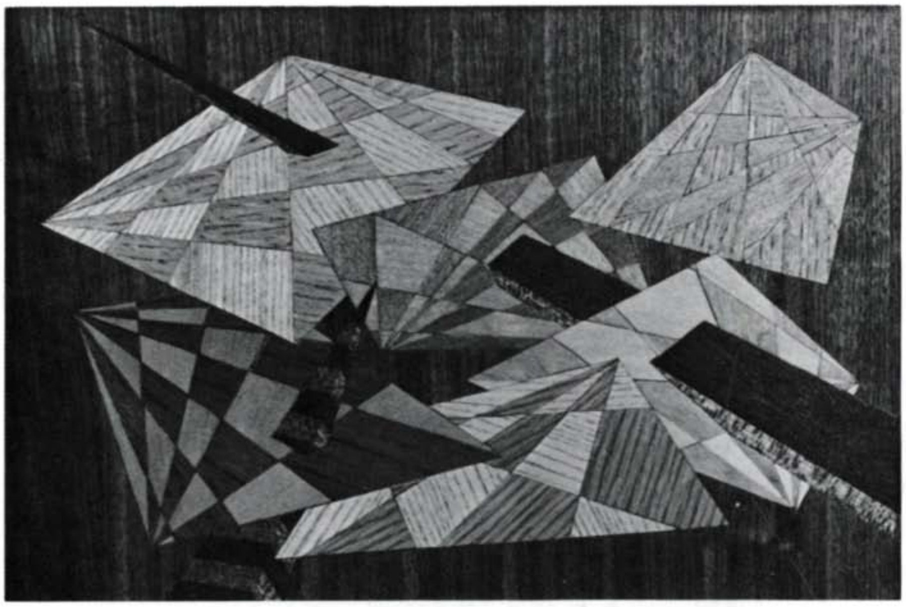
Above, musk-ox, satin walnut (eucalyptus), $1,200; below, fighting egrets, Brazilian walnut, $2,750.

Carvings in progress.

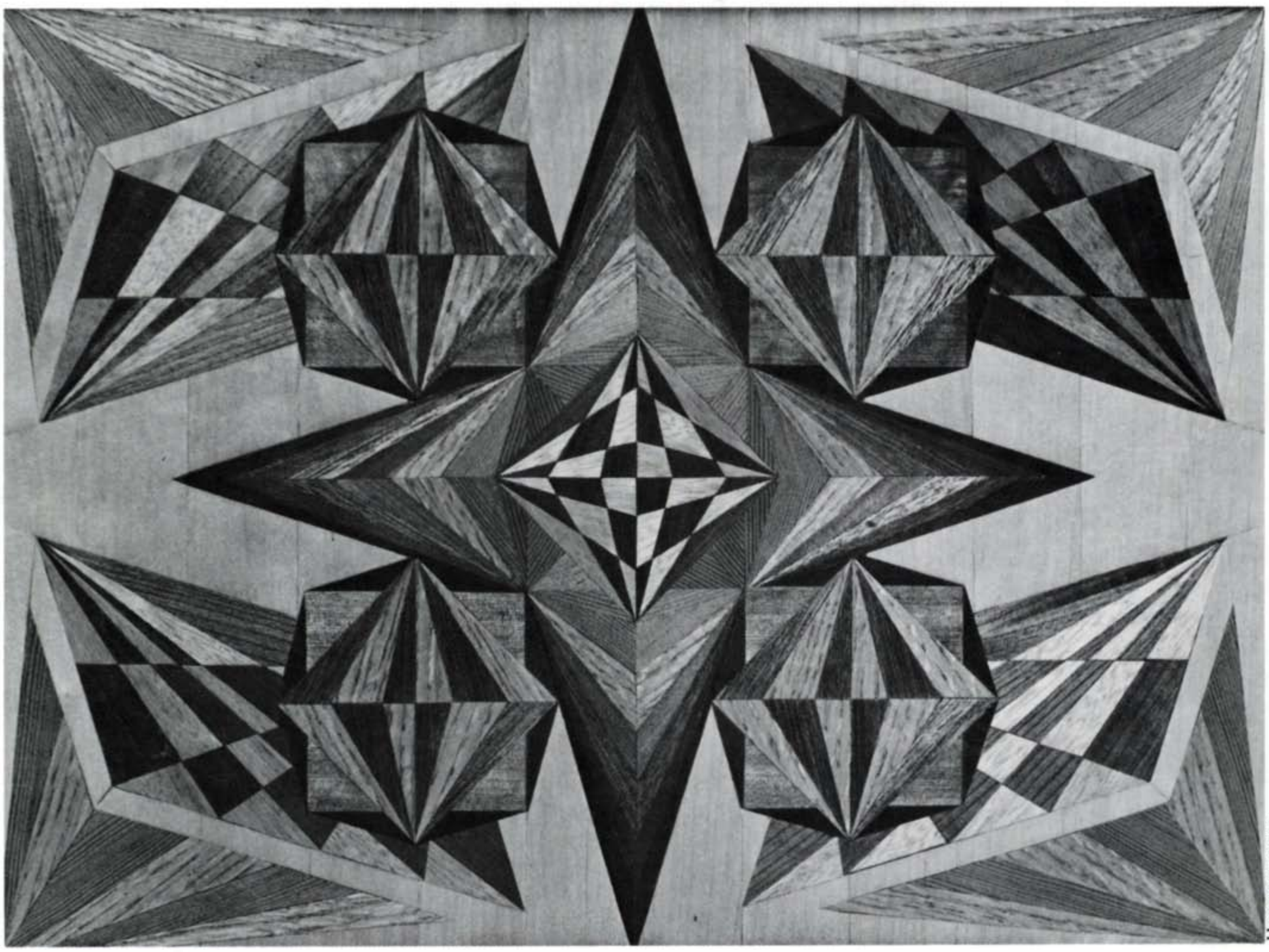
Geometric Marquetry

Terry Tallis, a sales developer for calculator products in Corvallis, Oregon, has never seen a marquetry picture that works. For seven years now, his own pieces have displayed an endless variety of wood hues, grain and texture, but in geometric or freeform patterns, never at the service of a pictorial image.

"I usually have a general mood or theme in mind, then allow the character of the wood to suggest its own design. Starting from a focal point, I select veneers on the basis of odd shadings, contrasts and three-dimensional effects. Most often I use ash, fir, mahoganies, rosewoods, ebony and birches, but I've experimented with over 70 different species, using as many as 54 different woods in one piece. Building out from the focal point of the piece, I cut the veneers individually, and match, fit and glue them directly to the base surface. Although this method may take more time and care to ensure good bonds than laying out the whole piece at once, I value the spontaneity it affords."



Plains of Mars, 12 in. by 16 in.



Photos: Peter Krupp

Star Plains, 16 in. by 22 in.

Hardwood Sources

This survey of hardwood supplie s in the United States and Canada is expanded and revised from listings that appeared in *Fine Woodworking*, nos. 4, 5 and 8. To compile this update, we wrote to firms in the previous listings, to our advertisers, to retailers of this magazine, and to suppliers recommended by readers. Of the dealers who returned our questionnaire, we have included only those who sell lumber retail in quantities of less than 1,000 board feet, or who deal in hardwood plywood, or veneers in less-than-a-flitch quantities. A listing does not represent an endorsement of a company, and we would appreciate readers' opinions, both positive and negative, as well as leads to more hardwood sources.

The dealers are grouped by state or province, and listed alphabetically within each group. The information presented is, of necessity, condensed; contact each firm directly for specifics—woods in stock, prices, shipping charges and so on. The key is:

Dom. = domestic lumber	Imp. = imported lumber
AD/KD = air-dried/kiln-dried	NMO = no mail order
Veneer = if less than a flitch	Planks = if thicker than 8/4
Logs = if sold	Plywood = hardwood plywood
Min. = minimum board-foot quantity sold; no min. means one board or less.	Unusual species in stock and specialties of the firm are listed last.

In addition to the firms listed here, there are small sawmills serving local markets in most regions of the country. Mills sawing pallet wood or fencing, for example, may come across some nice pieces and save them until a likely customer turns up. You may find the best source, especially of air-dried lumber, by taking a good look a ound your own county.

ALABAMA

Cowikee Lumber, Box 42, Eufaula 36027. (205) 687-2300. Dom. AD/KD, 500 min. Logs.

Dilworth Lumber Co., 415 Church St., N.W., Huntsville 35804. (205) 539-4123. Dom. & imp. KD, no min. Veneer; planks, plywood. Yellow poplar, Tennessee red cedar.

Glenwood Gin Co., Box 155, Glenwood 36034. (205) 335-3918. Dom. AD, 500 min.

A.L. Shirley Lumber Co., Box 304, Luverne 36049. (205) 335-3718. Dom. AD, no min. Planks. Poplar.

ALASKA

Hardwoods, Inc., 1940 Spar Ave., Anchorage 99501. (907) 278-9546. Dom. & imp. KD, no min. Plywood. Vermilion, purpleheart.

ARIZONA

Austin Hardwoods, 2045 N. Forbes #102-A, Tucson 85705. (602) 622-7383. Dom. & imp. AD/KD, no min. Planks. Cocobolo, wenge.

Burl House, 1635 W. Fisher Dr., Prescott 86301. (602) 445-9430. Dom. & imp. AD/KD, no min. Veneer; planks, plywood. Olive, bloodwood, Mexican rosewood.

Classic Grain Hardwood Co., 902 E. Hughes Access Rd., Tucson 85706. (602) 889-8496. Imp. KD, 100 min. Mesquite; mesquite flooring.

Mouat Hardwood, 1734 N. Louis La., Tucson 85712. Dom. & imp. AD/KD, no min. Yew, spalted maple, chinkapin, Oregon myrtle.

Southwest Hardwood Co., 2113 E. Jackson St., Phoenix 85001. (602) 244-0301. Dom. & imp. KD, 100 min. Veneer; planks, plywood.

Spellman Hardwoods, 2865 Grand Ave., Phoenix 85017. (602) 272-2313. Dom. & imp. AD/KD, no min. Veneer; planks, plywood.

CALIFORNIA

Robert M. Albrecht, 18701 Parthenia St., Northridge 91324. (213) 349-6500. Dom. & imp. KD, no min. Veneer; planks, logs. Honduras mahogany, zebrawood.

American Hardwood Co., 1900 E. 15th St., Los Angeles 90021. (213) 749-4235. Dom. & imp. KD, 100 min. Planks. Mansonia, hickory.

Baker Hardwood Lumber Co., Box 181, San Diego 92112. (714) 239-4181. Dom. & imp. KD, no min. Planks, plywood. Alder, ash, birch, Tennessee cedar, maple.

Baker Plywood Co., 2969 Century, Costa Mesa 92626. (714) 549-3073. Dom. & imp. AD/KD, no min. Veneer; planks, plywood. Zebrawood, Andaman padauk, paldoa.

Baser & Co., 1100 Glendon Ave., Los Angeles 90024. (213) 477-7551. Plywood.

Cal Oak Lumber Co., Box 689, Oroville 95965. (916) 534-1426. Dom. AD/KD, 100 min. Planks. Fremont cottonwood, madrone, tanoak.

Chico Hardwoods, 565 E. Lindo Ave., Chico 95926. (916) 891-0570. Dom. & imp. AD/KD, no min. Veneer; planks, plywood.

Custom Wood Craft, 2818 N. Main St., Walnut Creek 94596. (415) 938-2818. Dom. & imp. KD, no min. Veneer; planks. Old & rare veneers: satinwood, primavera, bird's-eye maple, ribbon walnut.

The Cutting Edge, 295 S. Robertson Blvd., Beverly Hills 90211; and 1836 Fourth St., Berkeley 94710. Dom. & imp. AD/KD, no min. Planks, logs. Cocobolo, goncalo alves, English holly, koa, ironwood.

Del Valle, Kahman & Co., 215 Market St., San Francisco 94105. (415) 981-4641. Dom. KD, imp. AD/KD, 20 min. Plywood: birch, oak, lauan, kapur; panels.

Frost Hardwood Lumber Co., 347 W. Market, San Diego 92112. (714) 233-7224. Dom. & imp. AD/KD, no min. Planks, plywood. Beech, oak, birch, Spanish cedar, lignum vitae, rosewood, poplar, tigerwood.

Ganahl Lumber Co., 1220 E. Ball Rd., Anaheim 92805. (714) 772-5444. Dom. & imp. KD, no min. Planks, plywood. Teak, purpleheart, zebrawood, basswood.

Handloggers, Foot of Spring St., Sausalito 94965. (415) 332-0506. Dom. KD, imp. AD/KD, no min. Veneer; planks, logs, plywood. Mexican hardwoods, bocote; boatbuilding lumber.

Hardwood Center, 11211 Slater Ave., Fountain Valley 92708. (714) 540-7117. Dom. & imp. KD, no min. Veneer; planks, logs, plywood. Wenge, bubinga, bocote, pau ferro, goncalo alves, ebony.

L & L Hardwoods, 1801 Smith Ave., San Jose 95112. (408) 275-6210. Dom. & imp. KD, no min. Planks, plywood. Maple chopping blocks.

M & H Wood Products, Box 310, Claremont 91711. (714) 621-3994. Rotary & sliced veneer; planks, logs.

M & M Hardwood, 5344 Vineland, N. Hollywood 91601. (213) 766-8325. Dom. & imp. KD., no min, NMO. Veneer; plywood. Bocote, E. Indian rosewood, purpleheart, shedua.

MacBeath Hardwood, 7653 Telegraph Rd., Montebello 90640. (213) 723-3301. Dom. & imp. AD/KD, no min. Veneer; planks, plywood. Rosewood, cocobolo, iroko, zebrawood, padauk.

MacBeath Hardwood, 2150 Oakdale Ave., San Francisco 94124. (415) 647-0782. Dom. & imp. AD/KD, no min. Veneer; planks, logs, plywood. South American hardwoods: lignum vitae, laurel, ebony, rosewood.

Mission Hardwoods, 1805 E. Dyer Rd., Santa Ana 92705. (714) 754-1847. Dom. & imp. KD, no min. Veneer; planks, plywood. Barcino, cristobal, aromatic cedar, white oak, bird's-eye maple, teak.

Orange Coast Hardwood & Lumber Co., 2727 S. Main St., Santa Ana 92705. (714) 556-1774. Dom. & imp. KD, no min. Veneer; planks, plywood. Koa, zebrawood, padauk, goncalo alves, shedua, basswood.

Pacific Plywood Co., 5233 Randolph St., Los Angeles 90040. (213) 773-0461. Hardwood plywood.

Penberthy Lumber Co., 5800 S. Boyle Ave., Los Angeles 90058. (213) 583-4511. Dom. & imp. KD, 100 min. Planks.

R & R Hardwood, 2520 W. Hellman Ave., Alhambra 91803. (213) 282-3332. Dom. & imp. KD, imp. AD, no min., NMO. Veneer; planks, plywood. Rosewood.

Redus & Aura Hardwood Lumber Co., 1099 S. 5th St., San Jose 95112. (408) 275-1990. Dom. AD/KD, imp. KD, no min. Veneer; planks. Kwila, vermilion, koa, pecan.

Reel Lumber Service, 301 E. Santa Ana St., Anaheim 92805. (714) 991-7770. Dom. & imp. KD, 100 min. Plywood. Industrial hardwood.

Royal Plywood Co., Box 367, La Mirada 90637. (714) 521-5735. Hardwood plywood.

Sand Door & Plywood Co., 3211S. Hooper Ave., Los Angeles 90011. (213) 233-4371. Dom. & imp. KD, 100 min. Hardwood plywood.

Sanford-Lussier, 6101 S. Van Ness Ave., Los Angeles 90047. (213) 292-9181. Dom. & imp. KD, 100 min. Wormy chestnut.

Saroyan Lumber Co., 3000 Exposition Blvd., Los Angeles 90018. (213) 292-0366. Dom. & imp. KD, 100 min. Planks. Teak, walnut.

Col. Buckeye Savage, 760 Illinois, San Francisco 94107. (415) 863-2115. Freeform cuts: redwood, buckeye.

Sawdust & Shavings Hardwood Lumber Co., 3518 Chicago Ave., Riverside 92507. (714) 781-0564. Dom. & imp. KD, no min. Veneer; planks, logs, plywood. Apitong.

Simmons Hardwood Lumber Co., Box 368, Montebello 90640. (213) 685-5880. Dom. & imp. KD, 500 min. Alder & ash planks.

Southern Lumber Co., 1402 S. First St., San Jose 95110. (408) 294-1487. Dom. & imp. KD, no min. Veneer; planks, plywood. Ebony, rosewood.

Stahl Lumber Co., 3855 E. Washington Blvd., Los Angeles 90023. (213) 263-6844. Dom. & imp. KD, 100 min. Veneer; planks.

Swaner Hardwood Co., Box 4200, Burbank 91503. (213) 849-6761. Dom. & imp. KD, 100 min. Planks, plywood. Pacific Coast hardwoods.

Lane Stanton Vance Lumber Co., 14710 Nelson Ave., Industry 91744. (213) 968-8331. Dom. & imp. KD, 500 min. Planks, plywood. Fiji species, Australian yuba.

White Brothers, 4801 Tidewater Ave., Oakland 94601. (415) 261-1600. Dom. & imp. KD, no min. Veneer; planks, logs, plywood.

Wood is Good, Box 477, Lakewood 90714. (213) 424-7377. Precut carving blanks.

COLORADO

Austin Hardwoods, Bldg, 1, Unit B, 2625 S. Santa Fe Dr., Denver 80223. (303) 733-1292. Dom. & imp. KD, no min. Veneer; planks, plywood.

Bill Collins Hardwoods, 500 W. Wesley Ave., Denver 80223. (303) 744-6046. Dom. & imp. KD, no min. Planks, plywood. Teak, koa.

H & B Hardwood Lumber, Box 16392, Denver 80216. (303) 825-2269. Dom. & imp. KD, no min. Planks, plywood.

Paul E. Killinger, 4309 Butler Circle, Boulder 80303. (303) 499-2648. Dom. & imp. KD, no min. Veneer; planks, logs. Orientalwood, bocote, lacewood, padauk; burl veneers.

Frank Paxton Lumber Co., 4837 Jackson St., Denver 80216. (303) 399-6814. Dom. & imp. KD, no min. Veneer; planks, plywood. Koa, angico, bubinga, cocobolo, jatoba.

Sears Trostel Lumber Co., 351 Linden St., Fort Collins 80524. (303) 482-1928. Dom. AD/KD, imp. KD, no min. Veneer; planks, plywood. Basswood, chestnut.

CONNECTICUT

General Woodcraft, 100 Blinman St., New London 06320. (203) 442-5301. Dom. & imp. KD, no min. Veneer; planks, plywood. Bubinga, ebony, cocobolo, padauk.

Leonard Lumber Co., 53 Farm River Rd., Branford 06405. (203) 269-2626. Dom. & imp. KD, no min. Veneer; planks, plywood.

Local Lumber Co., 161 Bowers Hill Rd., Oxford 06483. (203) 888-6509. Dom. AD/KD, no min. Planks, logs. Curly & figured maple, sassafras, cedar, cherry, oak.

Tech Plywood & Lumber Co., 110 Webb St., Hamden 06511. (203) 777-5315. Dom. & imp. KD, no min. Veneer; planks, plywood. Cocobolo, lignum vitae, mahogany.

DELAWARE

Shields Lumber & Coal Co., Kennett Pike, Greenville 19807. (302) 656-2541. Dom. & imp. KD, no min. Hardwood plywood.

FLORIDA

R.W. Haley Lumber Co., 5517 Mossy Top Way, Tallahassee 32303. (904) 386-7770. Dom. & imp. AD/KD, no min. Planks. Teak.

Henegan's Wood Shed, 7760 Southern Blvd., W. Palm Beach 33411. (305) 793-1557. Dom. & imp. AD/KD, no min. Planks. Mango, citrus, cajeput, poisonwood.

International Tropical Timbers, 4689 22nd Ave. S., St. Petersburg 33711. (813) 321-6515. Imp. AD, 100 min. Planks, logs. Cocobolo.

Lumber Sales Warehouse, Box 235, NW Branch, Miami 33147. (305) 836-1221. Dom. & imp. AD/KD, no min. Planks, plywood.

Marquette Lumber Co., Box 3040, Vero Beach 32960. (305) 567-5252. Dom. AD/KD, 500 min. Planks.

Jack B. Thigpen Lumber Co., Box 185, Chattahoochee 32324. (904) 663-4396. Dom. AD/KD, 500 min. Planks, logs, plywood.

GEORGIA

Atlanta Hardwood Corp., Box 39038, Atlanta 30318. (404) 799-8308. Dom. & imp. KD, no min. Planks, plywood. Ebony, padauk, red gum, zebrawood.

Austin Hardwoods, 4400-B Bankers Circle, Atlanta 30360. (404) 449-0522. Dom. & imp. KD, no min. Padauk, purpleheart, shedua.

Leon W. Colwell, 236 Peachtree Way, Atlanta 30305. (404) 237-0095. Dom. AD/KD, 100 min. Planks, logs. Wormy chestnut, walnut; chestnut beams.

ILLINOIS

Atlas Furniture Co., 1133 Railroad Ave., Rockford 61108. (815) 963-3852. Dom. & imp. KD, no min. Veneer; planks, plywood.

Carlson Plywood, 8890 67th St., Box 704, Hodgkins 60525. (312) 354-8200. Hardwood plywood: birch, red & white oak, ash, pecan.

Craftsman Hardwood Lumber Co., 13005 S. Western Ave., Blue Island 60406. (312) 385-6530. Dom. AD/KD, imp. KD, 500 min. Planks, plywood.

T.A. Foley Lumber Co., Box 336, Paris 61944. (217) 463-6180. Dom. AD/KD, imp. KD, no min. Veneer; planks, plywood. Padauk.

Geister Brothers Lumber Co., 100 Lawrence, Elgin 60120. (312) 741-0257. Dom. & imp. KD, no min. Planks, plywood. Sitka spruce.

Handcrafted Tool & Supply Co., 744 W. Fullerton Pkwy., Chicago 60614. (312) 549-2389. Dom. & imp. KD, 50 min. Veneer; planks, logs, marine-grade plywood. Teak.

Monarch Hardwood Lumber's Wood World, 9006 Waukegan Rd., Morton Grove 60053. (312) 965-4420. Dom. & imp. AD/KD, no min. Veneer; planks, plywood. Mansonia.

Paul Bunyan Hardwood Centre, 12658 Paulina St., Calumet Park 60643. (312) 389-7667. Dom. & imp. KD, no min. Veneer; planks, plywood. Bulletwood, teak.

INDIANA

Cash and Carry Lumber Co., State Route 32, Box 427, Daleville 47334. (317) 378-7575. Dom. & imp. KD, no min. Veneer; planks, logs, plywood. Osage orange, walnut.

Frank Miller Lumber Co., RR #5, Union City 47390. (317) 964-3196. Dom. AD/KD, 100 min. Planks.

Northwest Lumber Co., 5035 Lafayette Rd., Indianapolis 46254. (317) 293-1100. Dom. & imp. KD, no min. Veneer; planks, plywood. Ebony, rosewood.

Pike Lumber Co., Box 247, Akron 46910. (219) 893-4511. Dom. KD, 500 min.

Quality Hardwood Sales, 38 W. Grant St., Knightstown 46148. (317) 345-2971. Dom. KD, no min. Veneer; planks, logs. Coffeenut.

John Rodarmel Co., Box 34162, Indianapolis 46234. (317) 271-6666. Dom. & imp. KD, no min. Planks. Purpleheart, padauk, zebrawood.

John I. Shafer Hardwood Co., Box 568, Logansport 46947. (219) 753-3151. Dom. & imp. KD, no min. Planks. Yellow birch.

Southeastern Supply Co., Box 516, Indianapolis 46206. (317) 359-9551. Dom. & imp. KD, 100 min. Planks. Architectural & custom woodwork.

Chester B. Stem, Inc., Grant Line Rd., New Albany 47150. (812) 945-6646. Dom. & imp. KD, 100 min. Redwood burls, carving chunks, ebony, benge.

Wood-Crafter's Supply Center, 1715 N. Sherman, Indianapolis 46218. (317) 359-9607. Dom. & imp. KD, no min. Veneer; planks, plywood. Avodire, primavera, teak, bubinga.

IOWA

Jack Becker, Rte. 2, Dyersville 52040. (319) 875-2087. Dom. AD, no min. Planks, logs. Sumac.

Davis Fine Woods, 413 Chamber St., Sioux City 51101. (712) 252-2445. Dom. & imp. KD, no min. Planks, plywood. Cherry, cypress, ipe, pecan, willow.

Johnson Wood Products, Rte. 1, Strawberry Point 52076. (319) 933-4930. Dom. AD, no min. Planks. Gunstock blanks, carving stock, bowl blanks, fireplace mantels.

Frank Paxton Lumber Co., 205 S.W. 11th St., Des Moines 50303. (515) 283-2137. Dom. & imp. KD, no min. Veneer; planks, plywood. Koa.

KANSAS

The Wood Works, 7525 W. 80th St., Overland Park 66204. (913) 649-7520. Dom. KD, no min. Veneer; plywood.

KENTUCKY

Marwood, Box 34515, Louisville 40232. (502) 363-6668. Dom. & imported veneers: burls and purpleheart, yew, koa, satinwood, paldoa.

Bob Morgan Woodworking Supplies, 1123 Bardstown Rd., Louisville 40204. (502) 456-2545. Dom. KD, no min. Veneers; butts, burls.

Northland Corp., Box 265, La Grange 40031. (502) 222-1441. Dom. & imp. AD/KD, 100 min. Planks, plywood. Ash to zebrawood.

James P. Rogers Lumber Co., 835 Victoria Ave., Box 92, Bowling Green 42101. (502) 843-1101. Dom. AD, no min. Planks. Black walnut.

Wood Mosaic, Box 21159, Louisville 40221. (502) 363-3531. Dom. AD/KD, imp. KD, no min. Planks.

LOUISIANA

Kent Courtney, 1413 Texas Ave., Alexandria 71301. (318) 448-8032. Dom. AD/KD, no min. Planks. Tupelo gum stumps.

Ruston Lumber & Supply, 311 W. Mississippi, Box 823, Ruston 71270. (318) 255-4110. Dom. AD/KD, imp. KD, $100 min. mail order. Planks, logs, plywood. Holly, locust, sassafras, magnolia, mulberry.

MARYLAND

Braddock Design & Woodworks, 6 East St., Frederick 21701. (301) 663-1880. Dom. KD, no min. Planks, plywood.

Crafrwoods, 7 Beaver Run Lane & York Rd., Cockeysville 21030. (301) 667-9663. Dom. & imp. AD/KD, no min. Veneer; planks, plywood. Osage orange, applewood, angico.

Hobby Woods, 1305 Eastern Ave., Baltimore 21231. (301) 732-6071. Dom. & imp. KD, no min. Veneer; planks, logs, plywood. Amaranth.

House of Wood, Route 7, Box 3A, Waldorf 20601. (301) 645-1797. Dom. & imp. KD, no min. Planks, logs. Tiger maple, maple burls.

F. Scott Jay & Co., Box 146, 8174 Ritchie Hwy., Pasadena 21122. (301) 544-1122. Dom. & imp. AD/KD, no min. Veneer; planks. Teak, oak.

J. Gibson McIlvain Co., Rt. 7, White Marsh 21162. (301) 335-9600. Dom. & imp. AD/KD, 500 min. Planks. Mahogany; millwork.

Wood Products, 801 Aliceanna St., Baltimore 21202. (301) 837-3060. Dom. & imp. AD/KD, no min. Planks, logs, plywood. Teak.

The Wooden Era, 234 Main St., Reisterstown 21136. (301) 833-1444. Dom. AD/KD, imp. KD, no min. Planks. Brazilian rosewood.

Woodenware, Box 10, Brownsville 21715. (301) 432-6131. Dom. & imp. KD, 100 min. Planks. Boxwood.

World of Hardwoods, Harmans 21077. (301) 766-3991. Dom. & imp. AD/KD, no min. Veneer; planks, plywood. Oak, poplar.

MASSACHUSETTS

Albany Street Workshop, 533 Albany St., Boston 02118. (617) 338-8011. Dom. AD/KD, imp. KD, no min. NMO. Planks. Ebony.

Allied Plywood, Box 56, Charlestown 02129. (617) 241-9300, and Box 352, Highland Sta., Springfield 01109. (413) 543-2251. Hardwood plywood.

Amherst Wood Working, Hubbard Ave., Northampton 01060. (413) 584-3003. Dom. & imp. KD, no min. Planks, plywood. Oak, ash.

Amherst Woodworking & Supply, Box 464, Sunderland Rd., N. Amherst 01059. (413) 549-2806. Dom. AD/KD, no min. Planks, plywood. Holly, apple, ash, cherry, cedar.

Churchill Forest Products, 91 Franklin St., Box 186, Hanson 02341. (617) 293-3577. Dom. & imp. AD/KD, 100 min. Planks. Curly & bird's-eye maple.

The House Carpenters, Box 217, Shutesbury 01072. (413) 367-2673. Dom. KD, no min. Planks. Old-growth southern yellow pine.

North Country Guitar Building Supplies, 121 Union St., No. Adams 01247. (413) 663-3060. Imp. AD/KD, no min. Veneer. Rosewood, mahogany, Sitka spruce; ebony bridge & fingerboard blanks.

Palmer & Parker Co., Box 266, Tewksbury 01876. (617) 851-7337. Dom. & imp. AD/KD, no min. Veneer; planks. Rosewood, wenge.

Rex Lumber Co., 180 Fawcett St., Cambridge 02138. (617) 864-4484. Dom. & imp. AD/KD, 500 min. Planks. Oak, iroko, meranti, teak.

Steve Smith, Harlo Clark Rd., Huntington 01050. (413) 667-3220. Dom. AD/KD, 500 min. Logs. Eastern white pine, red oak.

Woodcraft Supply Corp., 313 Montvale Ave., Woburn 01888. (617) 935-5860. Dom. KD, imp. AD/KD, no min. Planks, logs. Cherry, bubinga, spalted maple & birch.

MICHIGAN

Armstrong Millworks, 3039 W. Highland Rd., Highland 48031. (313) 887-1037. Dom. & imp. KD, no min., NMO. Planks. Zebrawood.

Beyster, 2905 Beaufait Ave., Detroit 48207. (313) 921-3029. Dom. & imp. KD, no min. Teak, mahogany, oak, birch, poplar, maple.

H.A. Davidson Box Co., 11435 Schaefer Highway, Detroit 48227. (313) 834-6770. No min. Planks. Green rough hardwood construction lumber.

Fox Forest Products, Box 340, Iron Mountain 49801. (906) 774-4436. Dom. KD, no min. Planks.

Hamilton Lumber & Veneer, 510 Marywood Dr., Grand Rapids 49505. (616) 363-0004. Dom. AD/KD, no min. Planks, logs. Ash.

Johnson's Workbench, 563 N. Cochran St., Charlotte 48813. (517) 543-2727. Dom. & imp. AD/KD, no min. Veneer; planks, plywood. Obeche, butternut, hickory, iroko.

A.J. McGuire Hardwood Corp., 3499 East 10 Mile Rd., Warren 48091. (313) 759-2410. Dom. AD/KD, 100 min. Planks. Cherry.

Hugh Rader Lumber Co., 15175 Hamilton, Detroit 48203. (313) 868-7900. Dom. & imp. KD, no min. Planks. Walnut, mahogany.

Red Mill Lumber Co., 115 N. Hall St., Traverse City 49684. (616) 946-5330. Dom. KD, no min. Ash.

Van Keulen & Winchester Lumber Co., 245 54th St. S.W., Box 8428, Grand Rapids 49508. (616) 532-3678. Dom. AD/KD, imp. KD, 100 min. Planks.

Wolverine Hardwoods, Box 702, Plymouth 48170. (313) 459-7050. Dom. AD/KD, no min. Planks.

MINNESOTA

Jones Lumber Corp., 722 Kasota Circle, Minneapolis 55414. (612) 379-0793. Dom. & imp. AD/KD, no min. Planks, plywood. Cedar.

Lake Elmo Hardwood Lumber, Box 175, Lake Elmo 55042. (612) 777-8118. Dom. & imp. KD, no min. Veneer; planks, plywood. Rosewood, zebrawood, padauk.

Minnesota Woodworkers Supply Co., Industrial Boulevard, Rogers 55374. (612) 424-4101. Dom. KD, no min. Veneer.

Thompson Hardwood Lumber Co., 9925 Logan Ave. S., Minneapolis 55431. (612) 881-5853. Dom. KD, no min. Plywood.

Wood Carvers Supply Co., 3056 Excelsior Blvd., Minneapolis 55416. (612) 927-7491. Dom. AD/KD, imp. AD, no min. Logs. Imbuya, rosewood, carving woods.

MISSISSIPPI

Anderson-Tully Lumber Co., Box 38, Vicksburg 39180. (601) 638-2622. Dom. AD/KD, no min. Planks, logs. Ash, box elder, cypress.

Clarke Veneers & Plywood, Box 4876, Jackson 39216. (601) 366-0331. Rotary-cut veneer.

Pavco Industries, Box 612, Pascagoula 39567. (601) 762-3172. Hardwood plywood.

Phillips Hardwood Sales, Co., 10 Roselawn Dr., Natchez 39120. (601) 442-5479. Dom. & imp. AD/KD, 100 min. Planks, logs, plywood. Teak, banak, red gum; boat lumber.

M.L. Sandy Lumber, Box 1535, Corinth 38834. (601) 286-6087. Dom. KD, 100 min. Plywood.

Tradewinds, 109 Coachmans Rd., Madison 39110. (601) 856-8543. Dom. AD/KD, imp. KD, no min. Veneer; planks, plywood. Walnut.

MISSOURI

Cedar Park Manufacturing Co., Box 593, Mercer 64661. (816) 382-4912. Dom. AD/KD, no min. Planks, logs. Basswood.

Gaines Hardwood Lumber Co., 24 Branch St., St. Louis 63147. (314) 231-7022. Dom. & imp. AD/KD, no min. warehouse, 1,000 min. mail order. Veneer; planks, plywood. Dowels, turning squares.

Hibdon Hardwood, 1539 Chouteau, St. Louis 63103. (314) 621-7711. Dom. & imp. KD, no min. Planks.

Magic Woods, 21st & Baltimore, Box 1232, Kansas City 64141. (816) 421-2300. Dom. & imp. KD, no min. Plywood.

Frank Paxton Lumber Co., 6311 St. John Ave., Kansas City 64123. (816) 483-7000. Dom. & imp. KD, no min. Veneer; planks, plywood.

MONTANA

O'Neil Lumber Co., 424 Main St., Kalispell 59901. (406) 755-4595. Dom. AD/KD, imp. AD, no min. Planks, plywood. Brazilian walnut.

NEBRASKA

Midwest Woodworkers Supply, 13209 E St., Omaha 68137. (402) 330-5444. Dom. KD, no min. Veneer; planks. Oak, basswood.

NEW HAMPSHIRE

Monadnock Forest Products, Squantum Rd., Jaffrey 03452. Dom. KD, 100 min. Planks, logs.

Wholesale Forest Products, Box 45, Claremont 03743. (603) 542-2038. Dom. AD/KD, no min. Planks, logs. Butternut, ironwood, balm of Gilead; white oak whiskey barrels.

NEW JERSEY

Center Lumber Co., 85 Fulton St., Box 2242, Paterson 07509. (201) 742-8300. Dom. & imp. KD, no min. Veneer; planks, plywood. Jelutong, obeche, mahogany.

Interstate Hardwood Lumber Co., 850 Flora St., Elizabeth 07201. (201) 353-5661. Dom. & imp. KD, no min. Veneer; planks, plywood. Bubinga, cocobolo, caviuna, rosewood.

Manufacturers Reserve Supply, 16-22 Woolsey St., Irvington 07111. (201) 373-1881. 100 min. Flooring.

Orange Valley Hardware, 606-610 Freeman St., Orange 07050. (201) 676-0900. Dom. & imp. KD, no min. Veneer; planks, logs, plywood.

Quality Woods, Box 205, Lake Hiawatha 07034. (201) 927-0742. Imp. AD/KD, no min. Planks, plywood.

Real Wood Veneers, 107 Trumbull St., Elizabeth 07206. (201) 351-1990. Imported veneers.

Reisen-Seidel Hardwood Co., 1080 Morris Ave., Union 07083. (201) 354-7050. Dom. AD/KD, imp. KD, 100 min. Planks, plywood.

Willard Brothers Woodcutters, 300 Basin Rd., Trenton 08619. (609) 890-1990. Dom. & imp. AD/KD, no min. Veneer; planks, logs.

NEW MEXICO

Frank Paxton Lumber Co., 1909 Bellamah Ave. N.W., Albuquerque 87125. (505) 243-7891. Dom. & imp. AD/KD, no min. Veneer; planks, plywood. Goncalo alves.

NEW YORK

Allied Plywood, 47 Fuller Rd., Albany 12205. (518) 459-2380, and 1635 Poplar St., Bronx 10461. (212) 824-7100. Hardwood plywood.

Artistry in Veneers, 633 Montauk Avenue, Brooklyn 11208. (212) 272-3638. Veneer.

Cotton-Hanlon, Box 65, Cayuta 14824. (607) 594-3321. Dom. & imp. KD, no min., NMO. Planks. Banak, afrormosia, limba, makore.

Great Eastern Lumber Co., Box 4, North Creek 12853. (518) 251-2345. Dom. AD/KD, no min. Planks, logs. Birch, beech, ash, cherry, oak.

Hamlin Sawmill, 1873 Redman Rd., Hamlin 14464. (716) 964-3561. Dom. AD and green, no min., NMO. Planks.

John Harra Wood & Supply Co., 39 West 19th St., New York 10011. (212) 741-0290. Dom. KD, imp. AD/KD, $25 min. Planks, logs, plywood. Cocobolo, bocote, wenge.

Memphis Building Supply, 210 Church St., Memphis 13112. (315) 689-3949. Dom. AD/KD, imp. KD, no min. Veneer; planks, plywood. Teak, wormy chestnut.

J.H. Monteath, 2500 Park Ave., Bronx 10451. (212) 292-9333. Dom. & imp. AD/KD, $500 min. Planks, logs, plywood. Ebony, zebrawood.

Native American Hardwoods, West Valley 14171. (716) 942-6631. Dom. AD/KD, no min. Planks, logs. Maple, walnut, birch.

Pittsford Lumber and Woodshop, 50 State St., Pittsford 14534. (716) 586-1877. Dom. & imp. KD, no min. Veneer; plywood. Afrormosia.

Rode & Horn Lumber, 9 Lynch St., Brooklyn 11211. (212) 855-1740. Dom. & imp. KD, no min. Planks.

Rosenzweig Lumber Co., 801 East 135th St., Bronx 10454. (212) 585-8050. Dom. & imp. KD, no min. Planks, plywood. Rosewood.

Timber Operations, 333 East 79th St., New York 10021. (212) 988-5630. Dom. & imp. AD/KD, no min. Veneer; planks, logs, plywood. Cocobolo, ebony.

Tulnoy Lumber, 17 Ridgewood Pl., Brooklyn 11227. (212) 456-7575. Dom. & imp. AD/KD, 100 min. Planks, plywood. Timbers.

Wood Shed, 1807 Elmwood Ave., Buffalo 14207. (716) 876-4252. Dom. & imp. KD, no min. Veneer; planks. Burl veneers.

NORTH CAROLINA

Pete Armstrong Veneer, 2419 Ashford Circle, High Point 27261. (919) 888-4041. Veneer & veneer products.

W.M. Cramer Lumber Co., Box 2888, Hickory 28601. (704) 397-5531. Dom. & imp. AD/KD, 100 min. Planks.

Crowe & Coulter, Box 484, Cherokee 28719. (704) 497-5588. Dom. & imp. AD, no min. Logs. 12/4 and 16/4 carving blocks.

Educational Lumber Co., 21 Meadow Rd., Asheville 28803. (704) 255-8765. Dom. & imp. KD, 50 min. Veneer; planks, plywood. Ash, willow, basswood, cherry, oak.

Hasty Plywood Co., Box 417, Maxton 28364. (919) 844-5267. Hardwood plywood.

McEwen Lumber Co., Box 950, High Point 27261. (919) 855-0021. Dom. & imp. KD, 500 min. Planks. Teak, mahogany.

The Wood Center, 600 S. Graham St., Charlotte 28202. (704) 332-1553. Dom. & imp. KD, no min. Veneer; planks, plywood. Mozambique, paldoa, andiroba, oak.

OHIO

A Cut Above, Box 139, Greensburg 44232. (216) 494-7763. Veneer for marquetry: oro, banak, cedrio.

American Woodcrafters, Box 919, 1025 S. Roosevelt, Piqua 45356. (513) 773-7411. Dom. & imp. AD/KD, no min. Veneer; planks, logs. Cocobolo, rosewood, teak.

Denier Brothers, Box 15313, Cincinnati 45215. (513) 554-1914. Dom. AD/KD, 100 min. Appalachian hardwoods.

Gilbert Lumber Co., Box 216, Smithville 44677. (216) 669-2726. Dom. green, no min. Planks.

Hoge Lumber Co., New Knoxville 45871. (419) 753-2263. Dom. & imp. AD/KD, no min. Planks, logs, plywood. Oak, maple, ash, beech.

Industrial Wholesale Lumber Co., 6000 Harvard Ave., Cleveland 44105. (216) 271-1300. Dom. AD/KD, imp. KD, 100 min. Planks, plywood. Teak, mahogany.

Marietta Hardwood Center, 121 Pike St., Marietta 45750. (614) 373-3658. Dom. KD, no min. Planks. Sassafras, honey locust, walnut.

Seaway Lumber Co., 26021 Cannon Rd., Bedford Heights 44146. (216) 232-0345. Dom. AD/KD, imp. KD, 500 min. Planks. Teak.

Charles F. Shiels & Co., 1301 W. Eighth St., Cincinnati 45203. (513) 241-0239. Dom. AD/KD, imp. KD, 500 min. Planks.

Taylor Woodcraft, Box 245, Malta 43758. (614) 962-3741. Dom. & imp. KD, 100 min. Plywood.

Willis Lumber Co., 545 Millikan Ave., Washington Court House 43160. (614) 335-2601. Dom. & imp. KD, no min. Planks. Teak.

OKLAHOMA

Paxton Beautiful Woods, 1539 S. Yale, Tulsa 74112. (918) 932-5558. Dom. & imp. KD, no min. Veneer; planks, plywood. Baltic birch plywood, cocobolo.

Frank Paxton Lumber Co., 1815 S. Agnew, Oklahoma City 73108. (405) 235-4411. Dom. & imp. KD, no min. Veneer; planks, plywood.

OREGON

Emerson Hardwood Co., 2279 N.W. Front Ave., Portland 97209. (503) 227-6414. Dom. & imp. KD, 100 min. Planks, plywood. Ebony, rosewood, purpleheart, vermilion.

Fronville Commercial Co., Box 40, Wilsonville 97070. (503) 682-2922. Dom. & imp. AD/KD, $35 min. Veneer. Teak, rosewood, ebony.

Lachlan/Docherty, 517 N. Kutch, Box 397, Carlton 97111. (503) 852-7320. Dom. AD, no min. Planks. Musical-instrument wood.

Lumber Products, 2116 N.W. 20th, Portland 97209. (503) 223-8171. Dom. & imp. KD, 100 min. Plywood.

Merrill Lynch Wood Markets, Box 669, Portland 97207. (503) 243-5189. Veneer; planks, logs, plywood. Far East hardwoods.

Rogue River Myrtlewood Shop, Box 1387, Gold Beach 97444. (503) 247-2332. AD/KD myrtlewood, no min. Planks, logs.

Tree Products Hardwoods, Box 772, Eugene 97440. (503) 689-8515. Dom. AD/KD, imp. AD, no min. Planks. South Pacific lumber.

Woodcrafters, 212 N.E. 6th, Portland 97232. (503) 231-0226; and 960 Commercial N.E., Salem 97301. (503) 585-2262. Dom. & imp. KD, no min. Veneer; planks, plywood. Purpleheart, cocobolo, maple, red oak, walnut.

PENNSYLVANIA

Amaranth Gallery and Workshop, 2500-2502 N. Lawrence St., Philadelphia 19133. (215) 739-2600. Dom. & imp. AD/KD, no min. Planks. Oak, cherry, mahogany, bubinga, walnut.

Austin Hardwoods, 620 Vanadium Rd., Bridgeville 15017. (412) 221-2300. Dom. & imp. KD, no min. Planks. Honey locust, koa, meranti, mesquite, purpleheart.

Austin Hardwoods, 5250 Belfield Ave., Philadelphia 19144. (215) 848-9663. Dom. & imp. KD, no min. Planks. Iroko, pau ferro.

Bangkok Industries, Gillingham & Worth Sts., Philadelphia 19124. (215) 334-1500. Imp. KD, no min. Veneer; plywood. Teak, rosewood.

Buehler Lumber Co., W. Main St., Ridgway 15853. (814) 776-1121. Dom. AD/KD, no min. Veneer; planks, logs. Cherry, red oak.

Robert Butler, 341 E. Waring Ave., State College 16801. (814) 238-8863. Dom. AD, no min. Planks, logs. Osage orange; carving bolts.

Exotic Woodshed, 65 N. York Rd., Warminster 18974. (215) 672-2257. Dom. & imp. AD/KD, no min. Veneer; planks, plywood. Apitong.

Homecraft Veneer, 901 West Way, Latrobe 15650. (412) 537-8435. Dom. & imp. veneer, 3 sq.ft. min.

Lafferty & Co., 1100 Hummel Ave., Box 34, Lemoyne 17043. (717) 763-7725. Dom. AD/KD, imp. KD, no min. Planks.

Mann & Parker Lumber Co., Box 18, Constitution Ave., New Freedom 17349. (717) 235-4834. Dom. & imp. AD/KD, 500 min. Iroko, teak.

Matson Lumber Co., Box L, 132 Main St., Brookville 15825. (814) 849-5334. Dom. AD/KD, 100 min. Planks, logs.

William Moscovic Lumber Co., Paradise 17562. (717) 442-4590. Dom. & imp. AD/KD, 500 min. Planks. Philippine mahogany, teak.

Pennsylvania Woodworkers Supply, 5210 Mamont Rd., Murrysville 15668. (412) 325-3931. Dom. & imp. KD, no min. Planks. Walnut.

Ambrose Randa, Jr., 88 Tamenend Ave., New Britain 18901. (215) 345-1030. Dom. & imp. KD, no min. Planks. Curly maple, oak.

The Sawmill, Box 329, Nazareth 18064. (215) 759-2837. Dom. AD, imp. AD/KD, 100 min. Veneer; planks (green), logs. Rosewood.

Sam Talarico, RD 3 303, Mohnton 19540. (215) 775-0400. Dom. AD/KD. No min. at store, $75 min. if shipped. Planks, logs. Bookmatched flitches, walnut, cherry.

Terrier Lumber Co., 826 Trooper Rd., Betzwood, 19403. (215) 666-0357. Dom. AD, no min. Planks, logs. Walnut, cherry, oak.

Thompson Mahogany Co., 7400 Edmund St., Philadelphia 19136. (215) 624-1866. Imp. AD/KD, 100 min. Planks. Bubinga, mahogany, teak.

West Elizabeth Lumber Co., 5th St., West Elizabeth 15088. (412) 462-7433. Dom. & imp. KD, no min. Veneer; planks, plywood.

RHODE ISLAND

Allied Plywood, 60 Shipyard St., Providence 02905. (401) 467-9555. Hardwood plywood.

TENNESSEE

Bowen Lumber Co., Box 683, Dyersburg 38024. (901) 285-4753. Dom. & imp. AD/KD, 100 min. Planks, logs, plywood.

Curtner-Parker Lumber Co., 734 White Station Tower Bldg, 5050 Poplar Ave., Memphis 38157. (901) 685-8274. Dom. AD/KD, 500 min. Logs. Furniture squares.

F.T. Dooley Lumber Co., Box 7291, Memphis 38107. (901) 527-8419. Dom. AD/KD, 500 min.

Hardwoods of Memphis, Box 12449, Memphis 38112. (901) 452-9663. Dom. & imp. AD/KD, no min. Veneer; planks, plywood. Sassafras.

Roland Lumber Co., Box 259, Johnson City 37601. (615) 928-2109. Dom. AD, 500 min. Planks, logs. Walnut, chestnut.

Shea Forest Products, 1255 Lynnfield Rd., Memphis 38117. (901) 761-2694. Baltic birch plywood.

Ralph Taylor Lumber Co., Box 16021, Memphis 38116. (901) 332-2884. Dom. AD/KD, 100 min. Planks. Hardwood turning squares.

Wilson Lumber Co., Box 12526, Memphis 38112. (901) 274-6887. Dom. AD/KD, Philippine mahogany KD, 100 min. Planks. Oak.

Woodstream Arts, 107 Northview St., Knoxville 37919. (615) 588-2878. Dom. KD, 25 min.; imp. AD/KD, no min. Planks. Cherry.

TEXAS

Alamo Hardwoods, 1 Fredricksburg Rd., San Antonio 78201. (512) 736-3137. Dom. & imp. KD, no min. Veneer; planks. Persimmon.

All Woods/Schroeder, Box 5056, Houston 77012. (713) 921-6131. Dom. & imp. AD/KD, 100 min. Planks. Zebrawood, teak, ebony.

Austin Hardwoods, 2119 Goodrich, Austin 78703. (512) 442-4001. Other Texas locations are in Dallas, El Paso, Lubbock and Houston. Dom. & imp. KD, no min. Planks, plywood. Bubinga, paldoa, shedua.

Paxton Beautiful Woods, 2825 Hemphill, Fort Worth 76110. (817) 927-0611. Dom. & imp. KD, no min. Veneer; planks, plywood. Cocobolo, chechen, cordia, jatoba.

Woodworks, Box 79238, Saginaw 76137. (817) 232-4079. Walnut & oak dowels.

Wood World, 12323 N. Central Expressway, Dallas 75243. (214) 661-8168. Dom. KD, imp. AD/KD, no min. Veneer; planks, plywood. Angico, padauk, ebony, wenge.

UTAH

Fremont Lumber Co., 3149 S. State St., Salt Lake City 84115. (801) 485-5823. Dom. & imp. KD, no min. Veneer; planks, plywood.

Intermountain Lumber Co., 1948 S.W. Temple, Salt Lake City 84115. Dom. KD, no min. Plywood.

VERMONT

Michael K. Biddy, Box 424, Shaftsbury 05262. (802) 442-2197. Dom. AD, no min. Planks. Black cherry.

William F. Brooks Hardwood Supply, RFD 2, Box 71, Ludlow 05149. (802) 875-2317. Dom. KD, no min. Planks. Maple, cherry, butternut.

Depot Woodworking, Johnson 05656. (802) 635-7716. Dom. & imp. KD, no min. Planks, plywood.

Green Mountain Cabins, Box 190, Chester 05143. (802) 875-3535. Dom. & imp. AD/KD, no min. Planks, logs. Butternut, basswood.

Lathrop's Maple Supply, Bristol 05443. (802) 453-2897. Dom. AD/KD, 500 min. Planks. Maple.

Metropolitan Music Co., Mountain Rd., Stowe 05672. (802) 253-4814. Imp. AD, no min. Maple & spruce for violin and guitar makers; ebony.

Chris S. Pond Lumber Sales, 412 Pine St., Burlington 05401. (802) 863-5820. Dom. & imp. KD, no min. in shop, 50 min. mail order. Planks. Bird's-eye & curly maple.

Weird Wood, Rt. 103, Bartonsville 05140. (802) 875-2163. Dom. AD/KD, imp. AD, no min. Planks. Freeform slabs, carving stock.

VIRGINIA

Al-San Lumber Co., 4006 Killam Ave., Norfolk 23508. (804) 489-9401. Dom. & imp. KD, no min. Veneer; planks, plywood. Aromatic cedar, Sitka spruce, teak.

Arlington Woodworking and Lumber Co., 1560 Spring Hill Rd., Arlington 22101. (703) 893-4770. Dom. & imp. KD, no min. Veneer; planks, plywood.

S.W. Barnes, Box 85, Crozet 22932. (804) 823-4391. Dom. AD/KD, imp. KD, 500 min. Planks.

Colonial Hardwoods, 212 N. West St., Falls Church 22046, and 8453 Tyco Rd., Vienna 22180. (703) 893-3331. Dom. & imp. KD, no min. Veneer; planks, plywood. Sassafras, sycamore, guanacaste.

W.A. Smoot & Co., Box 88, Alexandria 22313. (703) 549-0960. Dom. AD/KD, imp. KD, no min. Planks, plywood. Sitka spruce, mahogany.

Woodshed Studio, 5003 W. Leigh St., Richmond 23230. (804) 353-8889. Dom. KD, imp. AD/KD, no min. Veneer; planks, plywood. Birch, holly, caviuna.

Yukon Lumber, 520 West 22nd St., Norfolk 23517. (804) 625-7131. Dom. & imp. AD/KD, no min. Veneer; planks, plywood. Padauk.

WASHINGTON

Flounder Bay Boat Shop, 3rd & O Sts., Anacortes 98221. (206) 293-2369. Dom. & imp. AD/KD, no min. Veneer; planks, plywood. Yew, kapur, balau, purpleheart.

General Hardwood Co., 1420 Port of Tacoma Rd., Tacoma 98421. (206) 272-5151. Dom. & imp. AD/KD, 100 min. Planks, plywood. Benge.

Hammond Ashley Associates, 19825 Des Moines Way S., Seattle 98148. (206) 878-3456. Dom. AD, no min. Planks. Spruce & maple for violins, violas, celli & basses.

Hardwood Specialties, 810 S.W. 151 St., Seattle 98166. (206) 242-0462. Dom. AD/KD, no min. Planks.

The Hardwood Warehouse, 19102 Des Moines Way S., Seattle 98148. (206) 243-1285. Dom. & imp. AD/KD, no min. Veneer; planks, plywood. Bocote, wormy chestnut.

WEST VIRGINIA

Dean Co., Box 1239, Princeton 24740. (304) 425-8701. Logs. Elm.

Sunshine Sawmill, Renick 24966. (304) 497-2473. Dom. AD/KD, no min. Planks, logs. Applewood, elm.

WISCONSIN

The Board Store, Box 205, Bangor 54614. (608) 486-2353. Dom. & imp. KD, no min. Veneer; planks. American chestnut; carving blocks in butternut, cherry, basswood.

Kilbourn Lumber & Supply Ltd., Box 12, Wisconsin Dells 53965. (608) 254-2585. Dom. & imp. KD, no min. Veneer; planks.

Vikwood, Box 554, 1221 A Superior Ave., Sheboygan 53081. (414) 458-9351. Dom. KD, imp. AD/KD, no min. Veneer; planks, logs. Rosewood for musical instruments.

CANADA

BRITISH COLUMBIA

Cascade Imperial Mills, 401-4946 Canada Way, Burnaby V5G 4H7. (604) 294-1451. Dom. AD/KD, imp. KD, 100 min. Plywood.

Sauder Industries, Box 49100, Bentall III, Vancouver V7X 1H3. (604) 683-2211. Dom. & imp. AD/KD, no min. Veneer; planks, plywood. Warehouses in Calgary & Edmonton (Alberta), Regina & Saskatoon (Saskatchewan) and Winnipeg (Manitoba).

QUEBEC

A.B. Clarke, 2900 Avenue Francis Hughes, Laval H7L 3J5. (514) 663-8770. Dom. & imp. AD/KD, 500 min. Planks.

Goodfellow Lumber, 101 Stinson Blvd., Montreal H4N 2E4. (514) 748-6511. Dom. & imp. AD/KD, 500 min. Planks. Lignum vitae.

E.J. Maxwell, 5080 St. Ambroise St., Montreal H4C 2G1. (514) 937-7712. Dom. & imp. KD, 100 min. Planks, logs, plywood. Balsa, pau ferro, meranti, lignum vitae.

Silvac Forest Products, CP 8, Station Youville, Montreal H2P 2V2. (514) 384-9080. Dom. AD/KD, imp. KD, 100 min. Veneer; planks.

ONTARIO

A & M Wood Specialty, 358 Eagle St. N., Cambridge (Preston) N3H 4S6. (519) 653-9322. Dom. & imp. AD/KD, no min. Veneer; planks, logs, plywood. Yew, olivewood.

Barlow Enterprises, Box 344, 4 Laurier Ave., Deep River K0J 1P0. (613) 584-3650. Dom. KD, imp. AD/KD, no min. Planks, plywood. Bird's-eye, curly & flaming maple.

Beauty-Wood Industries, Suite 2, 339 Lakeshore Rd. E., Mississauga L5G 1E7. (416) 278-1299. Dom. AD/KD, imp. KD., $50 min. out of province. Veneer; planks. Cypress, ironwood, imbuya, bocote.

MacLean and Murray, 100 Mill St., Box 275, Woodstock N4S 7X6. (519) 537-5591. Dom. & imp. AD/KD, no min. Veneer; planks, logs, plywood.

Oriole Lumber, 7181 Woodbine Ave., Markham L3R 1A3. (416) 495-6242. Dom. & imp. KD, no min. Veneer; planks, logs, plywood. Rosewood, marine plywood.

Selinger Wood, 199 Anglesea St., Box 396, Goderich N7A 4C6. (519) 524-2651. Dom. AD/KD, no min. Maple, beech, ash, basswood.

Semler Hardwood Co., RR #4, Perth K7H 3C6. (613) 267-4630. Dom. AD/KD, imp. KD, no min. Planks. Bird's-eye & curly maple.

Shenstone Forest Products, Box 479, King City L0G 1K0. (416) 889-6111. Dom. & imp. AD/KD, 100 min. Planks. Iroko, mahogany, oak.

Unicorn Universal Woods, 137 John St., Toronto M5V 2E4. (416) 363-1161. Dom. & imp. AD/KD, no min. at store, $100 min. mail order. Veneer; planks, logs. Musical-instrument woods.