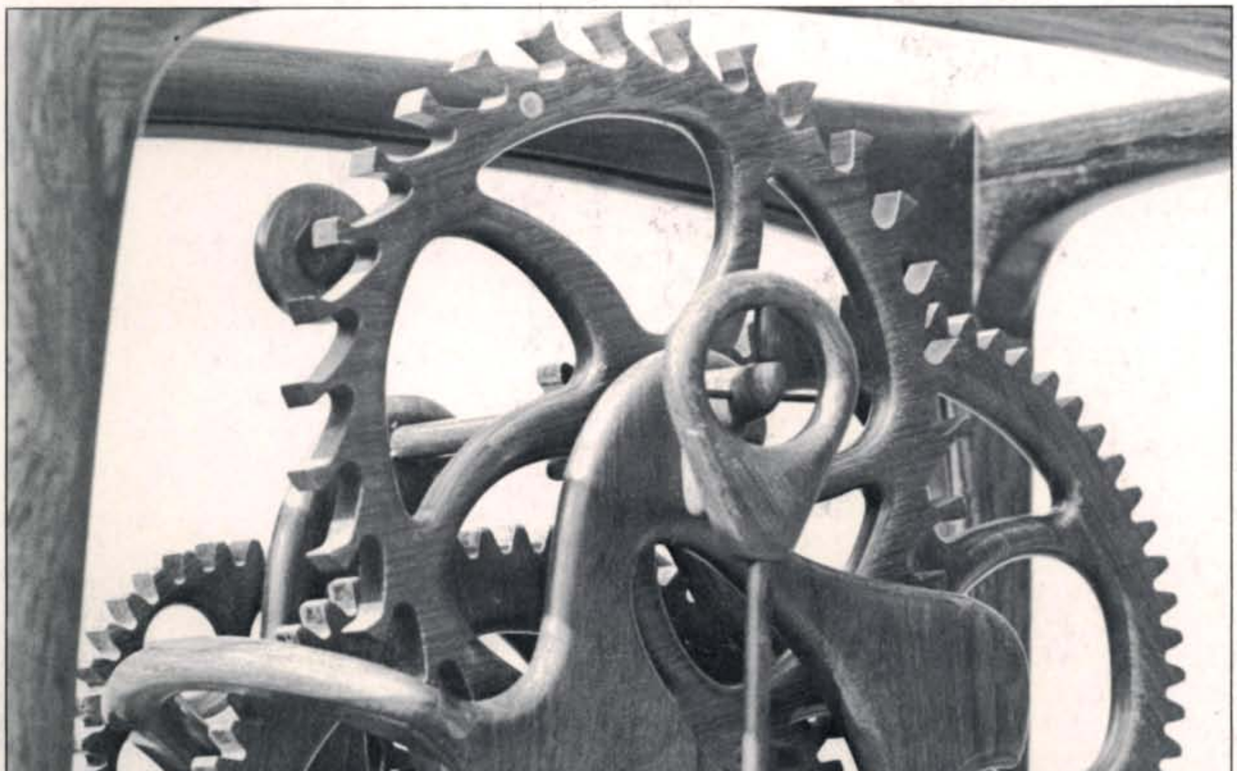
Fine WoodWorking



Clockworks

Spring 1978, $2.50

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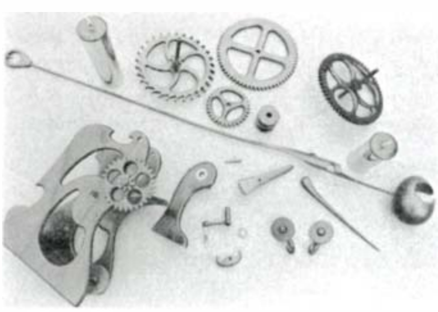
Fine WoodWorking

Spring 1978, Number 10

DEPARTMENTS

ARTICLES



Cover: Back view of walnut and rosewood clockworks, disassembled above, made by John Gaughan of Los Angeles. To cut the wheel teeth, Gaughan fastens the blank to a master gear with the correct number of teeth and mounts it on the headstock of a lathe. A router travels on a track parallel to the ways and a pin on its base indexes with the master gear. He removes the waste in several passes, with a special bit ground to the shape of the space between the teeth. He also routs the escape wheel, using an aluminum pattern bolted to the bottom of the blank and a pattern-following bit. More about Gaughan's clock on page 40; more about wooden clockworks on page 44.

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Timothy Philbrick's article, "Tall Chests" (Winter '77, p. 39), directs attention to a very important aspect of designing. He seems to suggest that the high degree of excellence found in 18th-century furniture design was due to the enlightened pursuance of carefully established rules rather than to the inherent instincts of those whose work we still regard so highly today. His reasoning has considerable merit, but I think the generalization too broad.

I believe that the production of many outstanding examples of fine work during this period was due to a number of other causes as well. One of these was that many otherwise skilled craftsmen had the ability to recognize quality when they saw it, but were more adept at adapting the good ideas of a very small number of more qualified originators of good designs than they were at creating their own.

The great similarity of certain categories of furniture of this period strongly supports my view, even though some style characteristics now attributed to certain individuals help identify them as the probable makers.

Most journeyman cabinetmakers, because of the rigid requirements of the apprenticeship system, were thoroughly grounded in the basic principles of good craftsmanship. This was required of them in order to achieve journeyman status. Such rigid training, and constant practice over rather long periods of time, enabled them to separate the grain from the chaff, but I think that from the design standpoint, there were many more copiers than innovators. I deduce this from the fact that so few distinctly new style elements saw the light of day during this long period of time, although there are any number of close similarities.

Among the few innovations of distinctly American origin were the block-front designs credited to the Goddards and Townsends of Newport, R.I. Nor did this condition change very much until quite recently with the advent of a new breed of young contemporary designers, who often go to fantastic lengths to break away from traditional forms, and more often than not, with but indifferent results.

Most craftsmen who still prefer to adhere to the traditional concepts of our past are not innovators. Rather than risk making grave mistakes, they elect to duplicate slavishly the work of old masters, down to the minutest detail.

A fairly recent and outspoken disciple of adhering to traditional designs was Wallace Nutting. During the time I worked at the furniture trade in his studio, he repeatedly told me he couldn't plane a board, nor saw a straight line! I never took him literally, for I knew he was making a point, but as far as I know he never built a piece of furniture himself. He was an ordained Congregational preacher, and until failing health forced him to give up preaching at the age of 50, he probably could not have distinguished one furniture style from another. His great knowledge, his books, lectures, pictures, and the fine furniture he produced, were all the products of the last 30 years of a busy and fruitful life. He was richly endowed with an instinctive sense of good design. . . . Furthermore, he strongly implied that anyone who laid claim to the title of furniture designer was masquerading under false pretenses, that such a person only copied.

On this point he and I often disagreed, and seeking to prove my position had at least as much merit as his was a major factor inducing me to embark on further study and research. This eventually led to my collecting data for the formulation of workable rules designed to improve the capabilities of workers in wood, metal, and other crafts, all of which are to be found in two of my books *(How to Design Period Furniture* and *Design for the Craftsman)*.

The only copies of these now available are in private hands and libraries, but the usefulness of my findings is attested to, I think, by the fact that both books were reissued many times before finally going out of print.

Tall chest designed by Gottshall.

One pitfall designers should seek to avoid is the formulation of rules, ratios, and relationships that too narrowly restrict their course of action. I am not particularly intrigued, as Mr. Philbrick seems to be, by his discovery that the width, length, and leg size of a particular piece of furniture happen to divide themselves into a certain number of modules of equal size. I think more often than not this is chance, or was done for the sake of convenience rather than for esthetic considerations. His discovery that the leg limits have the same ratio of length to width as the classic Corinthian column seems a bit far-fetched, since there is a considerable discrepancy in the mass content of the elements he compares. As he himself reminds us, "One can easily fall into the error of finding those ratios one sets out to find."

However, Mr. Philbrick is on the right track and has done a creditable job of bringing to the attention of his readers some matters of considerable importance. I hope to see more of this from him.

—*Franklin H. Gottshall, Boyertown, Pa.*

Concerning "Repair and Restoration," (Winter '77, p. 32) author Preiss reports the use of benzol (benzene) in the finish remover that Messrs. Ek and Tucker use. . . . Benzene is an extremely hazardous substance. Refer to Michael McCann's *Health Hazards Manual for Artists:* "It destroys the bone marrow which forms red and white blood cells and is even known to cause leukemia in some people." In our furniture conservation laboratory benzene is used with extreme care, and always under a fume hood with no skin contact. . .

—*Richard O. Byrne, Quebec, Que.*

. . . Benzene is quite toxic (a cumulative poison) and it has recently been found to be a carcinogen. . . . Toluene is much safer and nearly as effective.

—*James N. Cawse, S. Charleston, W.Va.*

. . . I would like to pass on the fact that farriers' hoof-trimming knives make excellent carving tools. There is a Swedish brand, A. B. Frost, that may appeal to some carvers; however my personal choice is the Italian Burdizzo made for either left or right hand. This knife has a bit more flexibility than the former. These knives are similar to Woodcraft's carver's hook except with a tighter hook. . . .

—*Thomas E. Mahnken, Julian, Calif.*

Re Donald L. McKinsey's letter (Winter '77), which states that "Philippine hardwoods" are available in crates from firms importing Japanese motorcycles: I have been fortunate enough to get crates made of "Philippine hardwoods" from a local firm importing plate glass made in Japan. The boards in these crates range in length up to 12 ft. and are in various widths up to 6 in., all clear lumber and many with few nail holes.

From another firm importing from Japan I was able to obtain large, random-sized sheets of "Philippine mahogany" plywood. These crates are free for the asking and the importing firms save dismantling and disposal costs.

I have designed and built three identical china hutches from the wood contained in these crates, one for ourselves and one each for our children. The hutches have embossed wood carvings and a carved molding in the top design. These were the only wood items purchased. All other moldings, bottom doors, sides, back, and total remainder were recycled from the crate material. They are finished with dark walnut stain and several coats of Flecto plastic oil.

—*Andrew Rossini, Alameda, Calif.*

Re "Carving Lab" by Robert Buyer (Winter '77, p. 64): While the article is well-written, the illustration showing the use of a gouge toward the carver is the most incorrect technique and should always be avoided (unless practicing for hara kiri). I also suggest using a crayon or pencil in preference to felt-tipped pens for marking wood (or stone).

—*Mortimer N. Haber, Roslyn, N.Y.*

I feel obliged to write you concerning the article "Routed Edge Joint" by John Harra (Winter '77, p. 66). . . . The first sentence in the second paragraph states, "Ideally, two pieces of wood would mate perfectly if they were held edge to edge and both edges were cut smooth with a single pass of the router." This would be true only if the guide fence were perfectly straight, or if the router bit diameter were zero. For any finite diameter it becomes more and more untrue as the cutter diameter increases. . . .

The author uses the term "gentle curve" and states that his system "can be used to match pieces with S curves or irregular compound curves." If this is so, the system should be able to make the "perfect joint" on pieces with a curvature down to a 24-in. or 12-in. radius, extending for lengths of about

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8 in. . . . The author further specifies a ¾-in. cutter as preferable. I have developed an approximate formula for calculating the size of the gap. With this cutter and a curve length of 8 in. at a 12-in. radius of curvature, the misfit is .0455 in.; at a 24-in. radius the misfit is .0106 in.; and at a 48-in. radius the misfit is .0026 in.

Even at the very gentle radius of 48 in. the fit is none too good. I use a .001-in. or .0015-in. feeler to check "invisible" joints before gluing, with little or no pressure. . . .

Further, the slightest relaxation of pressure from the router to the guide, or a tiny chip getting between the router base and the guide while the hands are busy with the machine spells disaster. One other important item—either the router must be held so that one spot only touches the guide, or its base circle must be absolutely concentric with the cutter—a condition not so easy to achieve.

—*W.E. Diefenderfer, Glastonbury, Conn.*

. . . Harra makes a basic error when he says, "Thus any bumps or hollows in the fence are imparted to the first piece and transferred in reverse to the second piece. . . . The two pieces of wood are perfect mirror images. . ." and "The same procedures can be used to join wood along curves." Nonsense. A couple of thousand years ago Euclid explained why this won't work.

Industrial woodworkers are beginning to use what they call a serpentine joint to increase yields from No.1 and No.2 common stock. . . . They have read their Euclid and let him help them with the programs for their tape-controlled overarm routers, and, using ¼-in. carbide bits, they write separate programs and make separate cuts for each half of the joint.

—*David Landen, Chapel Hill, N.C.*

[Editor's note: John Harra replies: "Mr. Diefenderfer's mathematics are correct. But pragmatically, the error factor here of a few thousandths of an inch is the price of being able to do curved work easily and quickly. I'd like to know if there is a better way."]

Recent articles on harvesting, cutting and drying your own lumber constitute an activity for which I can offer suggestions. White glue is about as good as anything to crack-proof end grain on freshly cut green logs or lumber. It should be applied within an hour of cutting. Paint does not seal and dulls saws. Roofing mastic is good if you must leave felled logs in the woods. Most species should have the bark removed—in the woods. I prefer a hatchet to a drawknife. Removing the bark has the dual benefit of weight reduction and removal of insect eggs. If lumber is slabbed at a mill without edging it is equally important to remove all bark and advisable to spray the sap edges with insecticide.

Much good, usable lumber up to 36 in. long by 6 in. wide can be produced with average shop equipment plus a chain saw, hatchet, sledge and wedges. While it is more wasteful, wood can be cleaved with little energy or time expended. Then the flitches are squared up somewhat with a hatchet and taken into the shop, where a 6-in. jointer will put everything in one plane. Green wood dulls knives and it is best to schedule this work when knives are somewhat dull. There is an optimum dryness at which green wood cuts best. Stack it

around inside and work on it in your spare time. Ripping saws for green wood must have the teeth at least one inch apart, preferably more. This means that the average 10-in. ripsaw must have every other tooth broken out and the gullet ground out and the remaining teeth given added forward hook. Saws with swaged or carbide teeth work well. And cut your lumber full or you may be unpleasantly surprised by shrinkage and warp. Finally, make every move one to protect your back in this strenuous activity.

—John W. Wood, Sulphur, La.

I wrote to the sources for shaper knives and knife blanks listed by Tommy Bargeron (Winter '76, p. 62). Charles G. G. Schmidt & Co., Inc., Montvale, N.J., was especially helpful. I unwittingly faced a particular tool steel problem that any knowledgeable supplier of shaper knives could anticipate. But if others saw the problem, only Frank Aurori at Schmidt & Co. volunteered some advice. I was saved time, money and trouble. Because good customer service is tough to find I thought other readers making or ordering shaper knives would be interested in my experience.

—Ian R. Walker, Cranbury, N.J.

We enjoyed Richard Showalter's "Wooden Clamps" (Fall '77, p. 64)... however we would like to take him to task on the length of the shank on our taps.

About two years ago, when we designed our thread box, much consideration was given to tap length. We consulted a good many woodworkers, both amateur and professional, and decided upon a shank length that was more than adequate for the needs of the average woodworker. We also felt that when the occasional very deep tapping job was encountered, an 8-point socket would see one through without the added expense of extra shank length.

—Ernie Conover, Conover Woodcraft, Parkman, Ohio

Gary Randall (Winter '77, p. 12) is quite right about hickory for wooden threads. It is usually possible to use hickory without any chipping. I always rub the dowel to be threaded with a candle before cutting the threads. Then I spray-shellac the cut threads to give more strength and greater wear....

Re Ray Schwenn's use of a vacuum cleaner to suck glue into cracks or splits (Fall '77, p. 22), the first job is to get the dirt or chips out of the crack. This is not always easy, but cloth or paper wet with alcohol or some other benign fluid can be worked into many cracks for this purpose. As to glue, the solution is usually simple: Put a bead of glue along the top of the crack, or its end. Cut a slender piece of thin card or high-quality paper, or even unwrinkled butcher's paper, and ease it down through the glue bead into the crack, working it back and forth until the surfaces are all covered....

Charles Riordan (Fall '77, p. 22) recommends a liquid wax solution to keep wood screws bright and also to make them easier to screw in. I'm sure it will. A squirt (spray) of oil or an antirust spray will also do the former, and a quick rub of the threads across an ordinary bar of soap just before insertion will do the latter.

—Henry Kramer, Somerville, N.J.

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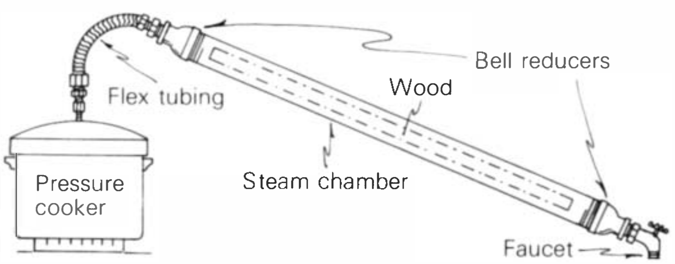
WORLD'S STANDARD IN WOODWORKING EQUIPMENT

Pipe steamer

A simple and cheap steamer for bending wood *(Fine Woodworking,* Fall '77*)* can be made using a pressure cooker and some ordinary pipe fittings. Screw out the center post of



a pressure cooker. A Presto brand cooker has ¼-in. pipe threads; others may be different. Purchase adapters for this fitting so it will connect with ½-in. flexible (ribbed) tubing, and a pipe nipple and bell adapter to bring the other end out to fit a 2-in. pipe. A piece of 2-in. pipe about 50 in. long makes an excellent steam chamber. The length should be an inch more than the longest piece you plan to bend; you can always lengthen the chamber by adding couplings and more pipe. Use another bell reducer on the other end, then put on a faucet to regulate the amount of steam and drain excess water. I use our kitchen pressure cooker; all these fittings cost less than $15.

Cut and shape the wood the way you want it to be finished, then put it in the chamber and screw on the bell reducer and faucet assembly. Fill the pressure cooker to about 2 in. from the top, tighten all fittings, screw into the top of the cooker, and open the faucet. After it starts to steam, close this valve so the water drips out but just a small amount of steam escapes. Never close the valve all the way, or an explosion could occur. A piece of straight-grained wood ⅝ in. thick should easily bend around a form for a Winsdor chair after thirty minutes of steaming.

If you use a pressure canner that has a gauge on it, you can safely steam wood with pressurized steam. For safest operation, remove the gauge and attach your steam tube to that hole, leaving the rocker assembly in place. Fit the gauge on at the end of the steam chamber by using a pipe tee and reducing bushings. Using the end valve as a regulator and keeping an eye on the gauge, you can generate superhot steam up to 240° F (at 15 lb. pressure). Ten pounds will cut the steaming time approximately in half. Watch the gauge at all times and be sure that the pressure cooker's safety valve is clean. Always let some steam escape through the end valve to keep the superheated steam flowing around the wood.

—George Pilling, Elgin, Ariz.

Repairing with glue

To re-attach edge splinters on lumber or to reglue a glue void beneath the face veneer of plywood, spread the splinter open or lift the veneer up with a sewing needle, razor blade or palette knife. Then lay a fine glue bead next to the crack or

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43-932	Stair Nose Cutters
43-933	Drawer Joint
43-950	½" Cove—5/16" Qr. Rd.
43-951	5/16" Cove—⅜" Bead
43-952	⅛" and ⅜" Qr. Rd.—¼" Bead

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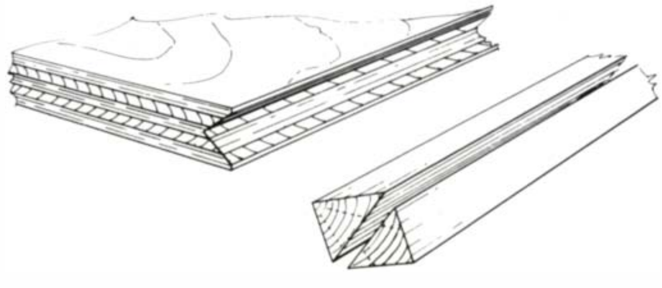
void. Force the glue into the void by blowing through a short length of flexible tubing that is narrow in diameter—windshield-washer hose or fine surgical tubing, for example. Then remove the spreaders and clamp.

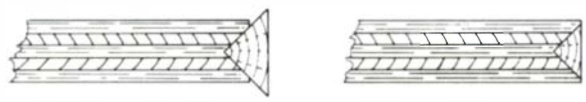
—*Steve Voorheis, Missoula, Mont.*

Banding plywood

Plywood can be easily and neatly edge-banded using a 90° flute shaper cutter (Rockwell #09-106) and cutoffs from solid stock. Adjust the shaper to cut a notch centered in the edge of the plywood and deep enough to cut into, but not through, the edge of the veneer on each face. If the cut is too deep, the cutter tends to fuzz up the end grain of the veneer or else chip it loose. For the band, rip triangular strips from solid stock of about the same thickness as the plywood. These strips can usually be made from scraps from the ripsaw if you choose pieces with two surfaces jointed at a right angle. Unless the bands are cut from the edge of a board, it is probably safer and easier to rip these narrow triangles on a band saw. Glue the strips into the notches, and trim the excess on a table saw, jointer or by hand plane. The jointer or table saw will need some sort of spacer, a piece of ¼-in. plywood, for example to prevent the corner of the band from causing an uneven cut.

If more than two parallel edges of the plywood are to be banded, all of the edges can be notched at the same time and





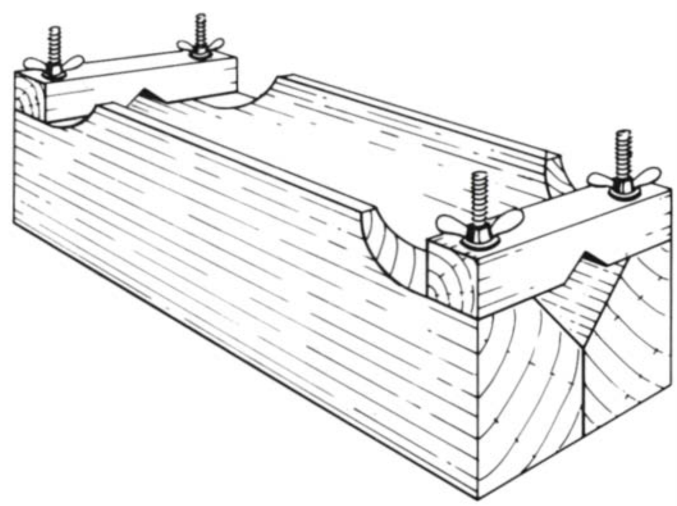
the bands mitered at the corners, or two parallel edges can be notched, banded and trimmed before the notches are cut into the other edges. The second procedure leaves two small triangles of end grain exposed on two edges of the plywood.

If the band is trimmed carefully, which is not too difficult to do, it is not visible on the face of the plywood, and the picture-frame look that usually accompanies edge bands is avoided. Because the notch provides a large surface area for gluing, the band is exceptionally strong. The solid wood edge makes hinges mounted on plywood doors more secure, for example, and even provides a reasonably strong glue surface for plywood-to-plywood butt joints and the like.

—*David Landen, Chapel Hill, N.C.*

Better V-block

I made a flageolet as Kent Forrester describes (Fall '77, p. 80) and ran into difficulties in laying out and drilling the holes and in holding the flageolet down while working on it. Although I used a V-block, the slightest jiggle caused misalignments that became painfully evident after all the holes were bored. By adding two clamps atop the block and using a fence for the drill-press table, I was able to drill the holes in successive flageolets precisely and predictably. Mounted in a workbench vise, my modified V-block held the flageolets securely while I worked the windways, channels and slots. To make this V-block, you need less than 2 ft. of construction-



grade 2x4, 6 in. of 1x1 and four hanger bolts with wing nuts and washers. The two 45° bevels that make up the 90° "V" are planed on the jointer and then carefully aligned before gluing. The clamps and the coves at the end of the body are bandsawn; a spindle or drum sander does a nice job of cleaning up the curves. Most of the dimensions are not critical.

—*Bernard Maas, Edinboro, Pa.*

Trimming veneers

There is an easier and cheaper way to trim long edges of veneer than Leon Bennett's pattern routing jig (Summer '77, p. 16). Make a guide from ¾-in. stock as long as the veneer, joint the edge straight and band with Formica. Put a lever-acting hold-down on each end of the guide board. Then set the veneer on the board, put a shorter piece of ¾-in. stock on top and tighten the hold-downs, as shown. Set the shaper or

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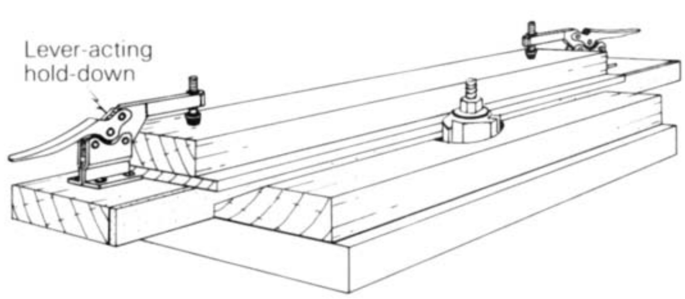

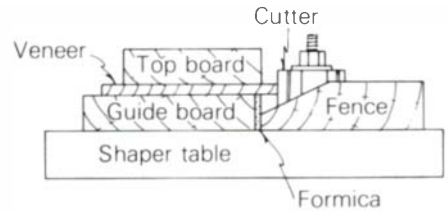

router cutter back 1/16 in. from the edge of the fence so that the cutter won't nick the edges of the guide boards as it trims the veneer. Trim with the grain of the veneer to prevent chipping, and be careful to hold onto the board. With this method I've joined veneers for 4-ft. x 10-ft. conference table tops with no problems.

—*Jim Sieburg, Chicago, Ill.*

Marquetry patching

Your marquetry picture is cut, mounted, sanded and with a coat of finish, but something seems wrong. This happens often, because no matter how carefully you select veneer, you don't notice until the end that a piece doesn't look right. Some people just cut out the section to be replaced, trace the opening and insert a new piece. With my method, the section is traced before cutting.

With tracing paper taped to the picture, draw the section you wish to replace. Tape the tracing paper with carbon paper and trace the pattern onto the new piece of veneer. Then cut out the piece. Lay it on top of the picture to see how it looks; if you don't like it, cut another piece.

With the new section positioned on the picture, secure half of it with tape and score around the other half with a knife, using the veneer as a guide. Then tape the scored side, remove the tape and cut very carefully along the marking through the veneer that is to be replaced. With a small chisel or square-bladed X-acto knife, stab this veneer in the center and pry it up, working carefully from the center to the edges. Now fit the new section into the gap. If it doesn't fit, sand or shave the edges until it does. Glue with white glue and press. Then wipe off the excess glue and sand just a little with fine sandpaper backed by a wooded block to get dust into the cracks that are filled with wet glue. Put a small board and a heavy weight atop the piece and let it dry overnight. Then sand until all is level, and finish.

—*Peter L. Rose, Saddle Brook, N.J.*

Storing clamps

Instead of piling all your clamps into a tub, as if the contents were to be thrown out with the trash (Fall '77, p. 64), you can easily make a rack to store them. Lay your wood clamps on a piece of ¾-in. plywood and determine the place-

BACK ISSUES

Fine WoodWorking

Our readers tell us they regard *Fine Woodworking* more as a reference resource than as a magazine because of the timeless and hard-to-find nature of its contents. And because there is so much material to cover (new ideas and techniques pop up all the time) we don't intend to repeat ourselves editorially. All nine back issues are available and you can still have a complete set for your shop. You can also order the *Biennial Design Book*, a compendium of 600 photos, showing the best woodworking being done today.

Winter 1975, Number 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, Number 2: Marquetry Today, Split Turnings, Eagle Carvings, Hand Dovetails, Mechanical Desks, Textbook Mistakes, Antique Tools, Sprial Steps, Gustav Stickley, Oil/Varnish Mix, Shaker Lap Desk, Back to School.

Summer 1976, Number 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, Number 4: Cabinetmaker's Notebook, Water and Wood, Hidden Beds, Exotic Woods, Veneer, Tackling Carving, Market Talk, Abstract Sculptures, Workbench, Ornamental Turning, Heat Treating, Mosaic Rosettes, Shaped Tambours, Buckeye Carvings, Hardwood Sources.

Winter 1976, Number 5: Stacking, Design Considerations, Keystone Carvers, Carcase Construction, Dealing With Plywood, Patch-Pad Cutting, Drying Wood, Gothic Tracery, Measured Drawings, Guitar Joinery, The Bowl Gouge, English Treen, Shaper Knives.

Spring 1977, Number 6: The Wood Butcher, Wood Threads, The Scraper, California Woodworking, Bend 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, Number 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, Number 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, Number 9: Repair and Restoration, Designing for Dining, Tall Chests, 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.

To order the back issues or the *Biennial Design Book*, send us your name, address and payment along with a list of what you want. Each back issue is $2.50 postpaid. The *Biennial Design Book* is $8.00 postpaid. Connecticut residents add 7% sales tax. Make your payments to the Taunton Press and send to the address below.

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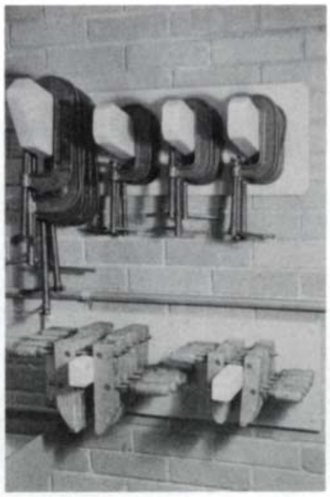
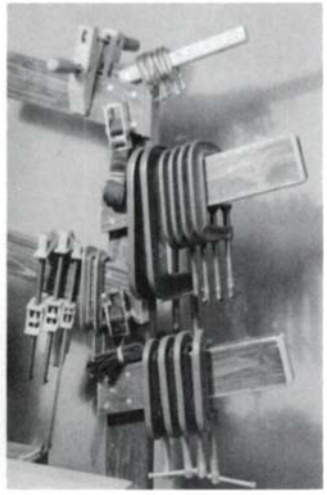




ment of the hangers by marking the space between adjusting screws and jaws. Hangers are made from 2x4 stock cut to a loose fit between adjusting screws and glued into snug holes in the plywood at 90° to the base. You can make a rack for C-clamps in the same way, but set in the hanger parts at 80° rather than 90°; for large C-clamps, use 2x6 stock. A free-standing clamp "tree" can be made from 2x4 stock.

—*Everett Traylor, Bettendorf, Iowa*

Glass scraper

Microscope slides work very well as scrapers, particularly in tight places like the interiors of small boxes, or drawers. When the edge is fresh, they cut beautifully, and though they lose the edge faster than a metal scraper, they are disposable and don't require the time spent on resharpening. I've found that so-called petrographic slides (27mm x 46mm) are sturdier than biological slides (25mm x 75mm). One supplier (of many) is Buehler, Ltd., 2120 Greenwood St., Evanston, Ill., 60204. The order number is 40-8000-001 for 1 gross, price $7.00.

—*John Reid, Amherst, Mass.*

Repairing trim

A piece of furniture may seem beyond repair if a large chunk of ornate trim is missing or damaged. The repairman may lack the skills to carve a new piece of wood, or the carving may cost more than the furniture itself. The answer is to make a mold from the existing trim and cast a new piece with auto body putty, better known as bondo.

Bondo comes in two parts, a resin and a catalyst. It does not dry, but rather cures, and therefore (unlike plastic wood) does not shrink. When it has cured it can be shaped and drilled like wood. It won't absorb stain, but can be painted or colored with Blendal powdered stains (from Mohawk Chemical Co., Amsterdam, N.Y.) to match the surrounding wood.

To make a mold, remove a section of undamaged trim from the furniture and drive a couple of finishing nails into the back of it, to act as handles. Fill a container with plaster of Paris, grease the front surface of the trim with any light oil, and push it firmly into the plaster. As you set the trim, wiggle it a bit to ensure a good contact and be careful not to let the plaster flow over the back of it. When the mold has hardened, use the nails to pull the trim out. The finish on it will

be blushed from the moisture in the plaster, but it can be restored by using Mohawk's blender flow-out, which comes both glossy and flat.

New trim can now be made by greasing the mold and pouring bondo into it. Stir gently to get rid of air bubbles. When the bondo starts to cure, set a few nails in the back for handles so it can be pulled from the mold. After it is solid it can be pared with a knife, sanded and cut to fill the damaged area on the furniture. Attach it with epoxy glue. Bondo continues to cure for about a week and if you wait too long to trim and sand it, it will be like steel.

Bondo can also be used to repair a damaged corner or other area where it isn't practical to make a mold from existing trim. First clean the damaged area and cut away any slivers of wood. Don't be afraid to enlarge it—another half-inch won't make any difference. Drive a few finishing nails into the damaged area to anchor the bondo, but make sure the heads are below the undamaged surface. Now wrap aluminum foil around some small pieces of wood, such as tongue depressors, and tape them to the undamaged wood so they bridge the repair zone and act as a form for the bondo. Trowel in the plastic, in layers if necessary, and when it cures remove the forms. You'll have a crude representation of the undamaged area, which can then be shaped with a knife and sandpaper.

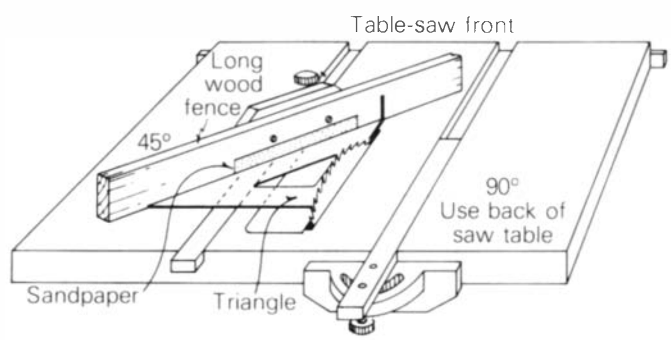
—Glenn Rathke, Pompano Beach, Fla.

Triangle tips

An architect's 45° triangle is inexpensive and handy around the shop. Attach a ½-in. x ½-in. strip of walnut along the hypotenuse with No. 2 R. H. brass wood screws to make a miter square. Take care not to cut into the edge of the triangle when you scribe with a metal instrument.

—Dwight G. Gorrell, Centerville, Kans.

An inexpensive but accurate plastic drafting triangle gives a perfect 45° setting on the table saw. A long wood face on the fence with sandpaper attached prevents slippage and further



improves accuracy. For a perfect 90° setting on the saw gauge, turn it over, push it against the back of the saw table, and tighten.

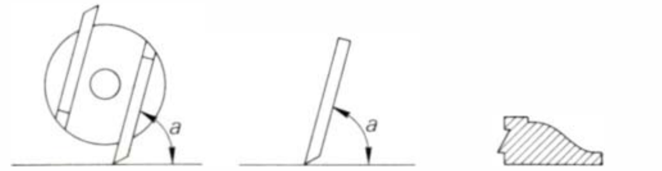
—Jim Richey, Houston, Tex.

Knife profile patterns

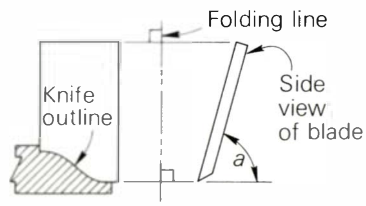
Because shaper knives and hand planes cut at an angle (*Fine Woodworking,* Winter '76, p. 61), a molding profile cannot be directly traced onto a blank and ground to shape.

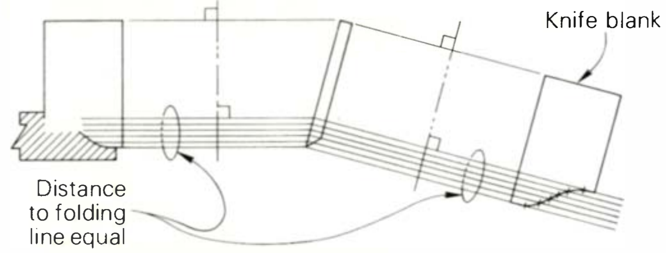
METHODS (continued)

This method will help you make a blade that will reproduce a desired molding pattern. First, determine the angle *a* of the knife as it cuts (either in a shaper or a hand plane). Then



draw a cross section of the molding shape. To this sketch add the outline of the knife as it cuts the wood. Then draw a folding line and a side view of the knife at angle *a* and at its true length. Now add another folding line parallel to the knife length, and beyond it draw a knife blank. Extend construction lines from several points on the molding profile, through the first folding line at 90°, to the edge of the knife length. It is possible to construct a template the actual shape and size of the knife you want to make by measuring with dividers from the first folding line back to the construction line intersection points on the molding outline, then transferring these measurements from the second folding line to the knife blank. All construction lines must pass through the folding lines at 90°.



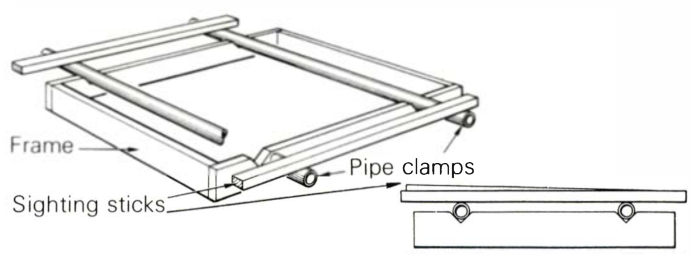


—*Ron Davidson, Port Angeles, Wash.*

Gluing frame

I found I did not have a really flat gluing surface and had to improvise one. I used an old window frame to set up my pipe clamps for gluing up solid wood panels. The trick is to keep the clamps parallel and in the same plane, to make sure the panels have no glued-in twist or wind. After notching the frame to accept about half the diameter of the two pipes, place winding sticks across them fore and aft and sight across the top of the sticks to spot any variation from parallel. If there is a variation, simply deepen the one notch necessary to bring the pipes into line.

Once you have trued this setup, don't move it, because the surface on which it is next placed may vary and change the



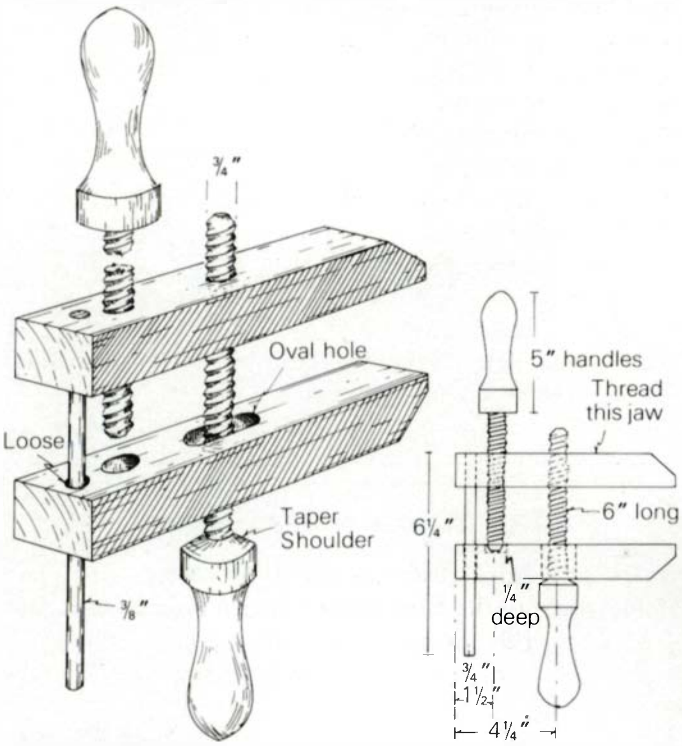
parallelism. When gluing the boards together, place the good side down and use one or two clamps across the top of the boards to even out the pressure. Always use scrap strips between the clamp jaws and the wood to distribute pressure and avoid marks.

—Duane Waskow, Marion, Iowa

And more clamps

Perhaps some readers might be interested in making some adjustable clamps entirely of wood, as I have done. The dimensions can be varied to suit one's needs.

These clamps don't operate quite like the metal-threaded ones since both screws are right-handed. However, I have found them to be quite satisfactory. In use one tightens the inner screw to clamp the work, then secures the jaws by spreading the outer screw. The small dowel serves as a guide rod to keep the loose jaw in alignment. The hole in the loose jaw should be oval to permit angular pieces to be clamped. Of course, hard maple or other dense wood should be used.



—Arvle E. Marshall, Watkinsville, Ga.

Sizing

When cutting threads in end grain, an aid to preventing tear-out (Fall '77, p. 19) that will give clean-running threads is to "size" the wood. After drilling the hole in the end grain (or any surface, for that matter) coat the hole with a watery glue (polyvinyl acetate, plastic resin, etc.) thin enough to penetrate the fibers. Less tear-out will occur during the tapping. Afterwards apply more coats of sizing to harden the wood further.

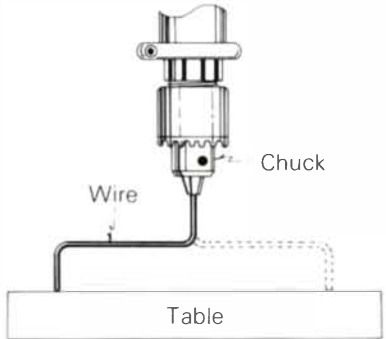
Sizing so applied increases the toughness of any running or bearing surface.

Another use of sizing is to raise the grain. Before the final sanding, apply a thin wash coat of sizing. Avoid thermoplastic adhesives (the white and yellow glues) because they soften with friction and load up abrasive paper. Brown glue such as Borden's or Weldwood plastic resin sand and harden the wood especially well. Another way to raise the grain is with thin shellac or lacquer. When it dries, the sizing "keeps" the wood fibers and grain raised, so they can be sanded away. If a better surface is not immediately noticed, the improvement may well be apparent after several months of humidity fluctuation.

—C. B. Oliver, Durham, N.H.

Truing a drill-press table

A drill-press table can be leveled easily and accurately with a piece of coat-hanger wire bent into a "Z." Fit one end into the drill chuck, and adjust the height until the other end of the wire just scrapes against the table. Now rotate the wire 180°. If the table is exactly 90° to the drill chuck, then the wire will still scrape the table slightly after being rotated. If it doesn't, adjust the table until it does. The surface is true when the wire scrapes it to the same degree in every position.



—Lyle Terrell, New Orleans, La.

Consulting editors Andy Marlow and George Frank invite questions from readers about cabinetmaking and finishing. We also encourage readers to join the discussion with their own answers to problems raised in this column, for there's always more to learn. Write Q/A, *Fine Woodworking*, Box 355, Newtown, Conn. 06470. (For period furniture patterns, consult our survey of plans in print, Summer '76 issue.)

Finishing

I am making a small round extension table for a dinette, using Brazilian cherry, a fragrant wood with grain and color similar to mahogany. I would like its final color to be beige rather than ruddy brown, and it would be nice to retain the fragrance if possible.

—Louis O. Heinold, Warwick, R.I.

George Frank replies: "To make a red wood blond you have to get rid of the red. You may be able to camouflage the red and come up with a beige-brown finish by putting hints of green into the stain (if you use any), into the filler and into the finish. Or you may have to bleach the wood by washing it two or three times with the strongest chlorine bleach you can find. Let the wood dry between washings, sandpaper when dry, and wash off with white vinegar to neutralize the bleach. If the red is gone, you are ready for staining and finishing. Peroxide bleach would surely remove the red, but would also eliminate all the beauty of your wood. Your problem is far more difficult than you realize. You must experiment on samples, don't hope for an easy solution, and be sure to treat both sides of the boards the same way.

"It is very unlikely that you'll be able to retain the fragrance. It will not resist repeated washing nor will it come through the finish."

I am building a French double harpsichord kit. The naturals on the keyboard have little slips of ebony glued on top. The instructions suggest dressing the ebony with urethane varnish thinned a little more than half with turpentine, to protect it from the oil of the hand. What do you think of a dressing of this kind?

On the sharps I have put slips of oil-free boiled beef bone, because I have heard that over the years bone remains white while ivory will yellow. Is this true, and would the bone need a dressing like the ebony?

Finally, the instructions recommend putting two thin coats of 1½ lb. cut shellac on the soundboard, to protect it without inhibiting its resonance. What do you think?

—Wesley Øye, New York

Frank replies: "There are only two reasons to finish wood: to protect it, and to enhance its beauty. If your harpsichord will be used by you or other serious musicians, the keys need no protection or improvement. Sandpaper them as smooth as you can and leave them alone. It would take 50 years for finger oil to stain them, so you can sand them again every 50 years. But if your harpsichord will be played by careless people or children, you should protect the keys with two thin coats of polyurethane.

"I believe bone can be bleached with hydrogen peroxide of 100 or 130 volume (your pharmacist can supply it). Before applying, soak the bone in caustic soda or lye, and wear rubber gloves.

"The finish of your soundboard should be shellac. It's very important

Fine WoodWorking

Biennial Design Book 2

AN INVITATION TO WOODWORKERS to show photographs of anything made of wood, the very best work you have done during the past two years.

EVERYTHING MADE OF WOOD—cabinets, chairs, tables, sculpture, carving, marquetry, inlay, turnings, toys, tools, musical instruments, boats, airplanes, houses, interiors. Any wood, any finish, any technique, any period.

FIVE HUNDRED of the best pieces will be selected by the editors of Fine Woodworking for publication in our Design Book 2, to reach the bookstores in June, 1979. As in our first Biennial Design Book, published last year, our emphasis will be on excellent design and craftsmanship; our intention is to display the state of the woodworker's art—a source of inspiration for today, a record for tomorrow.

RULES

- Each entry must be of original design and the primary material must be wood. A designer and a craftsman may enter jointly. Period furniture must be "after the style of," not a precise reproduction of an antique or a published plan.
- A maximum of four entries per craftsman, please.
- Send a glossy black-and-white photograph showing an overall view of each entry, along with as many supplementary photos, details, closeups, drawings and notes as you feel necessary to convey what you have made. We need a sharp black-and-white photograph with good contrast, at least 5x7 in size, to judge and to publish. The background should be featureless—plain white or black, grass, sand, snow, etc.—in order to emphasize the work itself. Be sure to leave adequate space around the object within the picture area, so that we have some layout flexibility.
- Snapshots, Polaroids, color slides, color prints and blurry photographs cannot be reproduced and therefore will not be judged.
- Put your name on the back of every photo. Be careful that ball-point pens don't emboss or mar the image, and that wet ink on the back of one photo doesn't rub off onto the next.
- Each entry must be accompanied by its own entry blank. Blanks are available upon request from the Taunton Press, or clip the one below, zerox or hand-copy it.
- Deadline for entries is Dec. 31, 1978.
- If you want your photos returned, enclose a stamped, self-addressed envelope. All entries will be kept until the book is published in June, 1979.
- The decision of the editors is final. Craftsmen whose work is selected for publication will receive a complimentary copy of Design Book 2, and may purchase additional copies at wholesale price.

ENTRY BLANK

Name ______________________

Street address ______________________

Town or city ______________________ State __________ Zip __________

Title and/or function of entry ______________________

Woods and other materials used ______________________

Dimensions (length, width, height) ______________ Price (optional) ______________

Principal techniques used, unusual techniques (enclose separate sheet if necessary) ________

____

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Period, if after the style of ______________________

Category in which you wish to be judged

☐ Accessories ☐ Architecture ☐ Beds, benches, couches
☐ Cabinets and chests ☐ Carving ☐ Chairs ☐ Desks
☐ Instruments ☐ Marquetry ☐ Tables ☐ Tools ☐ Toys
☐ Utensils ☐ Other (please specify) ______________________

Do you want your entry returned? ☐ yes ☐ no

Remarks (on design, construction, function, craftsmanship, life. . .) enclose separate sheet if necessary ______________________

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Send your entry to: Biennial Design Book Editor, The Taunton Press, 52 Church Hill Road, Box 355, Newtown, CT 06470

that it be fresh. Buy shellac flakes or buttons and dissolve in alcohol, and if you would really splurge, you could filter it through a paper towel. You will get the ingredient that, very probably, Stradivarius used."

I use wild cherry that I get out myself with a chain-saw mill. I am anxious to learn a method for finishing cherry Kentucky rifle stocks.
—Myron I. Morgan, Portsmouth, N.H.

Frank replies, "I would do the best possible sanding and would apply three or four coats of clear lacquer to the wood without sealer, stain or filler. I would allow proper drying time between coats and re-sand the stock with finer and finer grit. When the last coat is properly dry, I would cut the gloss with water and pumice stone. Compared to my gunstock, a baby's rear end would seem rather rough."

I'm using water/aniline dyes and I sand the wood before applying them, then after drying I use water to raise the grain and sand again. Following this the water stain still raises the grain like crazy. I've heard that a glue sizing may be used before the water stain. Is this right? How to do it? It sounds like any sizing would prevent or retard dye penetration.
—J.A. Osborn, Severna Park, Md.

Frank replies: "You have the right answer. Before using a water dye, you should wet the wood first with water to raise its grain, let it dry and sand it. However, you need a little finesse: First, you must use new, fine sandpaper that is sharp and will cut; second, your sanding strokes must not go in the direction of the grain, but on a slight bias, so as not to push the fibers back into their original cradles, but to cut them off permanently. After staining, sand the wood again, with even finer paper.

"A glue size is always a good thing and stain will penetrate it. You can use fairly thin hide glue, but the best is rabbit-skin glue, which is used by gilders and can be bought wherever gold leaf is sold. You must sand after every step."

Cabinetmaking

I work with large panels of ¾-in. lumbercore red birch plywood. I use the blind nailing technique on solid

Q & A (continued)

wood (lift a curl with a chisel, nail, and reglue the chip), but with plywood the veneer chip pops right out and the soft core rolls under the chisel to form a bump. Perhaps plywood can't handle this approach, but if it can I'd appreciate some guidance.

—James B. French, Portsmouth, R.I.

Andy Marlow replies: "Using nails in ¾-in. plywood is poor construction practice. Where nails could be used, concealed dowels may be substituted. Use a Forstner spurless ⅜-in. bit and spiral dowels."

Regarding rosewood, what is the best way to edge-join two boards, and what is the best glue?

—Joseph C. Marshall, Louisville, Ky.

Marlow replies: "Saturate a cloth in alcohol, wipe surfaces to be joined to remove the natural oils and let the alcohol evaporate dry. Use either hot hide glue, Weldwood plastic resin or its equivalent, and be sure to clamp adequately."

I have been using kiln-dried oak that has been sitting around for about a year. Some of it has developed small cracks in the ends, which run with the grain throughout the boards.

—Dave Watson, Newark, Del.

Marlow replies: "Ask the dealer for F.A.S. grade (Firsts And Seconds) lumber. Also you want quality-controlled kiln drying."

What causes a glue line to raise about a hair six months or more after glued-up stock has been finished?

—Tom Jordan, Novi, Mich.

Marlow replies: "You have used two pieces of lumber with different moisture contents. Or, it rarely happens, but the molecular structure of the adjoining pieces may vary to such an extent that change of seasons causes a slight difference, one to the other, in expansion and contraction."

I'm looking for a gauge used by the early-day carpenters when dovetail drawer joints were cut by hand. It was brass or steel at the necessary angle, placed over the wood to mark the pins and sockets.

—John C. Davis, Sacramento, Calif.

Marlow replies: "What you describe is a rigid bevel gauge that was probably made by each woodworker to suit his

Q & A (continued)

needs. The same results can be obtained by using a common adjustable bevel gauge as shown in the *Fine Woodworking* article on hand dovetailing (Spring '76, p. 28)."

I reproduce antique furniture, and right now I'm making a slant-top desk with a swan's neck pediment. How do I make the deep molding for the swan's neck with the limited equipment that I have? How did the old-timers do this?
—*Max Rubin, Auberry, Calif.*

Marlow replies: "The part you are interested in is called a broken pediment. Usually these ogee moldings are of a size that requires a heavy-duty shaper found only in furniture factories or millwork shops. After I bandsaw these parts for clocks, highboys or corner cupboards, I use only carving gouges."

I'm about to start a bonnet-top highboy. . . . I'm okay as far as the details of the highboy itself go, but unless I construct the bonnet top like a boat (ribs and planking) I'm stuck.
—*Roy W. Cole, Roswell, N.M.*

Marlow replies: "You seem to have no problem up to closing in the bonnet—ribs and shiplap planking are correct procedure. Ribs are really ¾-in. thick panels shaped to follow the front pediment curve but lowered for the planking thickness and based on the case top. Inside closure curves of ribs are your choice, with plank covering. You'll need four: front and back right, and front and back left."

How do you cut a domed panel for a panel door, without the convenience of a shaper? Is it possible to machine the inside corners square so they don't have to be chiseled?
—*Wally Jacobson, Pine City, Minn.*

Marlow replies: "Use a portable router with a shaped molding cutter of your choice. The inside corners must be hand tooled, no matter what machine tool you use."

Follow-up

. . . In reply to Richard O. Phipps' question about warped lumber (Winter '77). . . Another way to solve the problem of longitudinal bow is the same as Andy Marlow advises for flattening cupped boards. If a large power jointer is available, the board may be surfaced or sent across the jointer flat-wise with the back up. This will cut down both ends until the concave side has become level. Now, assuming that there is enough wood thickness remaining at least in the middle of the board, it may be sent through the thickness planer...

—James B. Small, Newville, Pa.

...In the Q/A department (Winter '77) I would suggest to Marcella Hudek that she buy shellac flakes and make her own shellac because manufacturers do not date their product, so one does not know how old the shellac may be when bought. I make my own shellac. And in the same department to Van Wagner, I would like to tell him that he need not worry about putting any finish on butcher blocks because by the time the block has been used for slicing vegetables and cutting meat and what have you, it will be almost impervious to water....

—Wm. V. del Solar, Westmont, Ill.

Contacts

Fine Woodworking will be pleased to put readers in contact with one another, by forwarding mail and providing addresses upon request.

Have had a workshop all my life as a hobby. Recently lost the use of my left arm. Have you any information about other woodworkers in same situation? Is there any source of information for a one-armed woodworker?

—J. Bryce Mearns, Hawthorne, N.J.

Encroaching blindness forces me reluctantly to let my subscription expire. While it is too late to be of any help to me, you might consider publishing an occasional article on projects feasible for the visually handicapped.

—Paul Kern Lee, San Francisco, Calif.

I would like to be put in touch with anyone who could help me with basic ideas on getting started on the rather large project of earning my living by making things in wood. I have secured a small shop and expect to begin experimentation with tools and processes...I know this is a common problem—how to get started—and I thought printing this letter would produce some contact with others

—Jim Wellborn, Springfield, Ohio

Staining and Polishing by Charles H. Hayward. *Drake Publishers, Inc., 801 Second Ave., New York, N.Y. 10017, 1974. $7.95 cloth, $4.95 paper; 214 pp.*

Woodfinishing by F. N. Vanderwalker. *Drake Publishers, Inc., 1976. $9.95 cloth, $4.95 paper; 387 pp.*

Wood Finishing and Refinishing by S. W. Gibbia. *Van Nostrand Reinhold, 7625 Empire Drive, Florence, Ky. 41042, 1971. $10.95 cloth, $6.95 paper; 192 pp.*

Furniture by A. B. Pattou and C. L. Vaughn. *Drake Publishers, Inc., 1970. $4.95 paper, 220 pp.*

In 1922 in Budapest, my elderly professor, while handing out our diplomas, made a speech: "My boys, by now you know about staining and woodfinishing as much as I do . . . very little. Many of you will go west, to Germany, France or America, and there you will see that most of what you have learned from me belongs to the past."

Yet these four books contain very little more than what I learned from my old professor. I have been pondering . . . Why is there so little new? Did progress simply forget woodfinishing? Here is the answer I propose:

Let us compare woodworking to a tree having two branches. One of the branches, the industrial production branch, absorbs nearly all the nutrient juices of the tree and grows bigger every year. Industrial production, with behemoth machinery, spits out anything made of wood and furiously finishes it on conveyor belts. The fruit that grows on this branch is called "profit" and since so many like its taste, this branch is well taken care of and keeps growing. The other branch, that of the fine craftsman, has grown very slowly over the past five decades. It is cared for by a few conservationists, true craftsmen, fine woodworkers. The fruit on our branch is far smaller, but much sweeter, and we call it "beauty." We are a dedicated bunch, we care nothing for speed and quantity, but we do care about quality and beauty. We find it in the simple ways of the craftsmen of yesteryear, and we are trying to perpetuate their ways of doing things. These four books were written for us.

My first impression of Hayward's

book was mixed. Some chapters are based on thorough knowledge of the subject, while others are superficial. Later I learned the answer: Hayward did not write the book, he merely edited it. He gathered his material from other publications and from leading craftsmen. The best part of his book is a detailed description of French polishing as practiced in England, and the person who supplied this information knew what he was talking about. He was a true master. Hayward's book is written in British, not in American. The American publishers should have known that the trade names of many products are not the same in England and here, and should have re-edited the book for the U. S. A. I picked about 50 trade names and showed the list to two suppliers of finishing products in New York. Three-fourths of my list was unknown to them.

Vanderwalker seems to be a very thorough American craftsman and a businessman. I do not think he dirtied his hands on the job as much as Hayward's French polisher did, but he studied more, has a more organized knowledge and way of dispersing it. If one had a masterpiece to finish, Hayward's man would be the one to do it, but if the executive suite of a big corporation, 116 doors, two paneled meeting rooms and the president's office were to be finished faultlessly, Vanderwalker and his organization should be entrusted with the job. His book lists nearly all the stain formulas that my old professor qualified as obsolete, although they may not be so for many of us, and many new ones, good to know about. He not only gives formulas, but explains the "why" of them. The chapter on varnishes is simply outstanding, and the one on brush-applied finishes is the best I have read. The book is not as good on hand and gun-applied finishes. You may not find the answer to your immediate finishing problem in Vanderwalker's book, but while looking you will find the answers to five others that you have been seeking for a long time.

The third book is written by S. W. Gibbia, to whom I present my sincerest compliments. Its appearance is exceptional in trade publications, with easy-to-read characters on heavy matte-finished paper. The book is amply illustrated with clear photos closely pertain-

BOOKS *(continued)*

ing to the text. It is a pleasure to hold and to look at, and its contents match this excellent impression. Gibbia is the kind of writer I would like to be. Whatever he writes about, he does not say one sentence or one word too many, nor one sentence or one word too few. His style is crisp, clean, clear and concise. Furthermore, he authoritatively knows the subject, woodfinishing.

If one reads the full title of the fourth book, by Pattou and Vaughn, one can get a fair idea of its contents. The whole title is *Furniture: Furniture, Finishing, Decorating and Patching.* The book fulfills the promise such a long title holds. It talks about furniture, its making, history, styles, the wood it is made of and how to finish it, and talks about scores of details related to the subject, such as lampshades, refrigerators, iron beds, mirror resilvering and more. Pattou and Vaughn write on all these subjects in the scholarly way, based on solid research and knowledge. One can learn a great deal from this book, but on woodfinishing Gibbia's book is straighter to the point and easier to follow.

All four books are good. Gibbia's is excellent.

—George Frank

The Timber Framing Book by Stewart Elliott and Eugenie Wallas. *Housesmiths Press, Box 416, York, Maine 03909, 1977. $9.95 paper, 169 pp.*

Last summer I attended the raising of an old barn that had been taken down and was being reassembled on a new site. Present was an 80-year-old woman who, as a small child, had attended the previous erection of the building. Furthermore, this was the third raising for this same frame, which in its original form predated the Civil War. This event is an excellent metaphor for the rebirth of the ancient art of timber framing as a viable building practice in the late 20th century, a renewal coming just before the death of the last hereditary practitioners of the craft.

Out of this renaissance of timber framing comes *The Timber Framing Book,* a modern successor to the centuries-old line of builder's guides. It is a how-to book for novices who aspire to build in the traditional style. It features a lucid explanation of the make-up of a house frame, the function of individual members—sills, joists, posts, braces, girts and plates, rafters—along with information on the joinery appropriate in each case and instruction on how to lay out and cut the joints. The text is accompanied by clear, step-by-step illustrations of the basic procedures. It also includes methods for dealing with irregularities in timber (bows, knots, variations from normal size) plus builder's math: how to calculate square footage, board footage, joist and rafter lengths, etc. Along with the expected technical material are informative chapters on the history of timber framing and its advantages, both material and spiritual. And perhaps the best part is its thorough treatment of the house-raising process. All in all, this book should give the novice enough confidence to take chisel in hand and start framing a house.

The book is not without its soft spots, however. The treatment of tools is somewhat scanty. No mention is made of the boring machine for removing waste from mortises. Tenons are cut directly with the saw rather than rough-sawn (or chopped) and then surfaced with a wide chisel, slick, or bench rabbet plane, the latter making for a more precise fit. In fact the authors advocate cutting mortises "a shade larger than the measured dimensions" in order to produce an easy fit. This is *not* a good procedure in any case, and especially not when working in green timber, which must inevitably shrink and further loosen the joint.

For layout the book prescribes a pencil and framing square. The alternative of marking knife (or scribe), template and mortise gauge is not dealt with. Pencil lines (especially on rough timber) are apt to be wide and vague and there is an irresistible tendency to "erase" a pencil line when surfacing the joint, whereas there can be no ambiguity when splitting a cut or scribed line. And the gauge or template (especially for dovetails) reproduces the layout exactly and repeatedly on both male and female parts of the joint.

The text's major weakness is in joinery and structural engineering. Half-lap joints are used excessively in corners and as splices. While suitable for joining joists to carrying timbers, a half-lap provides little restraint when used in sills, plates or girts. The book calls for thick tenons in wide posts and

thick pegs in large tenons—in 8-in. stuff a 4-in. thick tenon is prescribed, and a through tenon in a 7-in. timber calls for a 2¼-in. diameter peg. In the first case it would be far stronger to use either a smaller tenon and house the whole tenoned piece, or smaller twin tenons. In the second, two smaller pegs are far stronger than one fat one.

And on the subject of pegs, draw boring is pictured, but inexplicably never mentioned in the text. Draw boring—offsetting holes in mortise and tenon so the driven peg pulls the joint home—is the strongest way of ensuring tight pegged joints (especially since large, heavy beams can't be clamped).

These cautions notwithstanding, *The Timber Framing Book* is still a good place to start learning about post and beam construction—timber framing for beginners. For those seeking more sophisticated joinery, there is more to be learned in other, primary sources, and several good ones are included in the bibliography of *The Timber Framing Book.* Even more can be learned by dealing directly with one of the growing number of members of the new generation of timber framers—such as the authors of this book.

—*Ed Levin*

Hand or Simple Turning: Principles and Practice by John Jacob Holtzapffel. *Dover Publications, Inc., 180 Varick St., New York, N.Y. 10014, 1976. $15 cloth, 592 pp.*

Hand or Simple Turning is the fourth volume of a five-volume work originally published about a century ago. Anyone who has seen the final volume, which Dover earlier published as *The Principles and Practices of Ornamental or Complex Turning,* may wonder what "simple" turning would be like in the eyes of such a man as Holtzapffel. The short answer is, not very simple.

Holtzapffel was a professional who came from a line of professionals—his father wrote the first three volumes. When the son picked it up, he was near the peak of his professional development. The many years of training under his father, the subsequent years of managing the family's enterprise on his own, all funneled through a writing style that the generous might call stately and the waspish might call wooden,

produced a compendium that reflected the state of the mechanical arts in 1881, when volume four was published, but which raises certain difficulties for the modern reader. These difficulties are likely to be in inverse proportion to the reader's experience as a turner. However, this book is definitely not for a beginner.

Holtzapffel offers a wide range of theory and practice of the basic operations of a lathe of about the size a well-equipped craftsman would have today. He begins with a brief history of the development of the lathe, in which he makes clear that he considers himself intimately involved in the stream of history that has brought this tool to its contemporary state. In the 1880s, pole lathes were still widely used to make chair parts. Holtzapffel credits his father and other craftsmen-inventors by name for the improvements that had, during the 19th century, made back-geared industrial lathes common; one illustrated in the book has an 11-ton faceplate and a 10½-ft. mandrel. This section offers a great deal of detail on the construction of lathes in that era, and on the rigging of various cranks and treadles. In general, the author says, he has in mind as he writes a foot-driven lathe with a 5-in. center as generally the most convenient and efficient, "and especially so for the amateur." Readers who are not advanced amateurs may be overwhelmed by the detailed description of accessories like index plates, the long chapter on chucks (39 by my count), and especially the technical tables on various screw-cutting apparatus.

For the serious amateur the heart of the book starts about halfway through, where Holtzapffel begins a course of instruction on turning. It might even be possible to learn from scratch how to turn, with the book propped by the lathe and with much reading and re-reading. But compared to any of the good current works, this book would be a poor second for that purpose. The prose is dense, to say the least: There are very few illustrations, and none that show any part of the craftsman's body in relation to tool or lathe.

These reservations apply to the more experienced craftsperson as well, but one who already knows the basic techniques and has done some turning will not be at so great a disadvantage. An experienced turner, with perseverence, may learn here how to turn a sphere, an internal sphere, an internal cylinder, internal and external cones and a myriad of other shapes from wood or ivory. There is great detail on cutting basic shapes from metal, and a whole chapter on cutting screws. The latter features a description of the techniques for turning a screw by hand in wood or ivory (with special tools), and even a hint that this is possible in metal as well. If this idea seems a bit intimidating to today's hobbyist woodturner, the author offers the observation that "vigilance of eye, a sense of time and that of touch, acquired after a little practice," may prevent spoiling the work and eventually lead to improvement. That is reassuring.

The craftsman looking for new challenges may be intrigued by the last three chapters on turning spheres from ivory (including an erudite discussion of the growth patterns found in an elephant's tusk), and on turning the miraculous Chinese balls (which requires a specially-made chuck) and a number of other apparently impossible shapes within hollow spheres. For inspiration there are designs for egg cups, saltcellars, small vases, trays and candlesticks, some 70 designs in all. These are followed by engravings of a series of 80 rather elaborate, classically inspired stands, bases, chandeliers and the like, each conveying the essence of Victoriana. A final chapter treats the staining and dyeing of wood and ivory, offering recipes for stains derived from such exotica as alkanet root and "dragon's blood" (an East Indian resin), as well as turmeric and potash.

In sum, this is a volume with almost no evidence of the author's personality or individuality as a craftsman, no anecdote, very little helpful illustration and no charm, but a tremendous volume of information of the practice of turning for the craftsman who has the experience and determination to exploit it.

—*Phil Ginsburg*

George Frank is a retired woodfinisher and consulting editor of Fine Woodworking; *Ed Levin, of Canaan, N.H., designs and builds post-and-beam buildings; Phil Ginsburg, of Newmarket, N.H., is a professor of political science and a woodturner.*

EVENTS

This column is for gallery shows, major craft fairs, workshops and lectures of general interest to woodworkers.

American Woodcarvers—a show of contemporary carved sculpture. Feb. 10 through March 24 at the Craft Center, 25 Sagamore Rd., Worcester, Mass., and April 3 to 28, Warner Communications Building, 75 Rockefeller Plaza, New York.

American Chairs: Form, Function and Fantasy—a two-part exhibition at the John Michael Kohler Arts Center, 608 New York Ave., Sheboygan, Mich. Part one, Feb. 5 through March 25, is a historical survey of chairs from 1850 to 1975, emphasizing Midwest craftsmen and manufacturers. Part two, April 16 through May 28, is contemporary hand-made chairs.

Northeast Craft Fair—Dutchess County Fairgrounds, Rhinebeck, N.Y. June 20 through 25. Major wholesale-retail fair, all crafts.

Decorative Designs of Frank Lloyd Wright—book design, fabrics, furniture and glassware, through July 30, Renwick Gallery, Smithsonian Institution, Washington, D.C.

Young Americans: Fiber, Wood, Leather, Plastics—April 23 to June 4, Contemporary Arts Center, New Orleans (*Fine Woodworking*, Fall '77).

Renwick Multiples—March 18 to April 16, Pensacola (Fla.) Junior College (*Fine Woodworking*, Winter '75).

Woodturning symposium, March 24-26 and June 16-18, George School, Newtown, Pa. Write A. LeCoff, 520 Elkins Ave., Elkins Park, Pa. 19117.

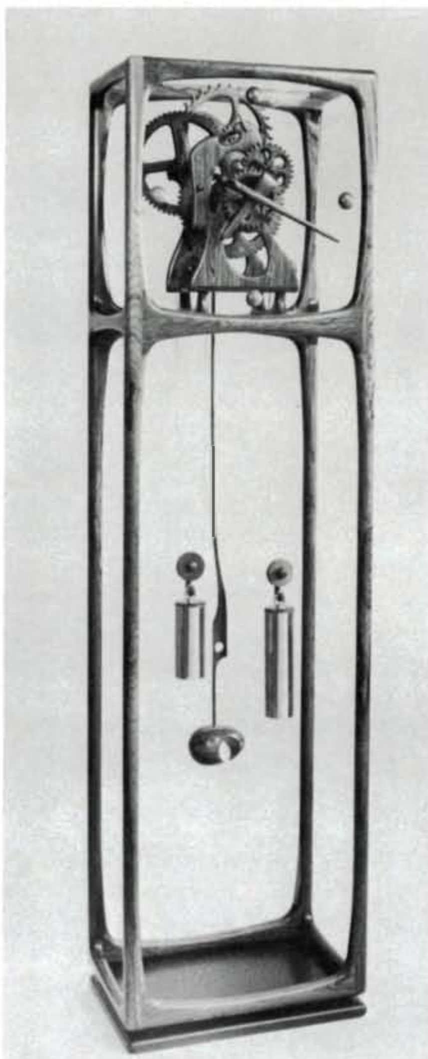
James Krenov, Swedish cabinetmaker and author, visits America this spring and summer. The following bookings are open to the woodworking public. Contact the sponsoring organizations for more information, times and cost, if any. Some dates are still available; contact Craig McArt, Environmental Design Dept., Rochester Institute of Technology, Rochester, N.Y. 14623.
March 13, lecture, slide show at Fine Arts department, Kean College, Union, N.J.
March 25, 1 p.m. slide show at Woodcraft Supply Corp., 313 Montvale Ave., Woburn, Mass.
March 28-29, slide show, critique of student work, Woodshop, Fine Arts Dept., University of New Hampshire, Durham, N.H.
April 5-8, seminar and workshop at Crafts Dept., Virginia Commonwealth University, Richmond, Va.
April 15, slide show at Frog Tool Co., 541 N. Franklin St., Chicago, Ill. 60610.
July 15-19, slides, workshop, Extension Dept., University of California, Santa Cruz.
July 24-Aug. 24, summer workshop at California College of Arts and Crafts, Broadway at College Ave., Oakland.

ADDENDA, ERRATA

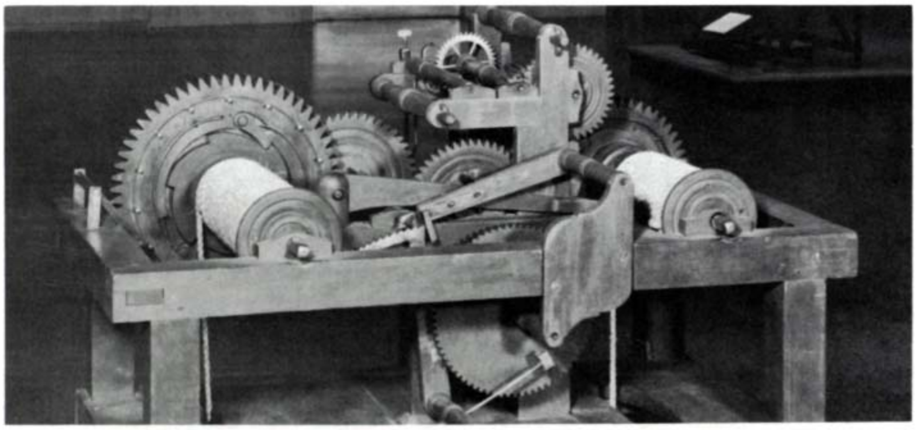
In the first issue of *Fine Woodworking*, Winter 1975, we published the photo reproduced below of a floor clock made of rosewood, walnut and Plexiglas by John Gaughan of Los Angeles. It had been exhibited in the Renwick Multiples competition. No other item has generated so many reader inquiries, most of them wanting plans and construction advice.

The photograph on this issue's cover is of the same Gaughan clockworks, and the article beginning on page 44 tells where to get Ralph D. Thomas's plans for a very similar mechanism. It also tells how to approach clockwork design, and some of the ways of making the various parts.

Despite their similarities, the Gaughan clock and the Thomas clock aren't the same (for one thing, Gaughan's escape lever is below the wheel; Thomas's is above it). They were independently designed, although both men drew upon some of the same sources. Gaughan, who



Floor clock by John Gaughan



Tower clock, made in 1830 of cherry and birch for a church in Connecticut.

designs and makes magicians' illusions for a living, says his inspiration came during a 1966 trip to Barcelona, Spain. He saw an enormous wooden clock inside a church, and obtained permission to measure and photograph it.

The church tower clock shown above arrived as part of our research, courtesy of the Smithsonian Institution. While the photo doesn't fit the contemporary theme of our article, it's so intriguing we couldn't resist showing it to you.

The format and typography of this issue of *Fine Woodworking* are a little different. We've tightened up the spacing around headlines, added a little space around pictures and diagrams, put large initial capitals at the start of articles, and replaced hand-lettering with type in many of the diagrams.

For the typographically minded, our body type is 10-point Garamond, set on 12-point slug. Picture captions are 9-point Garamond italic. The lettering inside diagrams is in 9-point Univers, main headlines are 30-point Garamond bold, secondary headlines are 18-point or 24-point Garamond light.

We also pass a publishing milestone with this issue, our tenth: The press run exceeds 100,000 copies. This is also the thickest *Fine Woodworking*, 88 pages against 52 pages in No. 1. Obviously the advertising has increased, but editorial space has kept pace: 60 pages, up from 48 in No. 1.

Art credits: 12-26, 62-65, 86, Joe Esposito; 24, 48-49, 52, 58, 70, 73-74, 80-84, Stan Tkaczuk, Image Area; 45, R. D. Thomas; 60-61, Morris J. Sheppard; 71, Garth F. Graves; 75, Thomas Webb.

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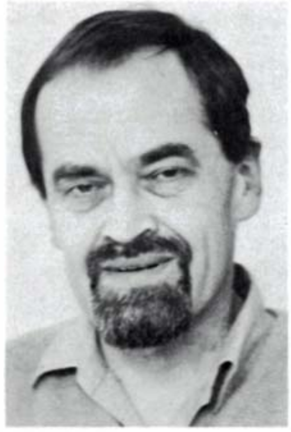
Two New Schools

by John Kelsey



Powell

Kirby

Once, you became a woodworker by enduring an apprenticeship, but that is rarely possible today. You can teach yourself, perhaps with help from your old uncle and a job with a carpenter or in a furniture factory. Or you can go to college. The former is uneven and risky, and the latter usually requires pursuing an academic degree in an ivory tower, away from the real problems of earning a living with what you make. Now two Englishmen transplanted to Massachusetts have opened two unusual schools of woodworking and furniture design, just a few hours drive apart.

The two are Ian Kirby of Hoosuck Design and Woodworking in North Adams, and David Powell of Leeds Design Workshops in Easthampton. Although they come from similar backgrounds in the same craft in a small country, they did not meet until this past fall. And although each is trying to solve the same problem, their solutions are quite different.

As young men, Powell (now 51) and Kirby (now 45) both studied with Edward Barnsley, the grand old man of British designer/craftsmen. Both pursued design studies at universities. But Kirby's subsequent career has been that of a college teacher in England and America, with a considerable amount of independent design and commission work on the side. Powell's time has been spent at the bench, designing and making furniture in his own shop, with a little teaching on the side. Both have emerged as gifted designers and highly skilled craftsmen who want to pass on what they've learned.

Hoosuck Design and Woodworking is on the ground floor of the Windsor Mill, an abandoned textile plant now operated as a community development corporation and filled with a variety of craft and design businesses. The woodworking shop includes a drawing and design classroom, a bench room (with student-made benches whose tops are recycled from a bowling alley), and a well-equipped machine room.

Kirby's criticism of college woodworking programs is that they don't prepare students to make a living, and they emphasize rarefied, one-of-a-kind designs that would cost thousands of dollars if a buyer could ever be found. Thus, alongside his school he is running his own contract design shop. This winter, he obtained and completed commissions for a large exhibit booth for a manufacturer of textile machinery, and for the lobby, furniture and interior fittings of a 20-office insurance firm. He is planning to start a production shop that would make furniture and wooden accessories for the retail market.

The Hoosuck school has room for 25 students, each paying $1,000 for a 15-week semester. Kirby tailors the curriculum to suit each student's background (college credit can be arranged) and advises those with no woodworking experience to stay for six or eight semesters (three to four years). At the end, a student should have a thorough knowledge of woodworking theory, hand and machine processes, furniture and interior design and business operations. Kirby employs some students part-time in his own enterprises, and some graduates may find jobs there, but most will leave as trained designers and craftsmen to set up their own shops or find jobs in industry.

Leeds Design and Woodworking is on the second floor of another abandoned textile mill, with high ceilings and beautiful natural lighting. The space is divided into six studios for resident craftsmen, a bench room for 20 students, and a superb machine room.

Powell proceeds from the fact that it is all but impossible for an independent designer/craftsman to amass enough capital to buy really fine machinery. Even if he could, it still takes many lean years to build a clientele for fine designer furniture, and very few are able to survive long enough to succeed.

His idea is that a group of six craftsmen, each working independently but showing their work together in Boston and New York, can make a big enough splash to attract business—with luck, enough business to justify all that really fine machinery. Prospective clients will see enough different work to find what they like, and the craftsmen will see enough ideas to keep their creativity cooking. A student in such a place will observe firsthand a number of diverse and successful woodworking businesses.

Leeds opened in early winter, and as yet has only one resident craftsman besides Powell himself. The two share the teaching, three days a week for each, putting the rest of their time to their own commissions. Jobs in house this winter include a board room, some residential stereo cabinetry and wall units, and an elaborate desk. When six residents are present one teaching position will rotate among them, and Powell will retain the other.

Students at Leeds are called "interns," which sidesteps state college certification problems (college credit can be arranged). They pay $2,500 for the academic year, September through May. Resident craftsmen pay rent of $200 a month. Residents can work off their rent as instructors, and students may find part-time employment with residents.

The curriculum at both Leeds and Hoosuck emphasizes fine design coupled with meticulous craftsmanship. Kirby and Powell both take pains to point out that their approaches to the problem and their organizations are quite different. In two visits to each shop, the biggest difference I found was intangible. Kirby is an extremely energetic man—the people hustle at Hoosuck and the air fairly crackles. Powell seems a more contemplative person and the best adjective for Leeds is serene. But they share the goal of training competent, professional craftsmen.

CLASSIFIED

Journeyman restorer wishes to affiliate with antique dealer. 20 years experience. Will relocate. H. Lindsay More, 70 Hamilton Avenue, Greenwich, CT 06830. (203) 869-7878.

CRAFTSMEN'S COOPERATIVE WOOD SUPPLY sells walnut $1.10, cherry $.75, oak, ash, maple, hickory. . .$.55. Exotics priced accordingly (bd. ft.). All nice boards, first come first served. Min. 20 boards. Albert LeCoff, Elkins Park, PA 19117. (215) 635-6475.

The Henley Optical Company makes finest ENGLISH PLANES in steel-faced gunmetal, rosewood lined, fully adjustable by a single-lever mechanism. Master craftsmen throughout the world acclaim them "the best." Mitre plane, 2½", £194; Shoulder plane, 1½", £274; Thumb plane, 1¼", £192; Smoothing plane, 2⅛", £324. Delivery 10 weeks, handbuilt to order. 4 Hart St., Henley-on-Thames, Oxon, England.

Woodworker's SWISS ZYLISS VISE regular $99, now $59 postpaid. Woodworker's bargain catalog $1. Rego, 49 Downing Street, Fall River, MA 02723.

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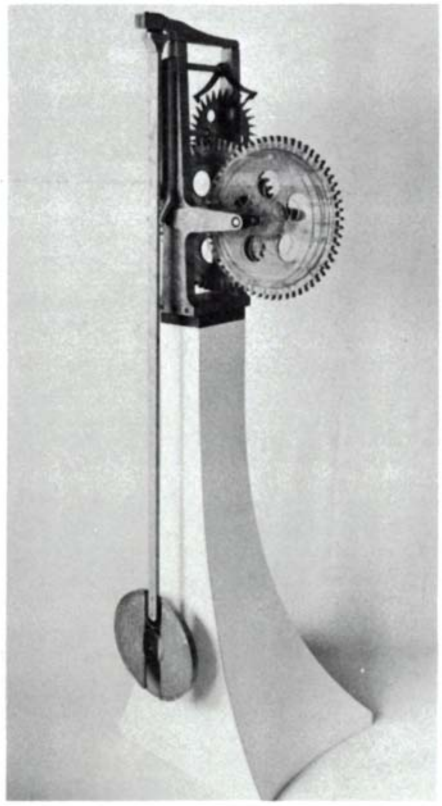
Wooden Clockworks

Design and construction require ingenuity, care

by John R. Lord



Clock designed and made by author ticks off the seconds but has no hands. Frame and pendulum are bird's-eye maple; large wheels are laminated from strips of various hardwoods with wooden teeth set into slots sawn in rims. Original wooden escapement has been replaced by experimental version of acrylic plastic (top center); base is Formica-covered plywood on hardwood framework. Pendulum has effective length of one meter and beats once a second; escape wheel has 30 teeth; center wheel (extreme right) rotates once in 144 minutes.

Clocks—old and new—are a subject of very personal interest to me, not only from the standpoint of historical value but also from one of design. It follows that the approach by which I design and construct my clocks is also personal. I hasten to mention that clock design and construction have been thoroughly documented down through history (further reading, page 51) and I make no claim as to the classical propriety of my designs or means of executing them. As an artist I formulate a careful plan at the outset. But then, within certain parameters of scale, strength and function, I may do almost anything, even violate all rules of horology, to pursue my vision. That confession out of the way, let us proceed.

I shall endeavor here to explain how clocks work, how to design a clock mechanism from scratch, and how to make it out of wood. The designing is not very difficult once the principles of escapements and gears are understood, and the manufacture is within the reach of an amateur craftsman with average facilities. A clock could be made entirely by hand, tediously. But there is no complete plan in this article, for I want most of all to encourage original design. Although a clock can be made to tell accurate time, it is a mistake to be constrained by this historically recent requirement. With the works exposed, face and hands can be absent, allowing greater appreciation of the marvelous machine called clock.

A clockwork is a transmission machine, a train of intermeshed gears and pinions, set in rotary motion by the kinetic energy of a falling weight. An escapement mechanism divides the weight's long fall to the floor into tiny increments. A swinging pendulum regulates the rate at which the weight is allowed to fall, eking out its energy in brief, uniform and countable bits.

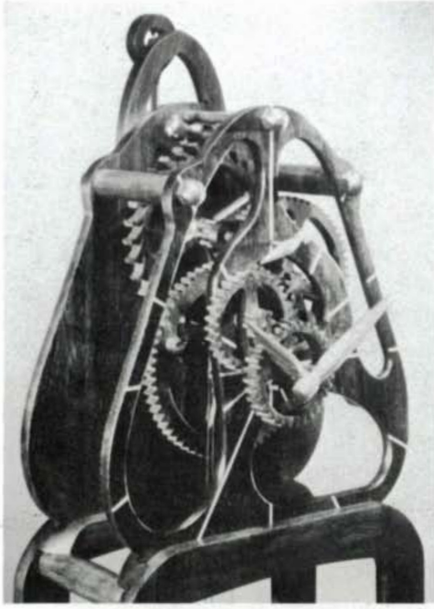
My romance with clockworks and timepieces (the term clock, strictly, denotes an hour-striking device as well) overtook me in London when I visited the National Science Museum. Some of the oldest running tower clocks are there, iron machines of great complexity and beauty, dating from the 14th century. I spent hours studying them as they beat the inexorable seconds.

Clockwork is not the product of a linear evolution, nor did it spring whole from any single source. It represents the convergence since the Middle Ages of several diverse technologies. Toothed wheels as a means of transmitting power were described by Archimedes, and ancient Greek artisans used them in complicated devices for computing the relative positions of the sun, moon and planets. This technology was preserved by Arab civilization and transmitted to Europe in the 12th century. The escapement was invented in China in the 9th century and reached Europe 500 years later, when monks developed weight-driven clockworks regulated by an inertial escapement called "verge and foliot." These clocks had no dials—they were used to automatically strike the prayer bells. In the 16th century, when faces were added to tower clocks, most had only an hour hand. A minute hand, while technically possible, would have been pointless. The mechanisms were too inaccurate to give meaning to the minutes, and anyway, few cared.

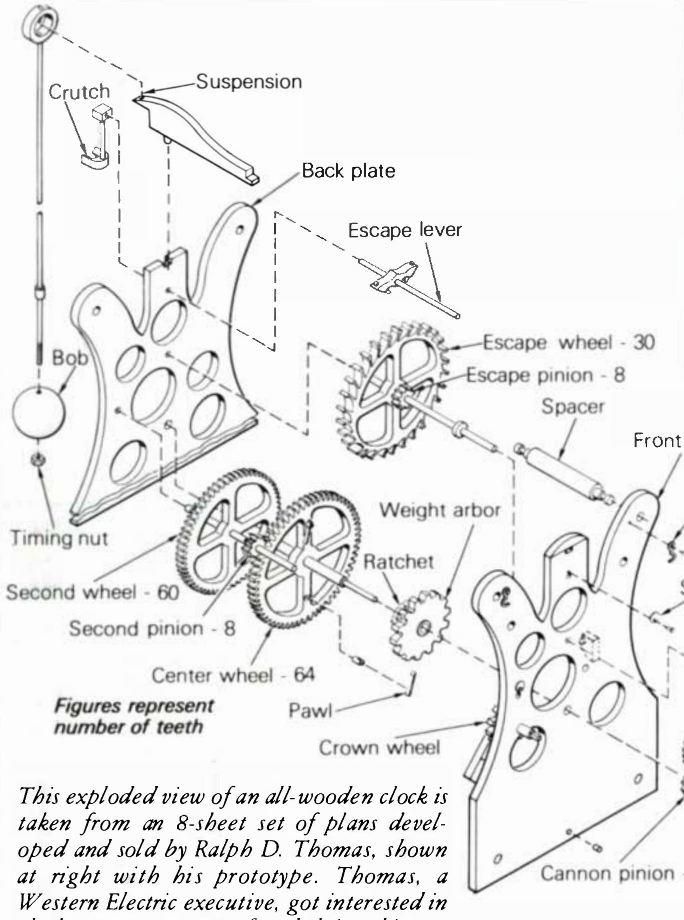
Clocks did not become accurate until the pendulum regulator replaced the verge and foliot. For a pendulum of any given length from suspension to bob, the period of oscillation is constant, regardless of the amount of swing or weight of bob. This was noticed in the middle of the 17th century by several observers, among them Galileo and Christian Huygens. Although Galileo made the first drawings of a pendulum clock, the Dutch astronomer Huygens first built one.

Most early clocks were hand-forged of iron, by blacksmiths. Not far into the 15th century, brass became more widely available and was quickly

John R. Lord, 29, of Waterloo, N.Y., has designed and built eight wildly different clock-like mechanisms. He has a master's degree in fine arts and design from Syracuse University.



Starting from the Thomas plans and using a Shopsmith with hand tools, Richard Heine of Santa Monica, Calif., built four clocks like this. Now he has formed a company, The Finest Hour, and is tooling up to produce about 20 a month to retail at $2,000. The clock stands 65 in. high. Case and works are Brazilian rosewood; hands and pendulum bob are cocobolo. The wheels for the prototypes were made by pasting paper patterns on the wood and bandsawing. Now Heine uses a metalworker's gear-cutting machine. These clocks use a watch-type escapement, a close cousin of the recoil anchor. The lever spans only three teeth, minimizing expansion problems, but the price is a complex escape wheel with fragile short grain across many of its teeth.



This exploded view of an all-wooden clock is taken from an 8-sheet set of plans developed and sold by Ralph D. Thomas, shown at right with his prototype. Thomas, a Western Electric executive, got interested in clocks 15 years ago, after helping his son make a gear-driven gizmo for science class. He found that although many old clocks use wooden wheel trains, none was made entirely of wood, so he made one. It takes 40 hours to build and comes apart.

Thomas with clock

Thomas sells his plans for $4.50 from his home at 1412 Drumcliffe Rd., Winston-Salem, N.C. 27103; the plans are also available from Constantine, 2065 Eastchester Rd., Bronx, N.Y. 10461.

adopted because it is much easier than iron to shape. A simultaneous interest in watches and smaller clocks demanded increased use of brass, although supply continued to be scarce until the Industrial Revolution because of the tortuous process by which it was made. A melt of copper and tin was poured from a crucible into a flat puddle and hammered by hand to work-harden it. The brass was reheated red, cooled and hammered some more, then cut to shape and filed smooth.

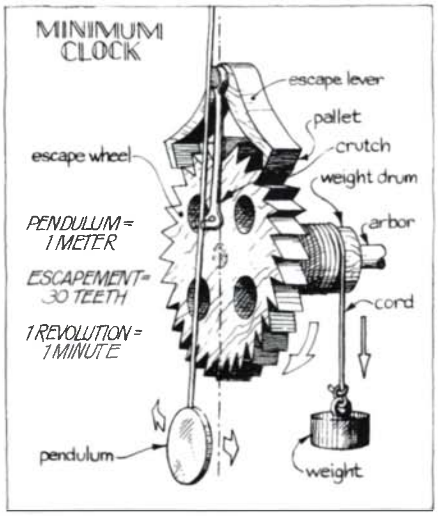
Wooden patterns were probably necessary for making these early clocks, and some enormous mechanisms were made entirely of wood, in the tradition of grist mills. Smaller wooden clockworks were made in backwaters such as the Black Forest of Germany, and in Colonial America. The American tradition of wooden wheel trains, using scarce metal only for arbors and escape wheels, continued during the development of mass production after 1800, but by the middle of the century the same Industrial Revolution had made brass readily available and wood was replaced. Many factory-made wooden clocks of 150 years ago are keeping good time today.

How clocks work

People usually don't understand just what it is that drives and regulates a pendulum clock. The most common questions are, "Where's the motor?" and "How does the pendulum make it go?" Although the swinging pendulum is the eye-catching part of most clocks, it is simply a regulator. All the energy comes from the gravity-induced fall of the suspended weight (which can be replaced by a coiled spring or an electric motor). The wheel train transmits this kinetic energy to the time-computing motion works for display by the hands, and also to the escape mechanism. The escapement's release-relock sequence passes tiny impulses on to the pendulum, making up for frictional losses and keeping it swinging. In turn, each beat of the pendulum allows the escapement to unwind, thereby emitting a tick or a tock.

All this time-computing and power-transmitting wheelwork could be removed, reducing the clock to its bare minimum: A weight hung from a cord wrapped directly around the arbor of an escape wheel with escape lever, crutch and pendulum (diagram on next page). This clock would run, but that's all. If it had a 30-tooth escape wheel and a one-meter pendulum, it would count the seconds. The weight acts through a lever arm whose length is the radius of the arbor, thus exerting force to turn the escape wheel. Unlike a spring or even an electric motor, this force never fluctuates and it needs no care other than periodic rewinding.

Instead of an escape wheel with 30 teeth, which would rotate once a minute, the minimum clock might be made with a single wheel of 1,800 teeth. Connected to the same one-meter pendulum, the wheel would ro-



Minimum clock would tick off the seconds, but that's all.

'Clock IV', by Lawrence B. Hunter of San Diego; 86 in. high, 36 in. wide, 19 in. deep; made of walnut with ⅛-in. birch dowel in an edition of six, $3,500 each. Hunter, a sculptor, writes that he is 'trying to eliminate the nonessential and distill down to the very essence of the clock and its skeletal structure, then organize the parts into a visual whole.' The great wheel has 160 pin-type teeth, the escape wheel has 72 teeth, the lantern pinion has eight leaves. The pendulum beats once in 1¼ seconds, and the single hand turns once an hour.

tate once an hour, still counting every second. But an 1,800-tooth wheel is hardly practical. This is why clockmakers use a train of wheels and pinions. The essential tick-tock mechanism remains the same.

Tick, tock

The diagram at left on the next page breaks the release-relock sequence of the escape mechanism into the stages that produce a tick and a tock—two seonds in the life of the clock. This is a recoil-anchor escapement, so called because the lever is shaped like an anchor, and because there is a small backward motion at the end of each beat.

Aside from the precise shape of the wheel and lever, which I will discuss shortly, the physical requirement here is that their arbors be mounted below the suspension point of the pendulum. The crutch, which transmits the impulse to the pendulum, is an extension of the arbor that carries the escape lever and embraces the pendulum rod without being attached to it. This ensures that the pendulum will beat freely without hindrance of friction. Note that the escape lever may be below the wheel or alongside it, as long as it is balanced to rock freely.

Without the governing influence of the pendulum, the escape mechanism would oscillate rapidly and irregularly, expending the energy of the system in a whirring clickety-clack. Thus the pendulum is the soul of the system, forcing it to eke out its store of power, second by second. It accomplishes this by virtue of the physical laws innate to it: A pendulum of given length, unhindered by frictional drag, will swing from side to side in a given time and that time will be constant no matter how wide the arc of swing. (This is not strictly true when the arc is very wide, but it is true when the arc is only a couple of degrees.) Further, a pendulum one meter long will always take one second to swing. Since each swing of the pendulum releases one-half tooth of the escape wheel, a 30-tooth wheel will rotate once a minute, and tick each second.

The time of the swing depends upon the length of the pendulum and the acceleration of gravity, which varies minutely according to latitude and elevation above sea level. The time of swing has nothing to do with the weight of the bob, as long as the bob is heavy compared to the weight of the arm from which it hangs. The formula is:

$$t = \pi\sqrt{\frac{l}{g}} \quad \text{or} \quad l = \frac{t^2 g}{\pi^2}$$

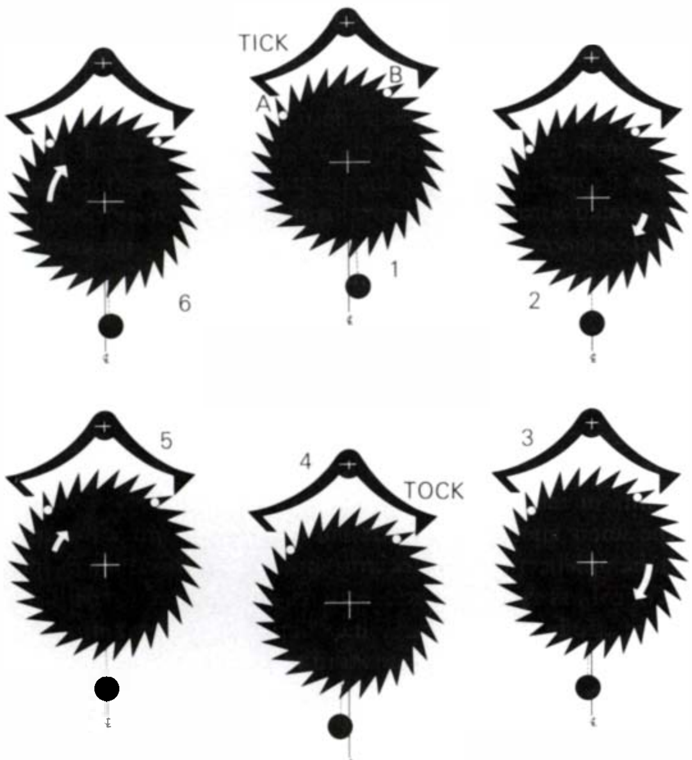
where t is the time of one swing from left to right in seconds, the familiar π equals 3.1416, l is the length of the pendulum and g is the acceleration of gravity, 32.17 ft/sec² or 9.81 meters/sec².

If the beat is to be 2 seconds, the pendulum will be 13 ft. ½ in. (or 4 meters) long; if the time is 1½ sec., the pendulum is 7 ft. 4 in. (or 2.25 meters) long; if it is one second, the pendulum is 39.14 in. (or 1 meter) long; if the time is a half-second, the pendulum is 9.8 in. (or 25 centimeters) long. A clock is adjusted by minutely changing the length of the pendulum, usually by means of a thread and nut at the suspension point or under the bob.

The escapement

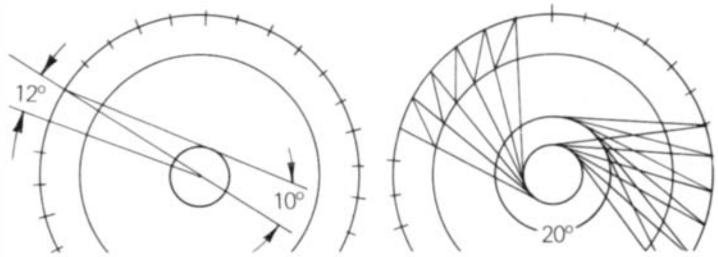
Whether the aim is a timepiece or a kinetic sculpture, the design process should begin with the pendulum and escapement. There are many types of escapement; the traditional workhorse is the recoil anchor shown here. It is a simple yet eminently workable design. The escape wheel and the escape lever (the anchor) are laid out together, as in the diagrams at right. The one shown is right-handed and turns clockwise. A left-handed wheel will also work. The most difficult procedure is spacing the 30 points around the circumference of the wheel. No matter how careful you are with an adjustable drafting triangle, there's always something left over at the end. I treasure an old 60-tooth ratchet wheel I found at a scrap yard. I can draw the wheel the size I want, plunk the master down on it, and extend lines from its points to the wheel's circumference.

The configuration shown, where the back of each tooth drops directly to the base of the next at the root circle, is sturdy enough for wooden construction. Wear will be least when the wheel is lightest, however, and narrower teeth are best for fabrication in brass or plastic. To draw them, construct a second circle tangent to a 20° angle from a radius, its vertex at one of the points on the rim. Draw the backs of all the teeth tangent to this circle, just as the fronts are tangent to a 10° circle. I have made escapements of solid and laminated wood, iron, and acrylic plastic, and



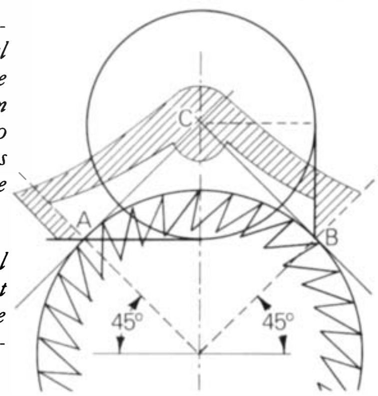
Two seconds in the life of an escapement, told in six steps reading clockwise. Sequence begins with a tick (1) as the tooth A smacks the entry pallet and the pendulum swings toward its rightmost point. The turning escape wheel pushes the entry pallet (2), rocking the lever and sending an impulse via the crutch to the pendulum as it begins to swing leftward. Tooth A escapes (3) and the wheel turns, but immediately tooth B is caught by the exit pallet, tock, stopping the motion (4). Tooth B pushes the exit pallet (5), rocking the lever and prodding the pendulum toward the right. Tooth B escapes (6) and the cycle repeats.

To lay out an escape wheel of 30 teeth: Draw circles of outside and root diameter, i.e. 6 in. and 4½ in. Divide circumference into 30 equal parts (12°). From one of these points, draw a radius and a line making an angle of 10° with it. Draw a circle tangent to the 10° line. Draw lines from each point tangent to the 10° circle. These lines define the front faces of the teeth. Connect each point to the root of the previous point. This defines the back face of each tooth. For a wheel of brass or plastic, draw a second circle at 20° to a radius and make the back face of each tooth tangent to it.



To lay out an escape lever spanning 7½ teeth: Draw a vertical line through the center of the wheel. Since the lever is to span ¼ of the teeth (7½), draw two lines at 45° to the vertical. This locates A *and* B, *the tips of the entry and exit pallets.*

Draw tangents to the wheel through A *and* B. *They intersect at* C, *the center of the escape lever axle. A tangent is perpendicular to a radius.*



Draw a circle at C *whose radius is one-half the distance between centers. Draw tangents to this circle through* A *and* B. *These tangents define the faces of the entry and exit pallets. The remainder of the escape lever may be any shape.*

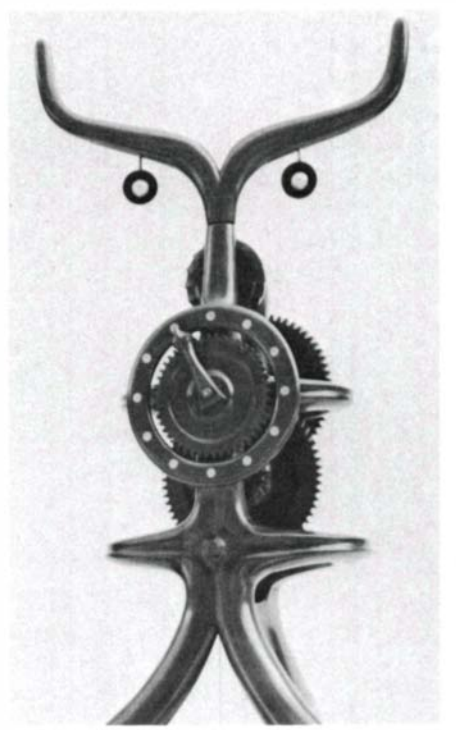
have settled on plastic.

The escape lever shown embraces one-quarter of the wheel's circumference, or 7½ teeth. This is the most common configuration, and (if you have no taste for geometric construction) the distance between arbors is 1.41 times the diameter of the wheel. The number of teeth embraced can be up to one fewer than half the total, and as few as two or three. The layout procedure is the same. The difference is the distance between arbors—the more teeth, the farther they are apart; the fewer, the closer together.

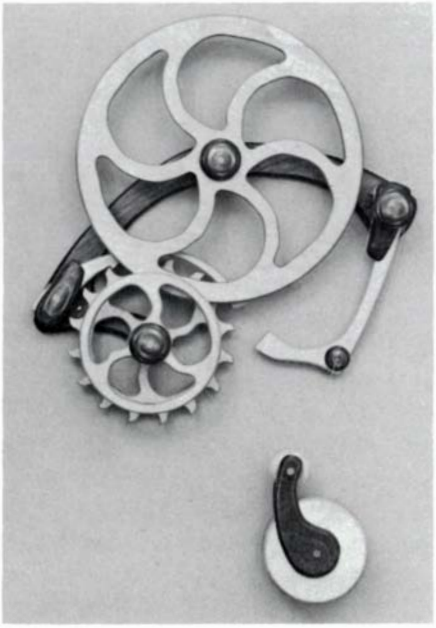
This construction locates the active faces of the entry and exit pallets, and the distance between arbors. These are the only absolutes—the form of the rest of the lever is left to the designer. But absolute precision is essential in locating and fabricating the active surfaces, else the clock won't run. The tips of the teeth and the pallets must be as smooth and hard as possible, allowing no irregularity in their motion. Some makers saw out the bearing surfaces and replace them with a denser material, a watchmaking practice whereby tiny, flat jewels are cemented to the pallets. They do not wear and they are absolutely smooth.

The importance of the pendulum in all this contrasts with the relative simplicity with which it can be made—the Thomas clock uses a croquet ball on the end of a dowel. It must be suspended above the escapement, on a vertical line with the wheel arbor. The suspension may be as simple as a strap of leather or a steel shim stock, a point set in a dimple (Thomas), a knife edge in a groove—anything that allows the pendulum to swing freely in a flat, smooth arc.

The exact location of the crutch is a function of the arc or swing and of the amount of rock designed into the escape lever, and is best found by experiment and observation. The exact shape of the crutch may range from a flat stick with two protruding dowels that embrace the arm, to wherever your imagination takes you. One caution: Not more than 1/32 in. of space should exist between the crutch forks and the arm, or the impulse won't be of sufficient duration ever to catch up.



'Clock III' by Lawrence Hunter uses a verge-and-foliot escapement. The horns atop the clock swivel majestically back and forth, taking two seconds each way, releasing a tooth of escape wheel each time. Wheel has 15 contrate teeth—that is, teeth are parallel to arbor rather than perpendicular to it.



'Inventor Released,' escapement-mechanism sculpture by David and Marji Roy of South Woodstock, Conn. Powered by the hanging weight, the L-shaped arm rises to kick escape lever, releasing a tooth and allowing large wheel to rotate a full turn clockwise or counterclockwise. The Roys produce a variety of escapement sculptures in limited editions that retail in the $100 to $250-range.

The time train

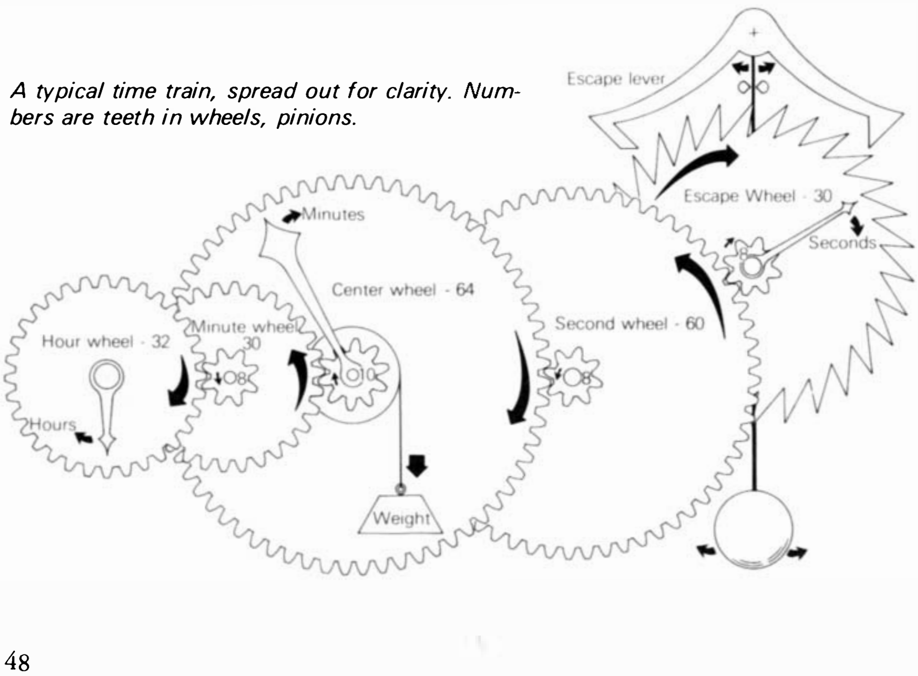
In the diagram below, the time train of a typical clock is spread out on a line. It proceeds in two directions from the center wheel: To the right, it energizes the pendulum and is regulated by it; to the left, it computes and displays the hour. The weight's energy is transmitted via the center wheel, which drives the pinion of the second wheel (so called because of its position in the train, not because it counts the seconds); the second wheel drives the pinion of the escape wheel. Proceeding the other way, the pinion of the center wheel (the cannon pinion) drives the minute wheel, whose pinion drives the hour wheel. The figures are the tooth counts of each wheel and pinion.

If you should somehow have access to a computer and plotter, it can be used to lay out very accurate wheels. It can also lay out elliptical wheels, square wheels and star-shaped wheels. They must run in identical pairs, and always turn end-to-side. They do not turn at a constant speed, but rather at double speed half-way around, and half-speed the rest of the way, averaging out where they ought. They seem to gallop.

The wheels are generally arranged—but needn't be—to run the minute and hour hands from a common center, which requires a hollow arbor called a cannon tube concentric with the arbor of the center wheel.

For convenience, the weight drum may also be on a hollow arbor concentric with the center wheel. Note that the weight drum may be connected to another whole train of wheels. These have nothing to do with computing the time, but rather with how often one must rewind the clock. Thirty-day movements are common in brass clocks, but in wood old friend gravity takes his vengeance in the form of friction and inertia at each connection. When the time is told, most of the weight's energy is lost. The longer the movement, the more slowly the weight must fall, and the more freely the mechanism must turn. Eight days is about the limit in wooden clockworks.

A typical time train, spread out for clarity. Numbers are teeth in wheels, pinions.



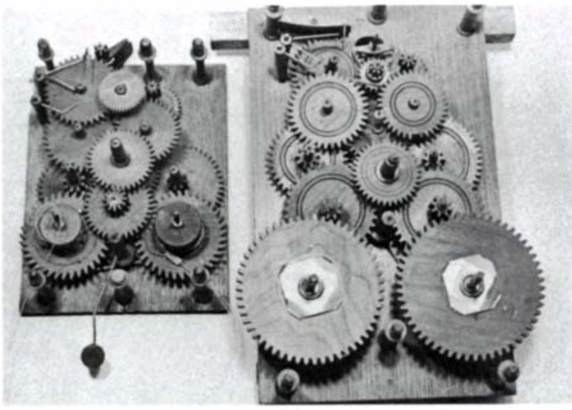
The ratios in the diagram are used in many grandfather clocks, but they aren't sacred. The point is to make the minute hand rotate once for 60 turns of the second hand, and the hour hand once for 12 turns of the minute hand. Many different wheel ratios, a few specified in the chart opposite, will do the same thing. These combinations will be most useful to the maker of wooden works, but others can be figured from the logic below. For practical purposes, begin with a one-meter pendulum and a 30-tooth escape wheel.

This pendulum beats once a second, and each beat releases half a tooth on the escape wheel (each tooth acts twice, once on each pallet of the escape lever). Thus the 30-tooth escape wheel rotates once a minute, or 60 times an hour. Its arbor is therefore a good place to mount the second hand. Since the escape wheel and its pinion are fastened to the same arbor, the pinion must also rotate 60 times an hour. In one hour the pinion's eight leaves will engage 60 × 8 or 480 teeth on the second wheel, thus turning it eight times. The second wheel pinion also turns eight times, engaging 8 × 8 = 64 teeth on the center wheel. The center wheel has exactly 64 teeth, so it will rotate once an hour. Put the minute hand here.

Turn now to the motion work to the left of the center wheel. The cannon pinion, 10 teeth, is fastened to the center wheel arbor and therefore rotates once an hour or 12 times in 12 hours, thereby engaging 120 teeth on the minute wheel. Since it has 30 teeth, it will have to rotate four times in 12 hours. The minute pinion also rotates four times, so in 12 hours its eight teeth will engage 32 teeth on the hour wheel, which happens to have exactly 32 teeth. It will rotate once in 12 hours. The hour hand goes here.

Notice that in 12 hours, while the hour wheel rotates only once, the pendulum beats once a second—an astonishing 43,200 times. In any gear train, the number of rotations of the last pinion to one rotation of the first wheel will be equal to the product of all teeth in the wheels divided by the product of all the leaves in the pinions. In a clock, the teeth in the escape wheel are multiplied by two because each acts twice. The pendulum itself is the last pinion, one beat being one "rotation." Thus,

$$\frac{32 \times 30 \times 64 \times 60 \times 30 \times 2}{8 \times 10 \times 8 \times 8} = 43{,}200$$



Chiming clock train made by M.C. Hall of Austin, Tex., right, is alongside a 19th-century Eli Terry movement. Hall, 74, a retired aircraft tool engineer, adds an extra wheel, a deadbeat anchor and brass bushings to get a 30-day movement. Front and back plates are quartersawn white oak, wheels are quartersawn black cherry, one-piece arbors and pinions are maple. Terry's pinions are holly.

Clock Trains

Center Wheel	Second Wheel	Second Pinion	Escape Wheel	Escape Pinion	Pendulum beats/min.	Pendulum Length
48	40	8	30	8	30	156.5″
64	40	8	30	8	40	88″
96	90	12	30	12	60	39.14″
64	60	8	30	8	60	39.14″
68	64	8	30	8	68	30.5″
80	80	8	30	8	100	14.1″
96	80	8	30	8	120	9.8″

Chart above relates number of teeth in each wheel and pinion to pendulum beats and lengths, to rotate center wheel once an hour. Chart at right specifies teeth in 12-hour motion trains.

Motion Works

Cannon Pinion	Minute Wheel	Minute Pinion	Hour Wheel
10	30	10	40
12	36	12	48
16	40	10	48

Wheels and pinions

A complete discussion of the geometry of wheels and pinions would fill a book. For clockwork purposes, consider two rollers pressed tightly together, one driving the other. The smaller, the pinion, is the driven; the larger, the wheel, is the driver. The relative speed of each would depend on their diameters, and if slippage could be prevented, rollers would drive a clock. In practice, teeth are necessary and teeth must mesh just as smoothly as if the wheels were plain rollers. The effective size of intermeshed gears is the size of the imaginary rollers, and is called the pitch circle. The teeth must be shaped so that the transmitted motion is absolutely uniform, or the clock will stop.

In engineering practice, for a wheel with N teeth, the relationship between the pitch diameter PD and the outside diameter OD has been standardized:

$$PD = OD \frac{N}{N+2}$$

For gears to mesh at all, the number of teeth in the wheel and the leaves in the pinion must be directly proportional to the diameters of their pitch circles. Engineers call this the pitch of the gear, and specify it by the number of teeth per inch of diameter of the pitch circle. Thus a 7½ in. wheel with 60 teeth is 8-pitch. So is a 1-in. pinion with eight leaves. The wheels in the Thomas clock are 8-pitch.

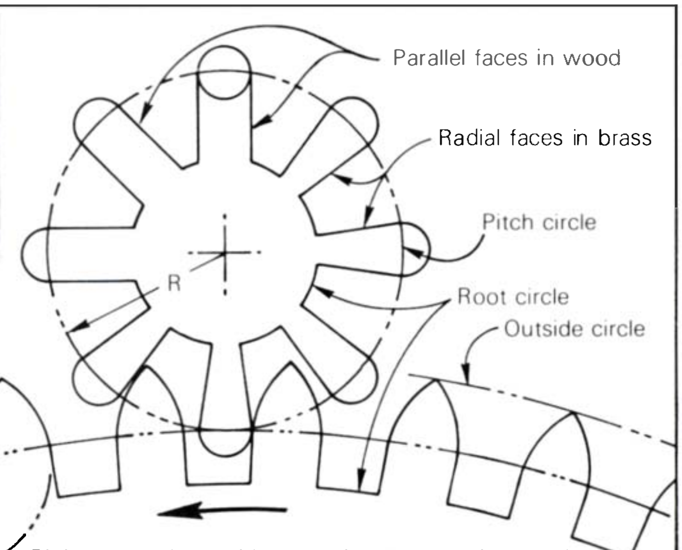
The Thomas clock uses the type of gears engineers use to transmit power. The teeth of the wheels and pinions have the shape of involute curves. Historically, clockmakers settled upon cycloidal teeth, a shape that is easier to make and equally efficient, since a clock doesn't transmit great amounts of torque. Cycloids generated by circles come in pairs, and one pair matches a straight line with an epicycloid that is so close to circular that the difference doesn't matter. The mating teeth are shaped as in the diagram below. When they are made of brass, the faces of the pinion leaves are radial; when made of wood, they are made parallel. The small circle that defines the profile of the wheel teeth is half the diameter of the pinion's pitch circle, and the arc is struck from midway between two teeth, on the pitch circle of the wheel.

While it would be convenient to design pinions with very few leaves, the practical lower limit is eight. This is because friction is markedly higher when gears begin to interact before the meshing teeth pass an imaginary line connecting the center of the wheel and pinion, compared to when they mesh after this line. With a pinion of fewer than eight teeth, the interaction begins before the line of centers; with eight, at the line; with more than eight, after the line. The situation is improved with the lantern pinion—even with as few as six pins, the action begins well after the line of centers. A lantern pinion will mesh well enough with both cycloidal and involute wheels, and also with tinker-toy style teeth made of dowel.

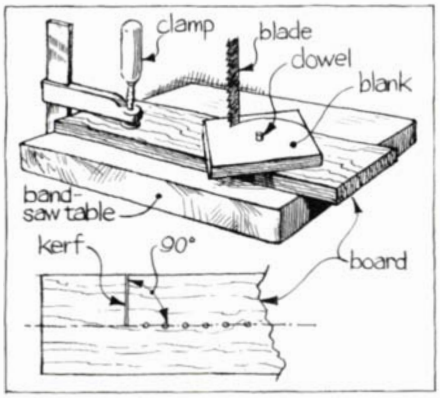
Wheel construction

Most woodworking shops aren't equipped for the specifics of gear cutting, so it becomes necessary to invent. An index wheel is the handiest tool, in

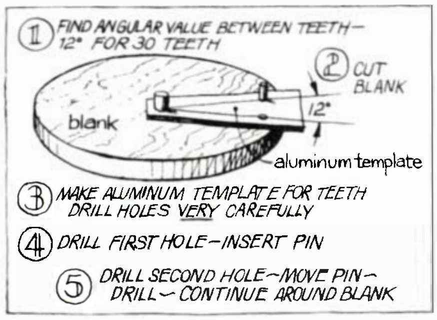
M. C. Hall's wood pinion



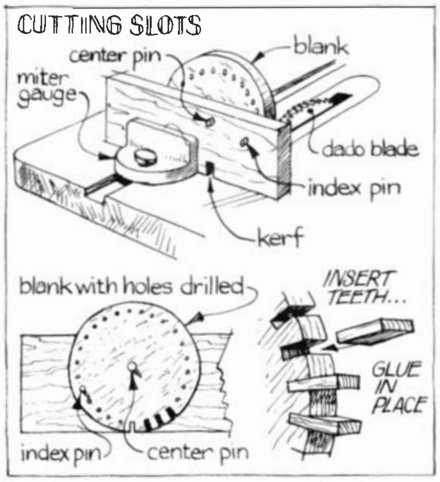
Pinion and wheel with approximately cycloidal teeth.



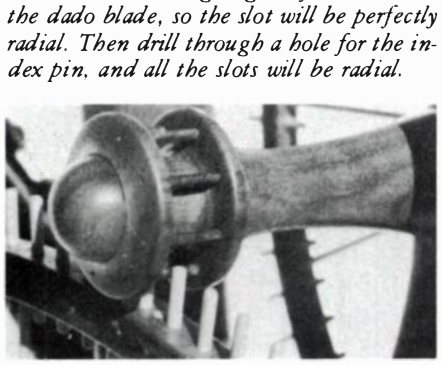
A piece of plywood can quickly become a circle-cutting jig for the band saw. Space holes for a dummy arbor along a line perpendicular to the blade. Carefully adjust guides, rotate blank into the blade.



An aluminum or brass template, carefully made, will space holes around a blank.



Use the table saw to turn the holes into slots. The trick is aligning the first hole with the dado blade, so the slot will be perfectly radial. Then drill through a hole for the index pin, and all the slots will be radial.



Lantern pinion from Lawrence Hunter's 'Clock IV' engages pin wheel laminated of seven veneer layers, five of them running around the rim and two running crosswise.

terms of accuracy gained and time saved, but it is rarely available. Fortunately there are ready substitutes. I urge constant surveillance of junkyards and scrap machinery for any gears of reasonable size and some number of teeth which will divide into usable numbers and provide a pattern for tracing. Two of the best to own have 60 teeth and 96 teeth. Between them they yield 2, 3, 4, 5, 6, 8, 10, 12, 15, 20, 24, 30, 32, and 48 teeth. The next best alternative is a protractor and an adjustable triangle.

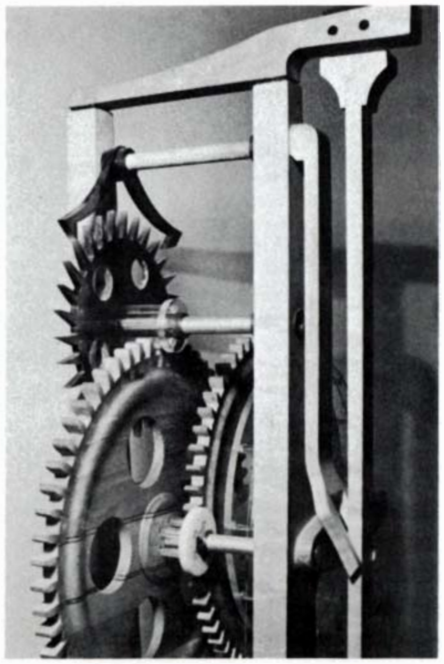
Another home remedy is a jig for cutting round wheel blanks, as in the diagram at left. Much cut and try goes into clockwork and the ability to generate wheels easily and quickly is a big help. With well-adjusted saw guides, a sharp blade and care in alignment, this jig will deliver a very accurate blank.

There are several alternatives regarding the actual fabrication of clock wheels. At its most basic, a wheel is no more than a single, solid disc of wood with teeth cut into its circumference. The easiest way to make one is to draw a full-size paper pattern, glue it onto the wood, and cut around the profile with a jigsaw, band saw or coping saw. The problem with this type of wheel is seasonal movement of the wood, short-grain fragility and difficulty of replacing a broken tooth in case of disaster.

As a hedge against the wood's tendency to warp with the weather, I laminate wheels of several narrow strips, or of pie-shaped wedges. I usually mismatch each strip with respect to the next according to the annual rings; veneers can be inserted between pieces for further visual interest. I've seen wheels cut of birch plywood, very stable.

I use inserted teeth because if one becomes damaged, it can be replaced singly. This necessitates sawing a series of radial slots in the rim of the wheel. I do this by first drilling a ring of properly spaced holes, using the template shown in the diagram. If the template layout and initial drilling are not absolutely accurate, the last hole will have a very strange relationship to the first. But the job can be done with care.

Thus far we have a set of holes evenly spaced around the wheel. We could press dowels into them and use them as pin wheels, which also allows interesting variations such as right-angle drives. To cut the holes into slots to accept inserted teeth, I use the table-saw



Close-up of author's clock shows laminated wheel construction with inset teeth and lantern pinions. Crutch is bandsawn from laminated veneers, pendulum rod is bird's-eye maple, suspension is a piece of leather caught in a saw kerf.

jig shown in the diagram. The difficult part comes only once, in aligning the blade with the first hole to be cut. Once this position is ascertained the locating pin is fixed and the rest of the slots follow like clockwork.

Such a simple jig is bound to chip the wood as the blade exits, but I find chipping minimal and anyway it is later negated by turning each wheel on a lathe. I do this both for esthetic reasons and to reduce the weight of the train. The result is a flat-bottomed radial slot ready for the inset tooth. I thickness a straight board and rip it to width, then slice the teeth to length and glue them in place. Once mounted, I file the faces of each tooth by hand to a close fit.

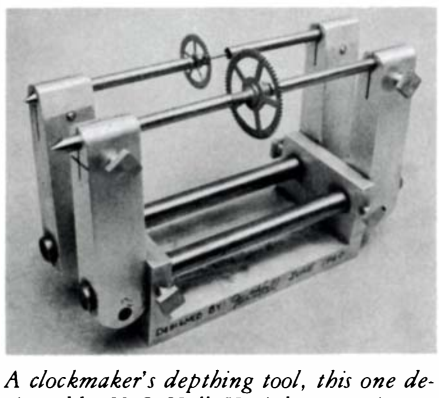
Pinions can be made just like small wheels, of solid or laminated wood. But they are tricky and I prefer the lantern pinion. It consists of two circular plates of wood, plastic or metal, with the necessary number of holes spaced around the pitch diameter. Leaves are simply short lengths of dowel or acrylic rod pressed into the holes. One of the circular plates can be eliminated and its holes drilled directly into the wheel.

The distance between centers of two mating gears ought to be the sum of the radii of their pitch circles. In practice, this is a good place to start. But it is best to put each pair of wheel and pinion on dummy arbors and adjust the distance until they turn most freely.

Most clock problems come from improperly depthed wheels. There must always be some clearance between the outside diameter and root diameter of mating wheels, and enough clearance between tooth faces to allow a little backlash. The remedies usually involve careful sanding. A stick the shape of the space between two teeth, with sandpaper glued to it, is a useful file. Sometimes the sanding goes too far and a tooth must be built up with a slip of veneer, or be replaced.

I've used dowel for the arbors on which the wheels ride, and I've turned my own dowel to try and avoid warping and swelling. But dowel vacillates between squeaky tight in the bushings to such looseness that the clock becomes a locked-up woodpile. I therefore switched to aluminum—I like the juxtaposition of color and texture, and it just plain works. However, many makers find dowel entirely satisfactory.

The arbors turn in bushings in the frame that keeps the clock together. The Thomas clock doesn't use bushings, merely countersunk holes lubricated with graphite to keep friction down. Others drill oversize holes and press bearings into them. In my effort to maintain high tolerances, I machined bushings of a very dense and stable monomer-impregnated maple. It is made by putting the wood in a vacuum to remove the air from the cells, then flooding it with plastic resin, which fills the voids in the wood and hardens. I machined the bushings several thousandths of an inch oversize and pressed them into the frames. They probably aren't necessary.



A clockmaker's depthing tool, this one designed by M.C. Hall. Upright arms pivot at baseplate, allowing large wheel (foreground) to mesh with pinion (concealed by smaller wheel). When teeth mesh perfectly, points (left) may be used to strike arcs, on which arbor centers must lie.

Once I've settled the layout of the holes, I tape the front and back frame pieces together and clamp them to the drill-press table. I drill one hole most of the way through, then turn the whole thing over and come back the other way, to avoid a bad chip-out. Then I press in a bushing or a dummy arbor and proceed to the next hole.

Because I want to emphasize the personal nature of design, I won't dwell on the details of the frame. It can be full front and back plates, or very skeletal supports just where they are needed for the wheel arbors, as long as they are absolutely rigid and parallel.

A ratchet-and-pawl system is the most direct way to wind up the weight and couple it to the wheelwork, as in the diagram below. The pawls may be attached directly to the center wheel, as in the Thomas clock, and the weight suspended by a pulley system to increase the time between windings. Or the pulleys may be eliminated by fixing the pawls to a separate great wheel, coupled by a pinion to the center wheel.

As the weight drum is wound up (by hand in my clock, but most use a couple more wheels and a key), the pawls back over the ratchet. When the weight is fully wound, the pawls move forward and engage the ratchet. I chose not to display the weight and so hung it from a fine cable inside the base of the clock. You may want it to be an integral part of the design. I've used a 7-Up can full of lead—since it is hidden, its lack of charm is not noticed. After the clock is running, tinkering and wear will eliminate some friction, and the beast will of its own accord run more easily and require less weight. I suggest avoiding cast lead weights and using a container full of sand, lead shot or ball bearings—some easily divisible material. □

Further Reading

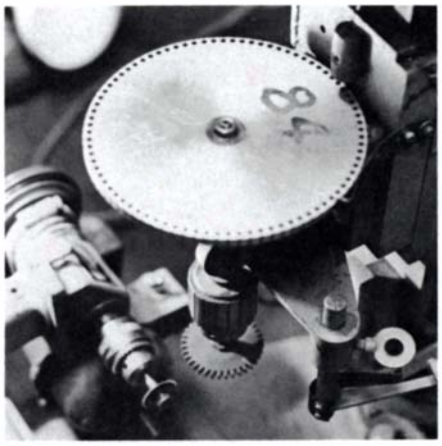
[Editor's note: Of the four books listed, only Britten's is still in print. For the others, check libraries and used bookstores.]

Britten, Frederick James, *Old Clocks and Watches and Their Makers.* 8th edition. Edited by Cecil Clutton et al. New York: E.P. Dutton, 1973, $40. The 7th edition, published in 1956, is more complete.

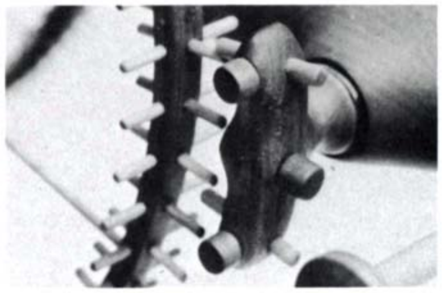
Gordon, G.F.C., *Clockmaking, Past and Present.* 2nd edition. London: Technical Press, 1949.

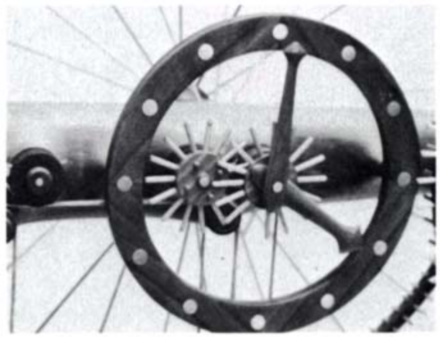
Grimthorpe, Edmund Beckett, *Rudimentary Treatise on Clocks and Watches and Bells.* London: J. Weale, 1850.

Milham, Willis I., *Time and Timekeepers.* New York: Macmillan, 1923.

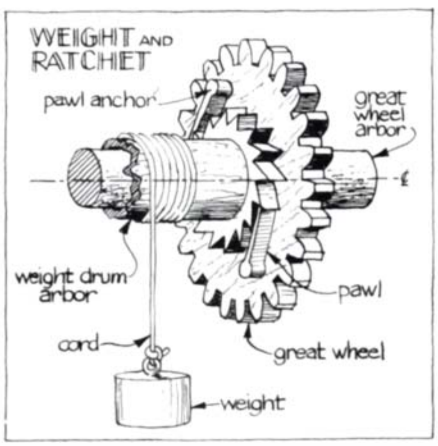


Wheel-cutting machine designed and built by M.C. Hall is indexed by interchangeable aluminum wheels mounted on the same shaft as chuck that holds the work. Assembly is lowered into saw-type cutter which is shaped to remove the space between two teeth at a single pass.





'Clock II' by Lawrence Hunter is regulated by dowel-pin escapement, above, with tinker-toy motion works, below.



Weights hang from pulleys on cord wrapped around arbor, and ratchet engages pawls on great wheel, which couples to time train via pinion on center wheel arbor. Or, pawls may be attached to center wheel itself.

Hammer Veneering

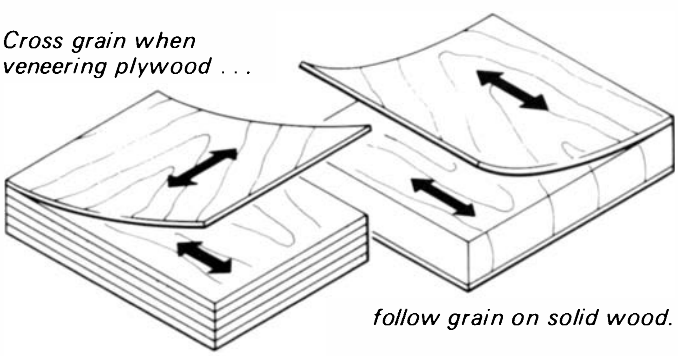
Veneer the whole world, without clamps

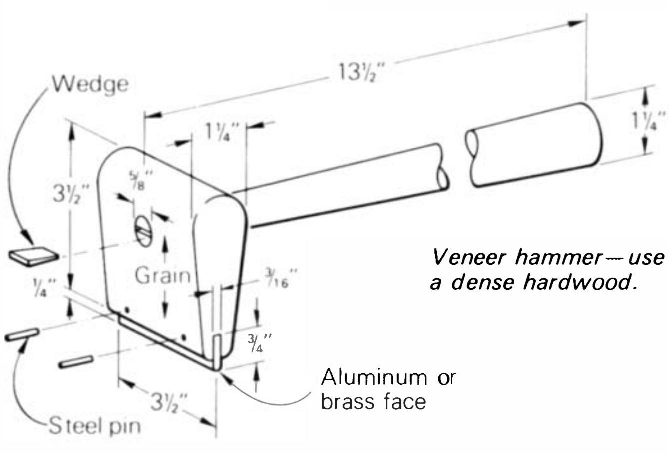
by Tage Frid

Hammer veneering is the old way of applying veneers to solid wood or to a plywood ground. The main tool is a veneer hammer, which is not used for hammering at all, but for applying pressure. The hammer has a very narrow face, so you can transmit the strength of your arms and the weight of your body to a tiny area of veneer. The veneer is held down by hot hide glue, which sticks as soon as it cools. You spread the hot glue on the ground surface and the veneer, then you use the hammer to squeeze it down tight before it cools. You can reheat the glue, and soften it, with an iron. Hammer veneering is usually the easiest way to fix old furniture with missing or broken veneers, or air bubbles under the veneers.

Hammer veneering is very fast to do, but the big advantage is that you don't need a veneer press or cauls or clamps. In regular methods of veneering, the size of the work is limited by the size of the veneer press or of the clamps. But with hammer veneering you could veneer the whole world if you wanted to. The same rules apply, however: When you veneer one side of a piece of wood, you have to veneer the other side too, or else the piece will be pulled concave toward the veneered side as the glue dries.

When veneering plywood, always cross the grain direction of the face veneer and of the ground layer. You can use some angle other than 90°, as long as the grain of the veneer and the grain of the top layer of plywood don't run parallel. If they are parallel, the veneer will crack later on. If your veneer is applied to solid wood, be sure the grain does run parallel so the two layers of wood can move together.





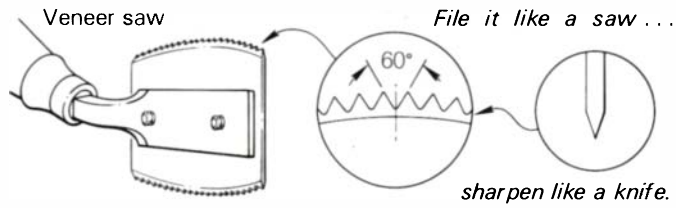
Veneer hammer—use a dense hardwood.

Equipment

You will need a veneer hammer, a veneer saw, a hot glue pot (or double boiler), animal glue, a brush and an iron.

Veneer hammers vary in design, but usually have a long handle and a hardwood wedge for a head, with an inset aluminum or brass strip, which is the working face. The face must be straight and about 3½ in. wide, with a rounded profile to squeeze the veneer along a thin line. If you make your own hammer, follow the dimensions in the sketch and use a hard, heavy wood such as maple. Don't use steel or iron for the face, because it would react with the tannic acid present in most woods and cause a stain. Before using a new hammer, soak it in raw linseed oil so the glue won't stick to it.

A veneer saw or knife is used to cut the veneer to size. It is called both a saw and a knife because it is filed as a saw and sharpened as a knife to make a smooth cut for edge-joining veneers. The curved blade of the saw is only about 3 in. long. Both sides of a veneer saw can be sharpened with a small triangular file. I file all the teeth at 90° to the surface of the blade, with no back or front, so that I can use the saw in either direction. This makes a slower but smoother cut.



After the teeth are filed sharp, the blade is sharpened so the cross section is like a knife, by rotating the saw along its curve against a stone. Hold the blade at a shallow angle, but be careful not to lose the points on the teeth.

A hot glue pot is a double boiler with a thermostat to prevent the glue from boiling. I don't use contact cement. I have seen too many failures, and it is just about impossible to repair. For large surfaces where veneers have to be edge-joined, contact cement could not be used. Contact cement has not been on the market very long, so nobody knows how long it will last. Hot glue is the oldest glue—it goes way back to the Egyptians. It is made from animal hides, bones and blood. It can be bought in dry sheets or as pearls. It must be soaked in water to soften it. Once it is soft, pour off any excess water. Then heat the glue in a glue pot or double boiler. Never put the pot directly on the heat source. It must always be over a pot of water. If hot glue boils it loses its strength, plus when it boils it doesn't smell like roses. When starting a new batch,

Tage Frid (the 'g' is silent, rhymes with 'hey, kid') teaches woodworking at Rhode Island School of Design in Providence.

melt the glue, let it cool and reheat it again and it will be ready to use. If the batch is already made up just heat it up and add water if it is too thick or let it heat for a while if it is too thin. Getting the right consistency is something you have to learn through experimenting. If the glue is hot all day its consistency changes constantly. If the consistency is right, the glue should drop from the brush like honey. You will know the glue is spoiled if it stays liquid after it cools.

To check that the glue is made correctly and is ready to use, put a drop between your fingers. Rub your fingers together, applying pressure. You should be able to squeeze out all the excess easily after about one minute if the room is around average temperature, 60° to 70° F. Your fingers should then start sticking together, because when hot glue gets cold it starts binding. The glue won't reach full strength until it dries completely, which takes about 24 hours.

Edge veneering

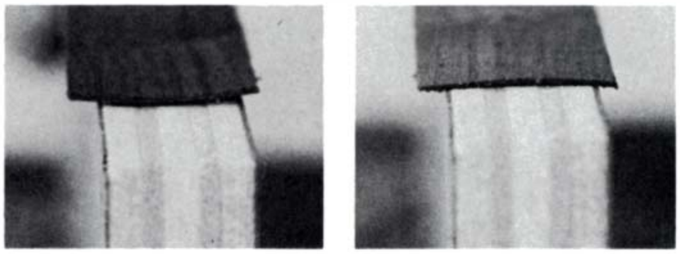
It is clumsy and time-consuming to veneer edges using clamps, but it is fast and easy to do it with the veneer hammer. It doesn't matter whether the edge is straight or curved. When you cut veneer, always have a flat piece of scrap wood underneath it to prevent cutting into the workbench, and use a straightedge to guide the saw. Cut strips of veneer only about ⅛ in. wider than the thickness of the work. If you cut them too wide, the excess sticking into the air will dry before the glue has cured and it will curl away from the wood.

When the veneer is cut, wet it on both sides to make it more flexible and also to see which way it naturally wants to arch. Glue it with the concave side toward the work, so the arch will keep it in place. If you do it the other way, it will be hard to keep the edges stuck down while the glue cures.

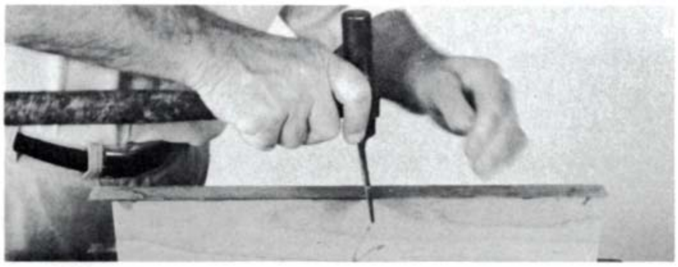
Begin by brushing glue onto the edge to be veneered, then turn the veneer over and lay what will be the outside surface right in the glue on the wood. Then brush glue onto the veneer. The glue that smears on the outside will help the hammer slide more easily. Later on you can scrape the veneer clean. Now flip the veneer over and hold it in place with one hand. Hot glue is very slippery. Hold the hammer in your other hand and press down hard to squeeze out the excess glue at one end. This will secure the veneer, and now you can put both hands on the hammer to squeeze out the excess glue all along the edge. You have to work fast to get all the veneer down while the glue is still hot. The minute the glue gets cold, the veneer will stick. Keep an old iron warmed up and handy. Then when you aren't fast enough, you can reheat the glue before going back with the hammer. Don't have the iron so hot that the glue burns, or you'll regret it. Burned glue makes an unpleasant stink that hangs around for a long time.

Use the veneer saw to clean off the extra glue and trim the veneer, while the glue is still soft. First dip the saw blade in hot water so it will be wet and warm and the glue won't stick to it. Then cut off the excess at both ends, holding the work up on an angle. After that, stand the work on edge and tilt it a little to apply pressure right at the corner, and saw off the excess veneer. Dip the blade in hot water after each cutting. Now put the piece aside to dry for about 24 hours.

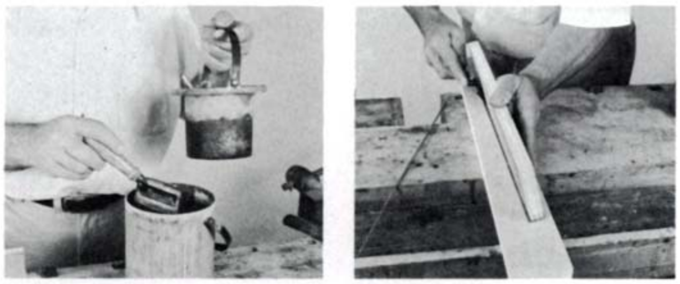
It doesn't make any difference if the edge is curved or some other shape. Veneer it exactly as if it were straight. But when the work isn't straight, you must wait until the glue is hard and dry to remove the excess veneer and squeezed-out glue. Then use a block plane or a smooth plane to clean it off.



Wet the veneer to see which way it curls, then glue the concave side down, right, so the arch will help hold it in place.



Use the veneer hammer to squeeze out the glue all along the edge.



When trimming veneer, keep the saw warm and wet by dipping it in the glue-pot water. Stand the work on edge and tilt it a little to apply pressure, then draw the saw along the face of the board.

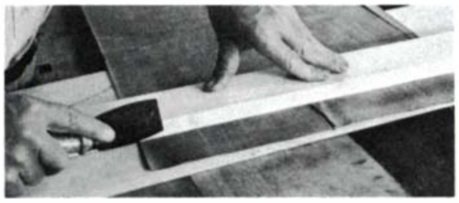
To trim a curved edge, let the glue dry hard, and plane.

Veneering large surfaces

To veneer a large surface, you will have to edge-join pieces of veneer either lengthwise or crosswise, or both. The edge joint must be very accurate. I ensure accuracy by overlapping the two pieces of veneer by about a half-inch at the joint, and after they are stuck down I cut through both pieces at the same time.

Begin by figuring out how you want the veneers to match and mark the location of each piece on the work. Then work on one section at a time. Wet the veneer and brush the hot glue onto the work. Place the moistened veneer upside down in the glue, exactly as when edge-veneering. Apply glue to the veneer itself, flip it over and put it in position, and use the hammer to secure it somewhere in the center.

Now use the warm iron to remelt the glue under a small section of the veneer. Push down with the veneer hammer as hard as you can, using the weight of your body, to squeeze out the excess glue. When that part is glued down, move to



Saw veneers to length with straightedge, backup board.

Lay veneer face down in glue. The glue that smears on it will help hammer slide easily.

With both sheets stuck and the seam trimmed, reheat with the iron and push hard with the hammer to squeeze the excess glue out through the line of the joint.

Lean your whole weight on the hammer, squeezing the glue toward the edges.

Saw through both veneers at once, carefully lift top sheet and peel away scrap beneath.

A hot iron remelts the glue in a troublesome spot. Then go over it with the hammer.

the next area. Heat the glue, press the veneer down, and proceed until the whole sheet is stuck tight. Work the hammer back and forth with the direction of the grain of the veneer, starting in the center of the width. But turn the face of the hammer at an angle so it will squeeze the excess glue toward the edges. Never work across the grain, as that would push the fibers apart and cause the veneer to crack when it dries.

Now apply glue to the next sheet of veneer and proceed in exactly the same way, making sure the edges to be joined overlap by about a half-inch. When they are both stuck, use a straightedge and a sharp, warm, wet veneer saw to cut through both sheets at once. Remove the scrap veneer from the top, then carefully lift up the top sheet and pull out the scrap from underneath. Then butt the edges together, heat with the iron, and push hard with the hammer to squeeze all the excess glue out through the line of the joint. When the joint is down tight, press a strip of heavy brown paper over the joint to prevent it from opening during drying. After the glue has dried, use a sharp scraper blade or a cabinet scraper to remove the paper and excess glue. But turn a heavier burr than normal on the blade (''The Scraper,'' Spring '77, p.29). A good seam should be invisible.

You must be sure there are no air bubbles under the veneer. If you can't find the bubbles when you push with the hammer, tap the surface lightly with your fingernail and listen for hollow spots. If you don't get these hollow spots glued down, they will eventually crack. The veneer I used for these photographs was very curly in one spot in the center, and it would not stay down. So I heated the area to melt the glue, covered it with brown paper, and clamped a block of wood over the curly place to hold it down tight while the glue cooled and dried. If you don't notice the air bubbles until several days or months later, just apply water, heat and pressure to work the piece down. The glue will still hold. □

Block and clamp hold curly spot down while glue cools; strip of heavy paper along seam keeps it closed until glue dries. Then a sharp scraper cleans off paper and glue.

Claw and Ball Feet

Where they came from

by Alastair A. Stair

The claw and ball foot, favored by 18th-century English and Colonial cabinetmakers, is a fascinating furniture ornament that has received little scholarly attention.

The derivation of the form is clear—a dragon's triple claw grasping a sacred, sometimes "flaming" jewel, usually a pearl, or a crystal ball. In Chinese mythology, this motif denotes the guarding of purity, integrity and wisdom from evil demons. It appears frequently on ancient Chinese bronzes and brocades, but the progress of its influence from the East through western Europe to England and its application from one artistic medium to another are not so apparent and imply a rich crosscurrent of influences.

The arts of China and Japan began to impinge on Europe in the Middle Ages, when the first imported specimens of porcelain excited the wonder of craftsmen and collectors. Europeans began trading formally with the Chinese with the establishment of a permanent settlement on Macao by the Portuguese in 1557. Portugal and Spain maintained a virtual monopoly on trade with the East Indies until the turn of the 17th century, when England and the Netherlands entered the trade. In 1588 in England, Packe published *The Historie of the Great and Mightie Kingdom of China* from the Spanish original, and several treatises on China and Japan followed. The East India Company was established in 1600 and its *Court Minutes* and accounts by travelers contain a considerable amount of information concerning the early trade in Eastern wares. Objects in the exotic style aroused widespread interest and admiration in Europe; by 1670 the taste for *chinoiserie* was strongly developed in France, and toward the end of the reign of Charles II (1660-1685) choice collections of Oriental curiosities began to appear.

Half-walnut ball on mahogany piecrust table allows greater stability. Cabriole legs curve close to ground. Lion clutches ball in Staffordshire pottery figure, c. 1800.

Rogers salt, 22 in. high.

These collections must have contained a goodly number of bronzes with claw and ball feet that served as prototypes for objects of English silver that appeared in the last quarter of the 16th century. Goldsmiths and silversmiths quickly became familiar with the new exotic ornamentation and reflected their admiration in their work. Some of the finest articles of London silver rested on claw and ball feet, as exemplified by a standing silver gilt salt, hallmarked for London, 1581, and the famed Rogers salt, hallmarked for 1601. Many Dutch and German immigrant silversmiths worked in Elizabethan England and they played an important role in promulgating this motif, inspired by objects Dutch navigators had brought home in the 16th century.

The claw and ball motif was soon applied in other metalwork. Goldsmiths and silversmiths work in the most precious and costly materials; hence, they are most often in the forefront of decorative experimentation. Craftsmen in other fields—textiles, glass, furniture—were exposed to the same pattern books from which metalworkers drew their ideas. The claw and ball foot found its way into the design books and became a stock ornament, freely used regardless of its original context. The element was slowly incorporated into the vocabulary of the cabinetmaker as an innovative and interesting

Regional Variations

New York: square, box-like foot.

Philadelphia: slightly flattened ball.

Newport: undercut claw and ball.

Boston and Salem: Side talons angle away from center to show more of ball beneath.

way to end the cabriole leg of a chair, table, stool or bureau.

Although the claw and ball foot was not taken directly from Oriental furniture pieces, many features of European chairs may well have been drawn from Oriental sources. Chinese chairs were brought home by European voyagers as objects of curiosity. The outline of the splat of the Queen Anne chair has been likened to the contours of Chinese vases.

18th-century armchair: Tense, exaggerated muscles of ankles and legs disappear at knee curvature.

The spooned effect of the splat on the Queen Anne chair was used on Chinese chairs dating at least 150 years before the reign of Queen Anne (1702-1714). The cabriole leg, another naturalistic form compared to the leg of a leaping goat, may be of Chinese derivation as well. Ball and claw feet did not actually appear on Chinese furniture until the mid-to-late 19th century, when it began to be made for the Western market—an example of reverse influence.

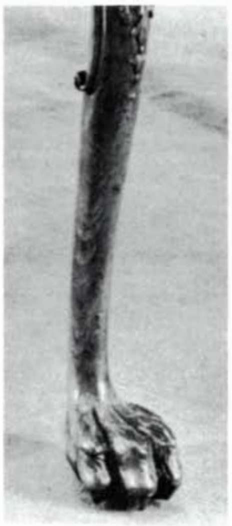
Naturalistic forms have always retained an inherent appeal for the English. For craftsmen in all the arts the exotic birds, animals, sea creatures and flowers that riot over their creations were part of the Elizabethan concept of an ordered world and the dance of life and death. The lion, eagle and oak tree in particular passed into the tradition of English thought and when a silversmith or a cabinetmaker designed an object to please his patron, his themes included the finest flowers, the rarest fruit and the noblest beasts and birds. The claw and ball foot was a worthy addition to this repertoire of ornamentation, and it was natural for the English craftsman to translate the paw of the Chinese dragon into a bird's talons.

The claw and ball foot became quite popular in England around 1710, reached its apex in the reign of George I (1714-1727) and continued through the reign of George II to c. 1750. The style is often mistakenly considered an invention of Thomas Chippendale, although his *Director* (1754) contained no such designs; the vogue was outmoded and no longer eye-catching and had been replaced by scroll feet. The American Colonial craftsman, slower both to adapt and discontinue the fashionable London trends, continued to favor the claw and ball foot well into the end of the 18th century. In the last quarter of the 19th century, when American Colonial furniture enjoyed a revival, this foot treatment was revived, often cast in brass with the claw clutching a glass ball.

In the Colonies, the various ways in which the claw and ball foot was carved became a regional stamp and often a clue to the identification of the cabinetmaker. The use of the claw and ball was almost universal. In New York a large, squared, box-like foot was preferred, while in Philadelphia the claws firmly grasped a slightly flattened ball. The Boston and Salem cabinetmakers angled the side talons away from the center with much of the ball beneath showing through. The talented Goddard and Townsend families in Newport pro-

Tripod table: Long, relaxed paw suggests animal in repose.

Armchair: Tall ball has knobby knuckles.



Gate-leg table: hairy paw carved in relief.

Piecrust table: hairy paw without toenails.

Rectangular table: Toes hug square stock.

duced the undercut claw and ball, with openings carved through between the talons and the ball. This refinement was sometimes employed on the best pieces of English furniture in George II's reign, but was rarely attempted by Colonial cabinetmakers other than in Newport.

English examples also show a rich diversity of carving on the claw and ball foot, both in walnut and mahogany. These feet appear on a wide variety of furniture including wing chairs, side chairs and armchairs; dropleaf, tripod, tea, and console tables; stools, slant-top desks and bureau bookcases. The foot most frequently emulated by New York cabinetmakers is one in which a bird's claw firmly grasps a heavy, square-shaped ball. Just as the dragon's paw symbolized the power of the Chinese emperor, the eagle's claw indicated the social importance of the cabinetmaker's patron. Three claws are stretched across the front and a fourth, and shorter, claw clutches the rear. Varying degrees of tension are expressed in the ankle and the leg, sometimes shown in the muscles right up to the knee curvature. Sometimes a ringlet is carved in relief just above the ankle. For greater realism long talons were often added, and webbing carved between the claws. When both characteristics appear the effect can be striking, almost disquieting. The combined effect of a curved leg, seemingly preparing to leap, and a clutching claw with tension expressed in the muscles can be most realistic.

Many carvers added a ringlet in relief just above ankle, as in this 18th-century upholstered stool.

Long talons and webbing.

In England the lion represents authority, and many feet look more like paws than bird claws. In many cases the claws are set so close together that the ball is not visible. The claws multiply—often five and six are carved tightly together. The carving of the paw is quite often highly naturalistic, with hairs shown in relief (commonly known as "hairy-paw" feet), long toenails or a series of nodules running along the claws. Sometimes the paws are elongated, rather drooping and without tension, like an animal in repose.

On tripod tables, the ball is altered to improve stability and balance on uneven floors. The ball, referred to as "half-walnut," is more squat and sometimes cut in half. In these instances the cabriole leg curves in closer to the ground and eliminates space for the fourth claw.

About 1755, when English cabinetmakers had exhausted the multitudinous ways in which to carve the claw and ball, they turned to other styles, including the scroll toe, a tapering leg terminating in a spade foot and various turned feet. Variations on the paw foot with ball and a hoofed foot with ball reappeared briefly during the Regency (1811-1820) when they were often gilded, with the ball barely visible beneath the closed paw. □

Some of the antique furniture sold at Alastair Stair's gallery in New York City has claw and ball feet.

Ball and Claw Feet

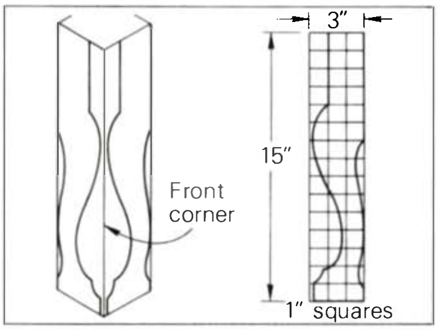
How to carve them

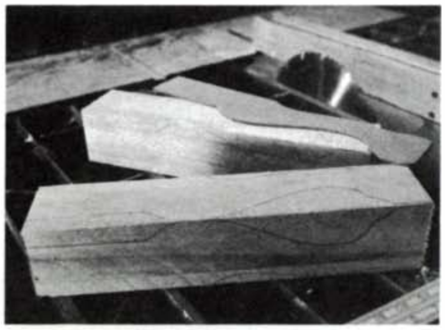
by A. W. Marlow

When combined with a cabriole leg, the ball and claw foot is a well-known furniture support dating back to ancient times. The industrial version is hardly recognizable—reason enough for every interested craftsman to develop his own.

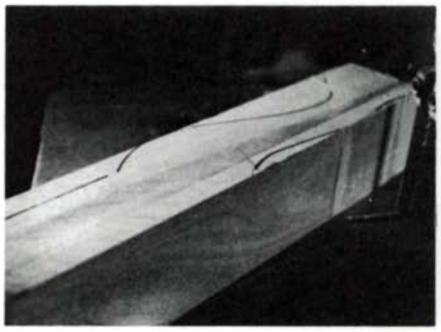
Few amateurs are satisfied with their ball and claw carvings. To illustrate the process, I've chosen cabriole legs with ball and claw feet made for a wing chair. To many craftsmen, shaping cabriole legs is an uncertain process, but this step-by-step procedure should be simple to follow. The ball and claw foot on a tripod table requires the same basic carving cuts, but the claw placement is different—the claws come in over the ball horizontally for a more natural look.

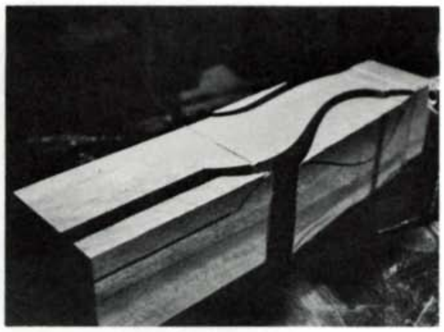
1 The average blank size for a cabriole leg, regardless of length, is 2¾ in. by 2¾ in. To make a pattern, follow the line drawing, which is laid out in 1-in. squares. Place the pattern on a blank, as shown in the drawing and the photo at right. Keep the front knee curve toward the right-angled front corner and outline in pencil.



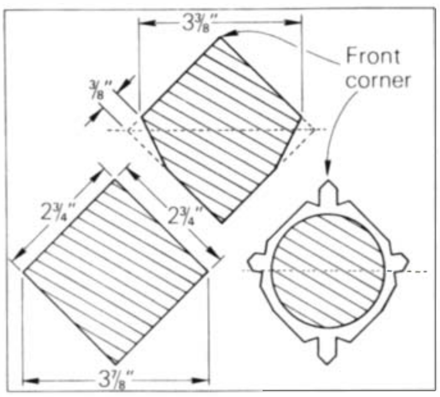


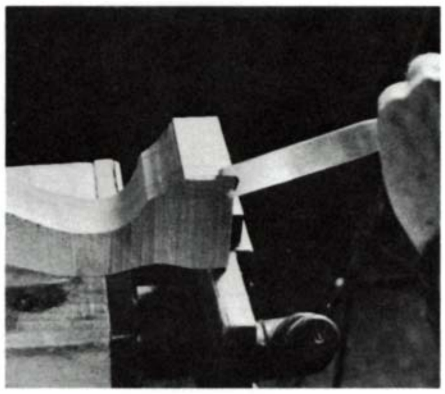
2 Shaping a cabriole leg can be quite simple when done on a band saw. Saw the first surface as shown at right, ending the cut before the waste piece is completely severed. This keeps the second or right-angled surface in place for the second cut. After the second cut has been made, turn the block back to the first surface and finish sawing the short, uncut portions of each curve.



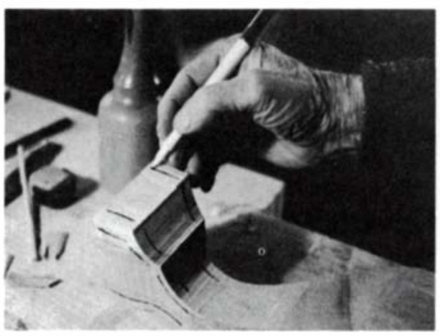


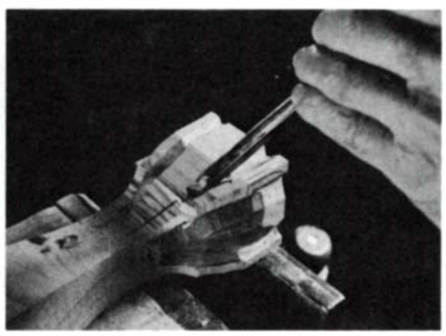
3 The next step is physically a minor one, but of major importance. Without it, the side claws look like wings sticking out. The line drawing shows three full bottom views of a leg as it is shaped. The first view shows the leg as it comes from the band saw. In the center drawing, a ⅜-in. wedge has been removed from each side claw to lessen the total width and give a more pleasing and realistic appearance to the finished foot. In the photo, a ¾-in. #3 gouge is used to chip away the wedge of wood. The third drawing adds the contour of the ball and the veiner cuts made in the next step.

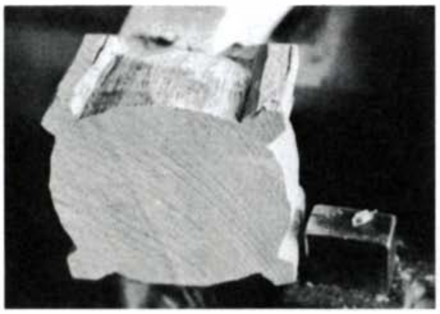
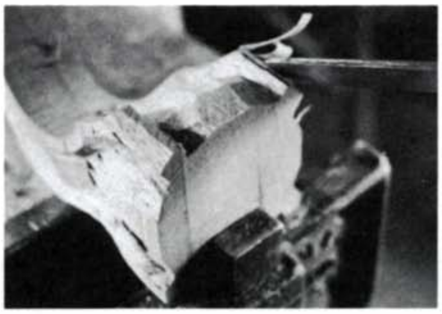
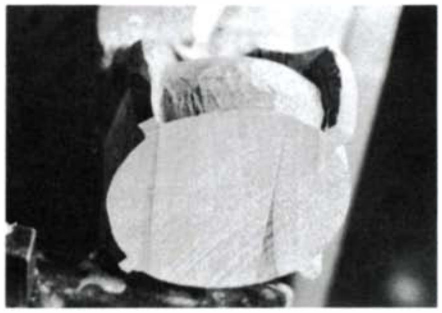




4 Now hold a pencil or ball-point pen as shown in the photo at right. Using your middle finger as a bearing against the wood, mark each side of each corner about ¼ in. in from the edge. These are the guide lines to follow when roughly positioning the claws with a ⅜-in. #41 veining tool. Continue the V-cuts into the angle area (as in the photo at far right), gradually lessening them in depth. If these feet are being cut in mahogany or walnut, you'll need a mallet to cut the rough V's.





5 The next step is to shape the ball and claws. In the first photo the claws of the foot have been narrowed closer to the finished width and the ball has been cut about halfway between rough and finished condition. When cutting the ball, check frequently to see that it is reasonably round, because if any adjustment must be made, the depth of the claws must follow the ball radius. Up to this point, the claws still retain the original band-saw outline and must be trimmed down to an average height of 1/4 in. In the center photo the #3 gouge is used to trim the claws. Front and back claws will need more trimming than the sides, and the knuckles, of course, will peak above the connecting bones.

In the last photo the ball of the foot has been smoothed down to finished size and radius. Also, the claws are another step closer to finished shape, leaving only the work of rounding bones and knuckles. The back claw follows the ball contour until it reaches the apparent knuckle immediately above the cuticle and nail.

6 The foot in the photo at right shows real promise of what to expect after a little more work. Take time to carefully round the claws from the ankle down to the knuckle above the cuticle. Now check the length of the nails. This dimension is not crucial, but shoot for 1/2 in. from the bottom up to the cuticle where they will be about 1/4 in. wide by 1/4 in. high. Before forming the nail, use a medium-width #7 gouge to press cross-grain over the top for a clean-cut cuticle, shown on the extreme right. Down the sides, instead of continuing to use the #7, choose a medium-width #3 gouge and press to clean-cut the full cuticle. Reduce the nail size so the cuticle appears to overlap the nail and taper the nail to about 1/8 in. by 1/8 in. at the bottom.

Study the lower side claw in the photo. Yours should now look like this except for the slightly rounded depression between cuticle and knuckle. That slight curve must be made carefully, first from the knuckle down, then from the cuticle upward, still using the #3 gouge.

After nail cutting, pencil in the web curve. As shown in the photo, the arc starts and ends just above the lower knuckles, although the placement is not critical. Some carvers of old felt that the web should start halfway between the knuckles.

Forming the web is a repeat performance of cuticle cutting. A #4 gouge about 1/2 in. wide should be close to the needed radius. Because of the larger area, tap the gouge with a mallet for a clean parting cut. Make tapered shaving cuts with a #3 gouge in the area of the web line to raise the web about 1/16 in. above the ball. Look at and feel the ball for any bumps that should be removed or any adjustments in contour that would improve its appearance.

7 So far, carving has ended at the ankle. Use a spokeshave to round the leg corners. Start at nothing where the curve swings into a wing block, to be attached later. Increase the radius as the tool descends, ending at the ankle in a near round. Round the high point of all knuckles.

Sanding may be done thoroughly, or slightly, leaving some tool marks. A smooth-looking job calls for a first sanding with 80-grit garnet paper followed by 120 grit. Wear rubber gloves to protect your finger tips and nails. If carving is planned for the knee, sand only to above the ankle. Should the knee be plain, sand to it now.


8 Infinitely varied foliage patterns are used on the knee for decoration. Lay flexible pattern board over the knee surface and outline the curves on the board as shown at right. Then pencil in your choice of design for carving. The photo at far right shows what to strive for. □


Andy Marlow, 74, a consulting editor for Fine Woodworking, *designs and makes traditional furniture in York, Pa.*

Block-Front Transformed

Contemporary designer tackles 18th-century theme

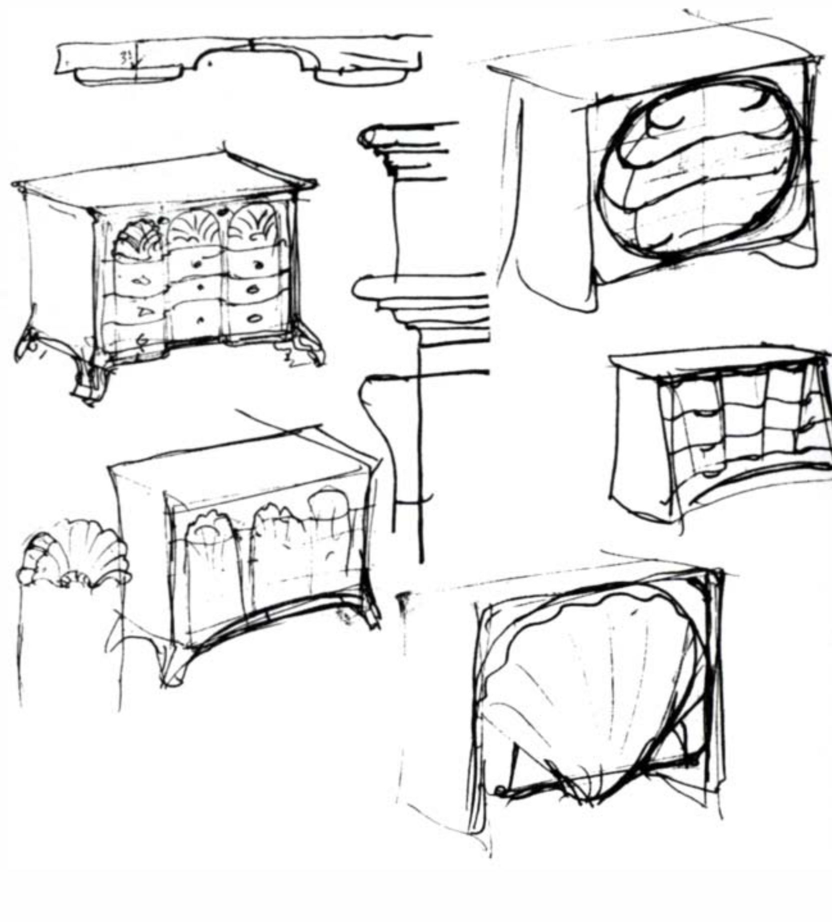
by Morris J. Sheppard

As a furniture maker I have long admired the work of our predecessors in this craft, which I feel is only now emerging from a state of decline. Most current work rarely reaches the levels of refinement, taste, elegance and sophistication that were regularly achieved until the early part of this century.Therefore, when the organizers of the 1976 California Design show notified prospective exhibitors that they were seeking works on a bicentennial theme, I decided to try to translate some of those early values directly into contemporary forms. I chose to do a piece based on a meticulously crafted four-drawer block-front chest, built in the 1760s by Edmund Townsend of the famous Goddard-Townsend workshops in Newport, R.I. The surface of the front is divided vertically into three sections, or blocks, with the outside two protruding and the inner receding; the total difference in depth is about 2½ in. The blocks are surmounted with stylized scallop-shell carvings, also with the outer ones curving positively and the inner one negatively. There is a line of molding under the top and the drawer fronts are outlined with bead molding. Bracket feet give a delightful stability to the whole. In perfect visual balance, it is far from plain or simple, yet equally far from gaudy or ostentatious.

I decided that my piece would be a four-drawer chest of the same wood, size and proportion as the block-front. Since the so-called San Domingo or Cuban mahogany is no longer available, I would use Honduras mahogany. My chest would have the same type of color and finish (potash salts for color and French polish). I also wished to incorporate the characteristic in-and-out undulations of the block-front and, if possible, the scallop-shell motif, although my carving is generally more abstract.

I always start with a sketch, so I started sketching. And sketching. After several dozen drawings—often just jotting down an idea in 5 or 10 minutes—I had no satisfactory solutions. The next day I saw that I was just drawing modernized versions of an old chest—this would not do. At this impasse, it seemed that a long walk along the beach was in order. On the beach at the bottom of my hill, I saw seashells, which inspired the Goddards, and fabulous formations where great upheaved and folded strata of rock have been exposed by the ceaseless erosion of the ocean.

Back in the studio, I looked again at the photograph of the Townsend chest. What was so appealing? The harmonious relationships between the volumes, the elegant use of linear and sculptural elements such as the carvings, the lines and shadows of the moldings and the flare of the bracket feet that gives it just the right stance. More than any particular form, it was these elusive feelings that I wanted to capture. At the drawing board I began to combine them with the modes I had been working in, such as dovetail case construction, conoid and hyperparaboloid surfaces, and the feelings I get from exploring the forms of nature. Thus, in my sketches the



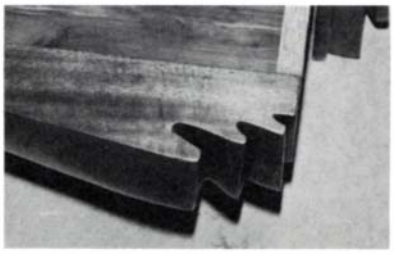
The Townsend block-front, from the Boston Museum of Fine Arts Karolik collection. Left, author's sketches evolve from abrupt volume changes and explicit shell motif to flowing final form.

abrupt volume changes of the block-front became flowing. The feet still flared outward but merged with the sides. The idea of layers like rock strata emerged to provide the shadow detail and the linearity of molding to relieve what can be the boring plainness of a simple edge and lighten up the mass of the 8/4-stock case sides. Finally a design coalesced and a drawing was developed. It was still vague on many carving details but, of necessity, set in terms of construction.

For this chest, I made a scale drawing. Small drawings are easier to handle and full-size views of individual components can always be drawn if needed. Full-size drawings are useful for a chair or other piece where the curves are critical.

The next step was to leave the two-dimensional world of the drawing board and enter the three-dimensional one of the wood itself. I made the case of three pieces of glued-up 8/4 stock, with two pieces of 12/4 stock glued to the front four inches of the sides to allow for the flare of the "feet." These were through-dovetailed together, with frame-and-panel dividers stop-rabbetted in for the drawer runners. At the bottom of the back a 2x2 brace was dovetailed into the sides, its top flush with the lowest panel. A mahogany plywood back floats in a dado cut into the bottom brace, top and sides. The whole was assembled in one operation. Next, I glued up the 4-in. boards for the drawer fronts. It is here, in the wood, that the ultimate design occurs. It is not only probably impossible, but also pointless, to draw a complex form on paper. As our eyes travel around an object, we perceive an infinite number of varying views of it. To "work" as form, the piece must be right from every viewpoint. Drawing one, two, or even ten viewpoints will be unsatisfactory and take a lot of time as well. We must see it in the solid and draw directly in three dimensions. So I began to carve.

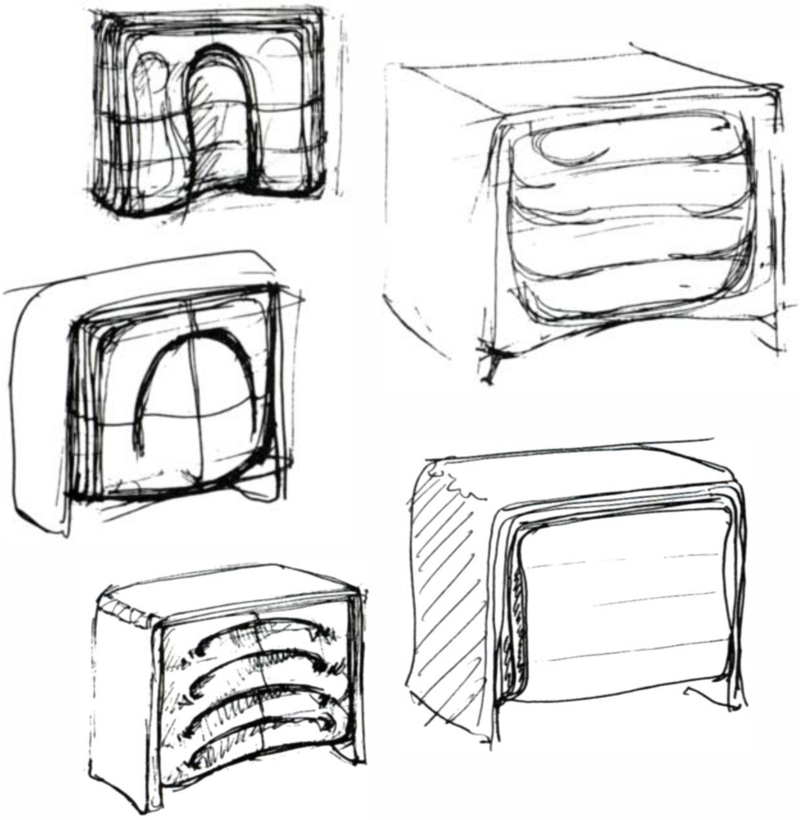
As I worked with a disc grinder, die grinder, gouge and mallet the forms began to emerge. The important thing here is constant critical re-evaluation. I had already decided to combine the handles into the form by making deep undercuts between the layers to serve as pulls. Looking at the blanked-out form I realized that I could both increase the sense of function of the pull and integrate the scallop-shell motif of my original inspiration by undulating the layers. This was my last major design decision. From that point on, it became a process of refinement—making the forms most satisfactorily express the forces that evolved them and bringing each line and volume into pleasing relationship, proper fullness or tautness, flow, tension and weight. One might write lots of words about this process but in the end it remains almost wholly subjective. Results will always reflect the inclinations and sensitivities of the individual craftsman.

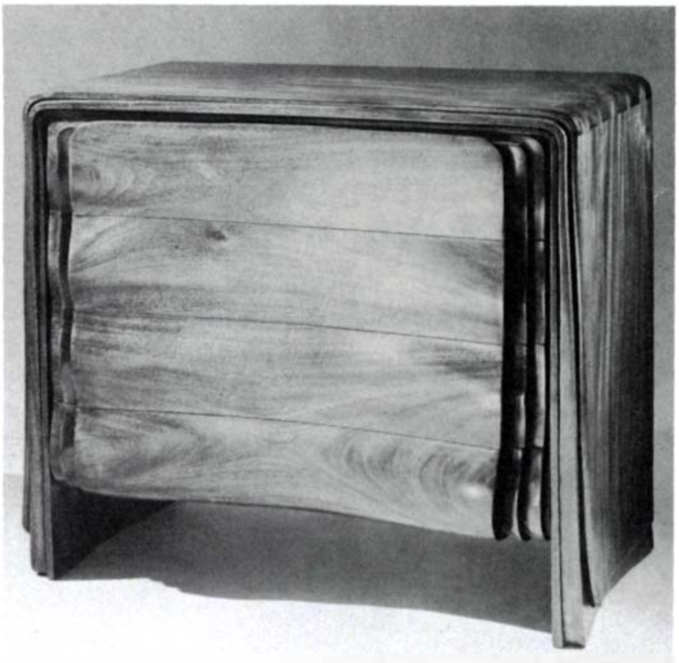



Detail, left, shows deep undercut 'pulls' on bottom drawer, seen from above. Right, drawer sides undulate.

In a sense I had finished. What remained was merely the mechanical work of cutting up the drawer fronts from the sculptured piece, dovetailing and assembling the drawers and sanding, staining and French-polishing. I had traveled a long way from my original inspiration, but it was really a process of evolution. The best designs seem always to be that: They are based on the past, yet different from it; they capture some of its essence, yet maintain their own personality, and with luck, they are a springboard for what is yet to come. □

Morris J. Sheppard, 31, is a professional furniture maker. He recently moved his studios from Big Sur to Los Angeles.





Sheppard's version of the Townsend chest: Scallop shells are reduced to undulating layers, feet flare and merge with sides. Wavy figure of drawer fronts suggests ocean.

Hot-Pipe Bending

Coordination, concentration and practice ensure success

by William R. Cumpiano

Bending guitar sides on a hot pipe is the most dramatic and challenging of all instrument-making techniques. All your senses come into play in the "dance" in front of the bending iron. You feel the intense heat radiating onto your face and chest. You can smell the sweet aroma of hot wood and the quite different odor of a singed surface. You hear the creaking sound of straining wood fibers, and the change in sound that tells you the wood is about to break. In hot-pipe bending, one hand moves a thin, wet piece of wood over a hot pipe in short hops, while the other hand pushes down on the heated wood to bend it. The operation is tricky and requires coordination, concentration and practice. There is nothing quite as heart-stopping as watching a select Brazilian rosewood guitar side, with $10 market value, turn in an instant into scrap—accompanied, of course, by its unbent matching side.

Not surprisingly, many professional hand-builders resort to various molds and hydraulic/electric devices to circumvent hand-bending. But such devices limit their production to one or two body shapes. Those who have mastered the technique of hand-bending can custom-bend to the purchaser's specifications. One might also bend sides for boxes and trays, or to create sculpture.

The first step is to make a template of the curve to be bent. Stiff paper is fine for making other templates or for keeping a record of different body shapes, but for bending, something more durable and stiffer is needed. Tempered Masonite ⅛ in. thick is adequate; it does not get wrinkled and soggy when wet. The ideal material, albeit expensive, is 1/16-in. aluminum sheet. Score the outline from the paper original onto the aluminum. After cutting as close to the line as possible with a tinner's snips, mill-file to the scored line.

William Cumpiano makes and repairs guitars in North Adams, Mass.

Study the template. Your success at capturing the outline in the bent wood depends on your familiarity with its shape. The two types of curves found most commonly are "fair" curves (sections of a circle) and accented curves. An accented curve is one that seems to have the force of a point straining to push it outwards. A fair curve has no accent. Mentally subdividing the template into straight-line segments, fair curves and accented curves will help you during bending.

Even with ideal facilities and the best guidance, your efforts will come to naught with poorly selected side blanks. Textbook-perfect side blank material is flawlessly quartersawn wood of perfectly even and homogenous consistency. Such material is indeed difficult to break accidentally. On the finished instrument it is superior for its stability and its ease of repair. But perfect side blanks are rare and one must often compromise. My criteria vary with the species. Maple can be used even if not well quartersawn, providing it is soaked a short time, because it is extremely tough and flexible in thin sheets. However, curly maple must be flawlessly surfaced, lest a small chip or dig allow a crack to start. Mahogany is the most forgiving of all: I select primarily for appearance and homogeneity. However, failure can occur along sap lines and pieces containing them must be avoided.

Because rosewood is often brittle, vitreous and non-uniform, it must be selected with the most care of all. What may appear to be fine, even material may actually hide long, fine cracks that render it useless. Gently flex and probe the entire

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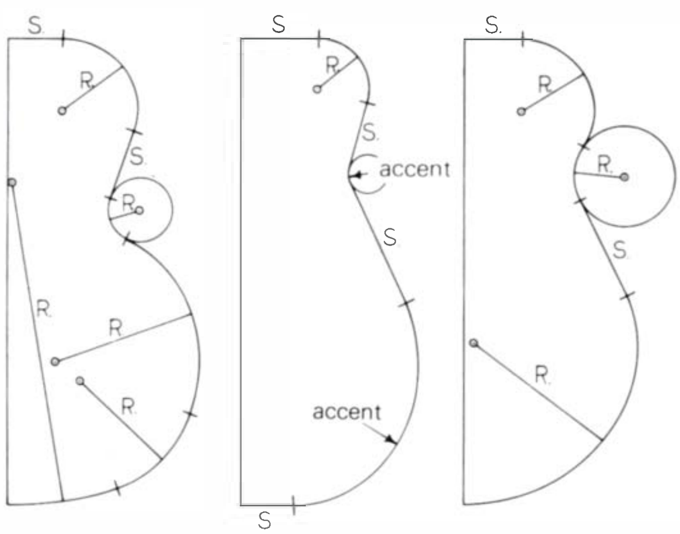
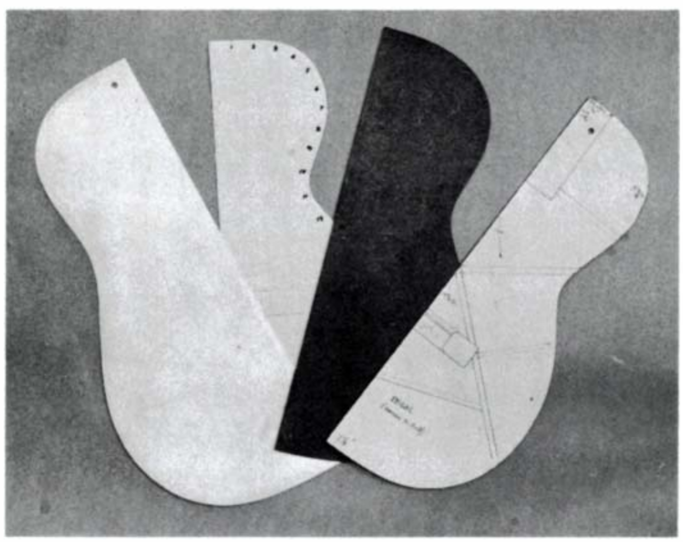


Typical guitar profiles include straight-line segments (S), fair curves, or sections of a circle (R indicates a radius to an imaginary center), and accented curves.



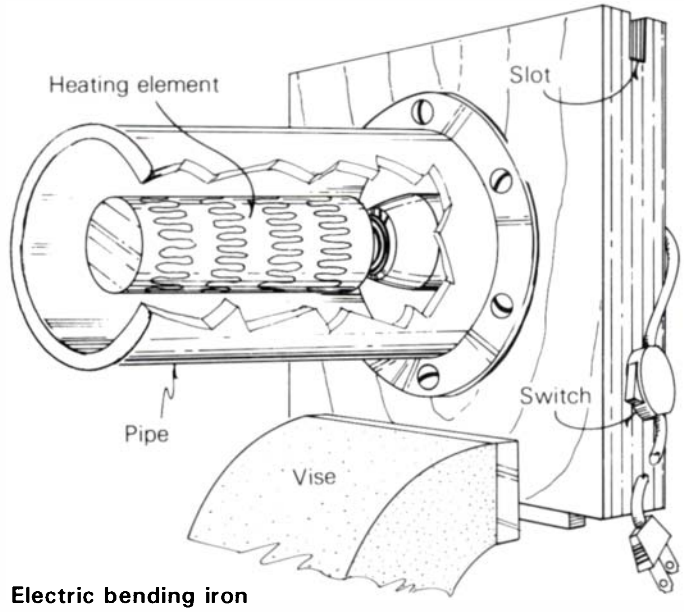
Templates may be made of (left to right) paper, cardboard, Masonite or aluminum. Beginners should start with gentle, large-radius bends, as in classical or 'dreadnaught' guitars.

Bending Irons

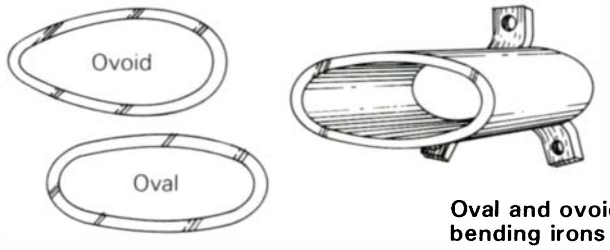
The simplest bending iron is made from a 2½-in.-diameter by 6-in. long pipe nipple, available in plumbing supply shops. Thread one end of the nipple into a flange. Screw the flange onto a sturdy board on which is mounted a ceramic bulb socket holding a heating coil. Bulb-socket heating coils can be obtained from an electric supply house; they may be difficult to find because they are the heating elements on infrared lamp fixtures and old-fashioned electric space heaters, which may be illegal in your state. A cylindrical coil is better than a cone-shaped one.

The round bending iron shown here is a beginner's apparatus. It is cheap, adequate and easy to throw together, but unsatisfactory in the long run, since the coils burn out frequently. A round bending iron offers only a line-contact source of heat. The pipe cannot bend a curve with a radius tighter than 1¼ in. Also, you must manually shut the iron on and off to maintain the correct temperature, a very troublesome and clumsy hindrance.

If you have started bending with a round pipe, you may be able to become proficient, in time. However, bending is easier if you replace the pipe nipple with an oval, or even better, egg-shaped bending iron. Start with an 8-in. length of thick-walled, large-diameter (about 6 in.) pipe. It can be made egg-shaped in a large vise, beaten to shape with a sledge, or taken to a scrapyard and pressed by having the wrecker's magnet dropped on it from the height of a few inches. You can improve heat transfer by filing the contact surface flat. Iron pipe is fine, but I've also used copper and aluminum. With a hacksaw, cut tabs that can be bent back and drilled for mounting. Asbestos "washers" at the tabs will prolong the life of the unit.



Electric bending iron

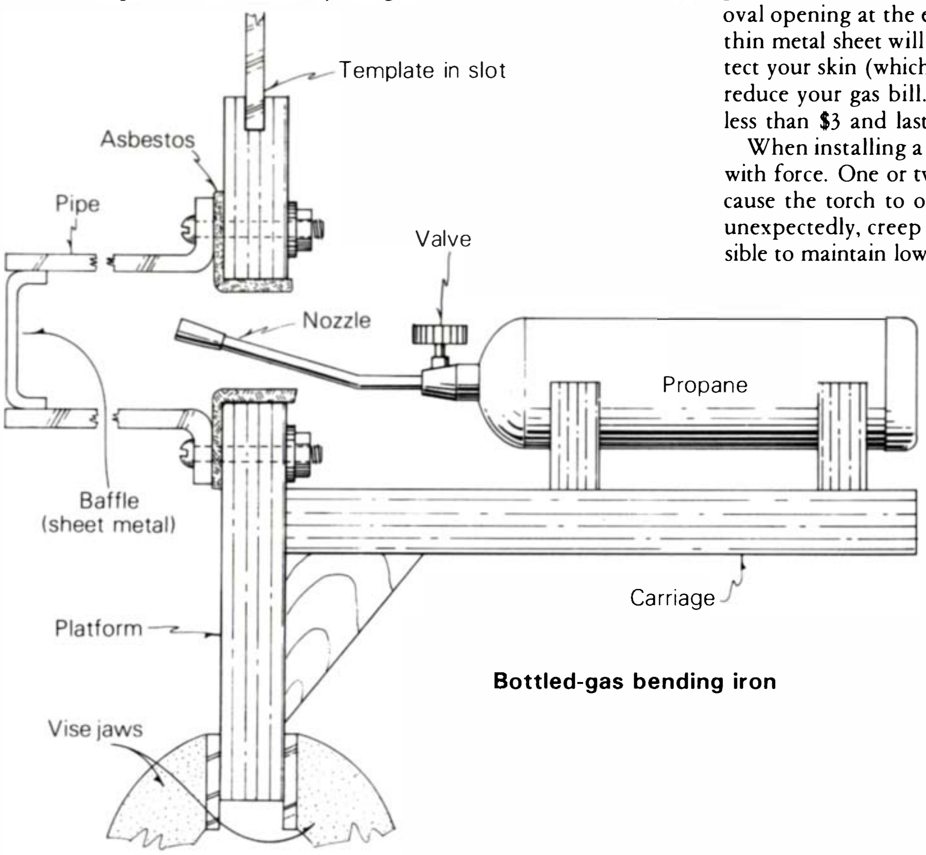


Oval and ovoid bending irons

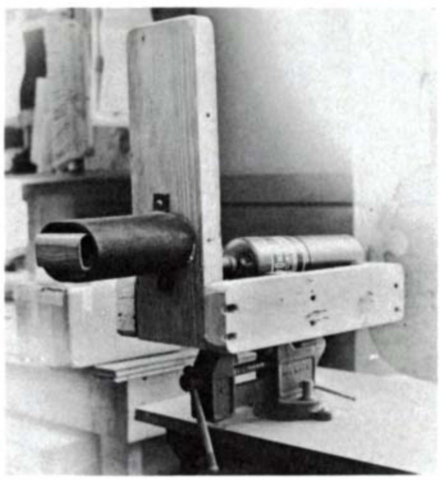
As with the round pipe, an electric heating coil may be used. The entire scheme can be greatly improved by hooking up a thermostatic device. I have seen various successful arrangements using lighting rheostats, electric-iron rheostats, and electric frying-pan controls. However, a heating coil may require as much as 1000 watts and whatever rheostat you use must operate within this capacity. You can purchase one of several electric bending irons, thermostatically controlled, that work very well but are frightfully expensive.

Bottled gas can be a heat source for the pipe. Build a small carriage behind the bending-iron platform to support the gas torch bottle valve upwards, with its nozzle inserted into a large opening in the platform. The nozzle controls heat effectively. Partially closing the oval opening at the end of the iron with a bent rectangular baffle of thin metal sheet will conserve heat that would otherwise be lost, protect your skin (which is usually directly in front of the opening) and reduce your gas bill. I use an ordinary propane torch. A refill costs less than $3 and lasts me about a month.

When installing a new torch, remember never to tighten the valve with force. One or two firm tightenings will ruin the valve seats and cause the torch to operate erratically. It will flare dramatically and unexpectedly, creep open or closed while in use, and make it impossible to maintain low settings.



Bottled-gas bending iron



Author's bending iron, mounted on a table; note oval pipe and heat baffle. Slot on top can hold template.

surface. A small end check may cause the whole blank to split dramatically in twain when flexed during bending. Beware of uniformly textured rosewood that has a single, very black line running down its length. This is an interface between two varying densities, a line of stress that may split the blank. Start with material as straight and uniform as possible. If well-quartered yet dramatically grained material is used, its pattern should likewise be even and uniform. Do not use edge grain that wiggles and runs off quickly. Edge grain that runs off gently over a reasonable length of stock is acceptable.

The thin wood (1/16 in. to 1/8 in.) used in instrument making must be stored with fastidious care. Plates must be separated with dry spacers of uniform thickness placed accurately and neatly. The first slat in the pile must be similarly spaced from the supporting shelf, as must the last from the heavy weight above the entire pile. Rosewood and ebony blanks must have both ends parafinned or painted. Improperly stored material, however select and expensive, is liable to check or warp and will have to be discarded.

Various guitarmaking texts suggest that side blanks must first be treated vigorously and harshly to persuade them to bend, for example, by immersing them in boiling water for an hour, or soaking rosewood blanks in hot solvents and soapy water for days. I have observed that a great many problems in hand-bending in fact stem from overwetting and boiling thin slats. For example, maple falls apart under tension as the too-soft material simply separates away from itself under even the mildest pressure. Mahogany that has undergone too much soaking loses its "memory" and must be rebent time and again. Thin, waterlogged maple and mahogany will ripple across the grain after drying. Leaching out the resins by boiling leaves the wood lifeless and crack-prone.

Immersion time varies directly with blank thickness. Blanks of average thickness (.095 in. to .080 in.) need only be immersed in tepid water for a short time: rosewood for 30 to 40 minutes, mahogany for 15 to 20 minutes and maple for as little as 1 to 10 minutes. Side blanks thinner than .080 in. should be used on only the smallest guitars, although modern lute ribs may be as thin as .060 in. Marquetry strips should be immersed in very hot water for 60 to 90 seconds. No prebending is necessary for properly stored strips if the template curves are moderate; strips can be eased into place on the guitar immediately after wetting during the binding process. An ordinary 36-in. sheet metal window-box planter makes an excellent soaking trough.

You must remove all encumbrances and place the bending iron conveniently. You will be bending, taking the piece off the pipe at intervals and comparing it to your template. The template must be firmly secured; a slot in the platform that holds it snugly at eye level will minimize your movements. Another way is to clamp the template to an adjacent tabletop. Having it flat will help discourage the common tendency to bend a skew, or twist, into the blank. Keep handy a small dish with water and a sponge for wetting the wood, to minimize scorching.

Several reference marks in yellow crayon on your blanks will help ensure the proper bookmatch on right and left sides. I find the bookmatch, put the sides together and joint only the common edges, leaving the opposite edges rough or even wany. This helps prevent the mistake of accidentally bending two right or two left sides. The straight, true edge will be glued to the guitartop; the rough edge will be hand-planed and sanded to the proper arch just before the instrument's back is assembled. Allow no less than 1/4-in. extra width.

I also find it helpful to mark the finished length on the blanks (allowing not less than a 1-in. overhang at each end) and to mark "outside" and "inside" on both pieces. If you choose to bend the waist first, a clear mark on the blank at the apex will keep you from running out of material while bending the upper and lower bouts. This point can be calculated by measuring with a string from the template centerline to the waist apex. Another way is to mark off 1-in. increments on the template perimeter with a compass and transfer the waist measurement directly to the side blank with a ruler.

While the iron is heating, take stock of yourself and your task. Choose a time when you will be at your most alert. Take your phone off the hook and lock your shop door.

If you have planned correctly your pipe heat should be just right by the time the blanks are sufficiently wet. If you are a slow bender remove both sides from the trough. As you get faster, you will find yourself leaving the second side in the water while you bend the first.

Pipe heat is critical. The pipe should be the hottest that will not burn the wood on immediate contact. Remember that you will be constantly moving a wet piece of wood over the pipe. If it burns in spite of this, your pipe is too hot. A good test for correct heat is to sprinkle a few drops of water on the pipe. If they sit calmly or boil on the surface, the pipe is too cold. If the drops hop about, sizzling loudly, it is hot enough. If they instantly pop or vaporize, the pipe is too hot.

Even at the right temperature, the pipe may burn the wood if you pause for more than several seconds while bending a tight curve, since the side sometimes must be stopped and wrapped tightly around the pipe. Here additional moisture and short lifting and pressing movements are called for. Some singeing is inevitable, and lightly singed wood can be scraped away later. A tight bend demands some experience, so a beginner should choose a template with only gentle, large-radius bends (such as classical or "dreadnaught" shapes).

The two common procedures are bending from one end to the other and bending the waist first, followed by the upper and lower bouts. The first is considered to be the more difficult, but both will give excellent results when mastered.

If you are right-handed, feed the blank horizontally over the pipe with your right hand in a rapid succession of short up-and-down movements, which will advance the side in short hopping increments. A tight curve will require a slower feed, with faster hopping movements. A broad, gentle curve will require a faster feed, with slower, longer hops. You should rarely, if ever, stop the blank on the pipe. This will cause a kink or lump in the curve. An educated right hand advances the blank at an even, machine-like pace.

Your left hand determines the amount of pressure to apply, and thus the tightness of the resulting curve, by the angle at which the hot blank leaves the pipe surface as it is advanced by the right hand. Apply pressure square to the pipe, and keep the blank square to the pipe. The tendency is to angle the blank as it advances, and to tip the blank surface toward you as you grasp and press it. This results in a complex, changing twist in the finished piece, which in turn results in an instrument with one shape when viewed from the front and a different shape when viewed from the back.

The most valuable "feel" that you should be anticipating is the feedback given you by the change in springiness of the material as heat is applied. As you advance the blank over the top surface of the oval pipe, the rate of feed must be matched to the rate at which the wood absorbs enough heat to become plastic, or "relax." You should attempt to feel this change in stiffness, for it is at this point where the best bending occurs. If you are not sensitive to this change you may be applying pressure ineffectively—at best, the blank will simply not take the bend; at worst, the blank may crack.

If you have mentally subdivided the template into simplified steps, deciding when and where to apply pressure is likewise simplified. At the end of each step, or even more frequently, you should compare the piece with the template. But unless you maintain tension as you take the blank to the template, the piece will not hold the desired shape. Hesitate momentarily and allow the piece to cool slightly under tension. This pause is critical: The wood is "curing" at this time and the fibers are returning to a rigid state in the new shape. If you relax tension here, the piece will return to a random shape, and there will be no bending progress.

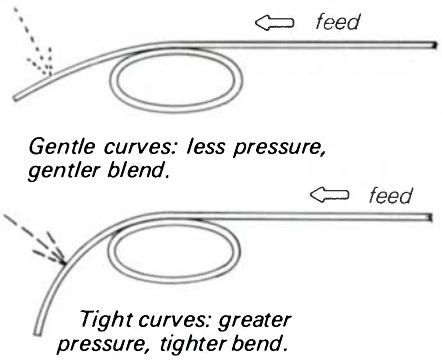
Take advantage of this curing interval by flexing the piece to match the template segment, then holding it still for a few moments against the template. The piece will retain the correct shape with little springback. Springback can be remedied at this point (after letting go of the piece) by gently and rhythmically flexing the piece while it is still warm until it springs back to the desired shape.

Bending mistakes can be corrected by reverse bending, but if you unbend too frequently and guess poorly at the place to rectify your error, the piece will take on a tortured, lumpy shape that is impossible ever to correct.

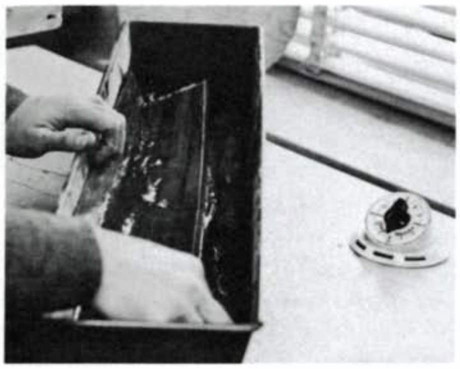
Acceptable deviation from the template should not exceed the ability of the material to flex after bending. Your criteria should be the wood's ability to be coaxed to the template line with only the gentlest pressure. Some builders feel that all the parts of an instrument should be under moderate tension during and after assembly, the justification being that the stress adds energy to the acoustic vibrations rippling through the guitar. Others feel exactly the opposite. This is a moot point, because there is no practical way of testing these contradictory assumptions. I choose to approximate the template to the best of my ability and reduce the variation to a minimum for other reasons: ease of assembly and the resulting improvement in the final appearance of the instrument.

Occasionally cracks and surface tearing of fibers at tight bends can occur. Some can be repaired. Cracks that appear as straight lines along straight-grained material can be closed by gentle clamping with glue and reinforcement from the back with a strip of tightly woven fabric saturated in white glue and pressed behind the glued crack. If jagged cracks occur in flatsawn materials, discard the piece. Moderate tearing of the surface fibers on tight bends can be repaired by working glue into the fracture and pressing the fibers down with a clamp and a gently curved caul.

Wet material locked into a mold over extended periods may mildew. I let the pieces air-dry for several hours and then tape them tightly to each other until assembly. Springback can be corrected by touching up dry on a moderately heated iron just before assembly. □

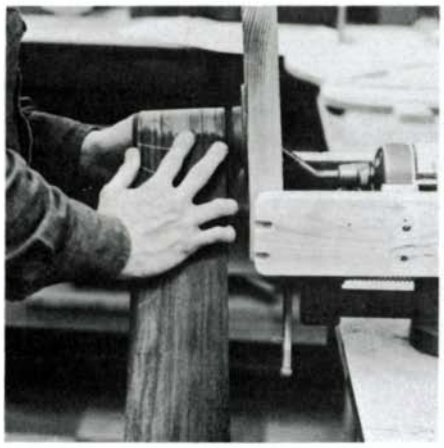


Amount of pressure and rate of feed determine tightness or curve. Fast feed with slow, long hops makes broad, gentle curve.



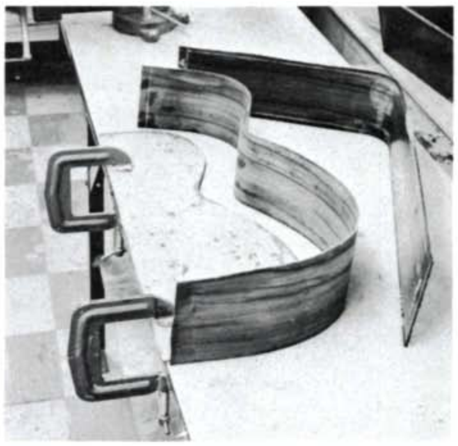
Side blanks are immersed in water in window-box planter; kitchen timer keeps track of minutes, prevents overwetting.

Right hand feeds evenly while the left fans rapidly (note blur) to advance the blank in small hops across the pipe.



Waist-first bending: Mark at center of blank, where waist will be, ensures sufficient length for upper and lower bouts.

Neck-to-tail bending: Major curve section of upper bout is held in tension momentarily to permit wood to 'cure' in new shape.



Finished side is checked against template. Some deviation is acceptable; reverse bending, in moderation, can correct mistakes.

Furniture Galleries

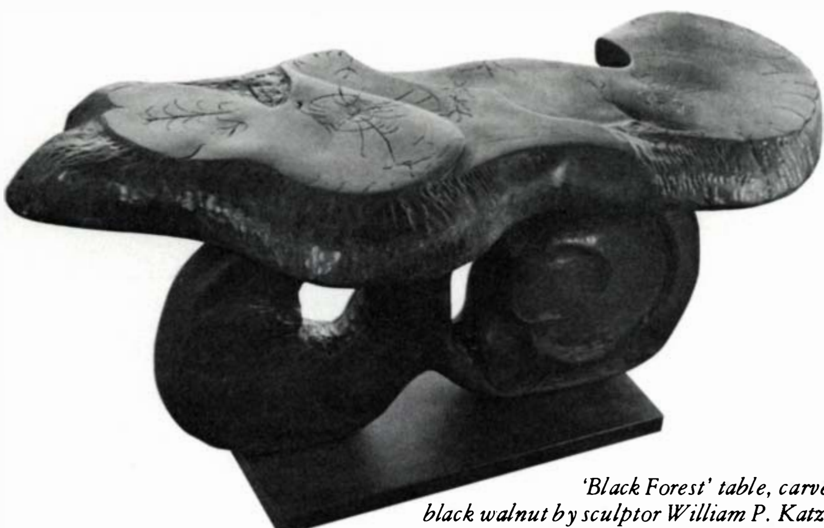
Several recent shows

Overall shot of the 'Westchester Furniture Makers' show staged in September at Westlake Gallery in White Plains, N.Y.

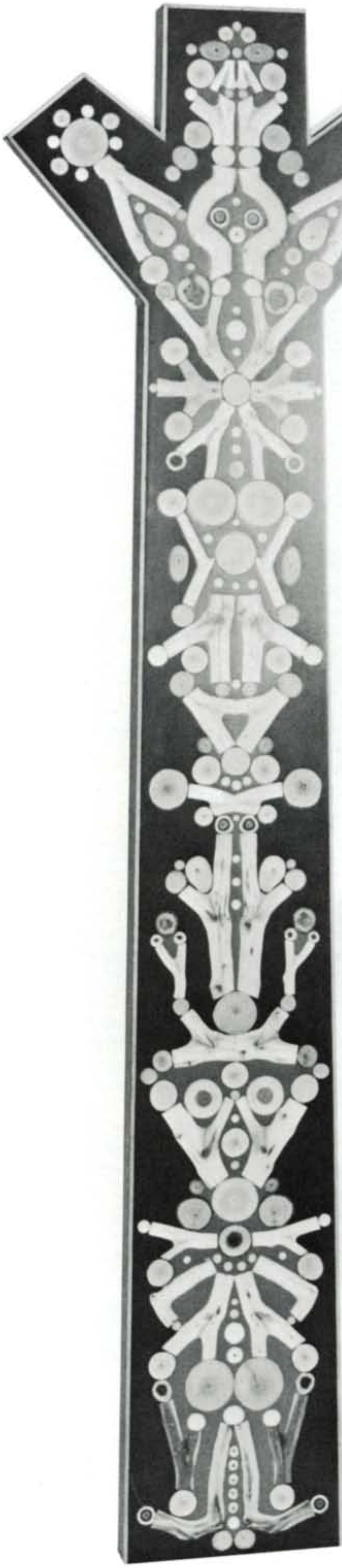
Editor's note: Art galleries across the country are paying more attention to finely made wooden furniture, giving it showroom space and either selling the work on display or connecting the craftsman with the potential customer. The photos on these three pages were taken at recent woodworking shows around the country. The captions came from notes and letters written by our friends and correspondents.

Pendulum clock, mounted on a roughsawn burl stand, made by Victor Dinovi, was shown at last summer's Laguna (Calif.) Festival of the Arts and Sawdust Festival. Bas-relief mirror frame by Virginia Hancock was also shown at Laguna Beach.

McAllister box by Michael Graham, pao ferro, 8 in. wide, shown at the California State Fair, which featured woodworking for the first time last fall. "First Graham drills out the space for the small central drawer, then he works the wood around it. He starts from a careful drawing, but as the box begins to take shape, the figure of the wood takes over and guides the growth of the design." —Kathleen Price

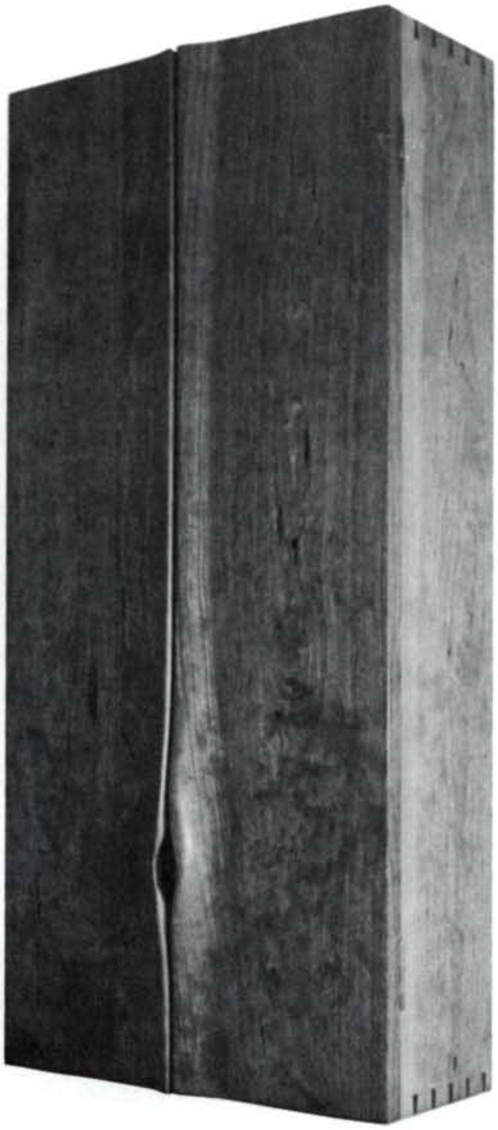


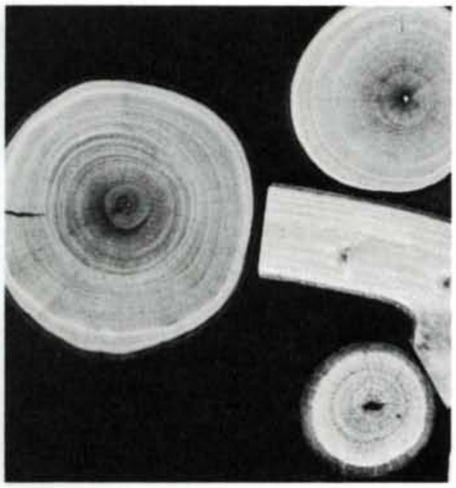
'Black Forest' table, carved in black walnut by sculptor William P. Katz and shown last fall at Westlake Gallery in White Plains, N.Y., with work by eight other woodworkers who all live in surrounding Westchester County.



Wall cabinet by Roger Deatherage, solid cherry and Peruvian walnut, 33 in. high, 18 in. wide, 5 in. deep, shown at Art Resources Gallery in Houston, Tex.

"Deatherage, a college teacher who plans to open a cabinet shop soon, has done a series of pieces using these lipped, center-opening doors. No special tricks in the construction, just good, standard carcase joints. The shelves have blind slots cut in their ends and are held by concealed brass pins installed in holes. The finish is a clear synthetic oil." —Jim Richey





Left and above, 'Totem' by Friedolin Kessler, 7 ft. high, composite of epoxy resin and cross sections of twigs and branches, shown at the California State Fair.

"Kessler is a professional artist who was first impressed eight years ago by how interesting the cross sections were that he was trimming from his apricot and Chinese elm trees. He's been collecting unusual samples ever since. The small bits of wood are sliced thin, carefully dried and sealed with lacquer before being glued to a backboard and frame. Then Kessler pours resin around them, sands, and polishes." —K.P.

Bookcase by Steven Cooper of Richmond, Va., walnut, 36 in. high, 10 in. deep.

"The 501 Gallery of the Mint Museum in Charlotte, N.C., recently invited 15 craftsmen from the Southeast to display quilts and woodwork. Cooper's bookcase and a mahogany desk (not shown), the only traditional pieces, exhibit excellent joinery and careful attention to detail, which much of the contemporary work lacks. The drawers open slickly, the doors effortlessly, and the finish is without a blemish." —David Landen

Table by Tim Coursey of Dallas, Tex., cherry, 9 ft. long, 3 ft. wide, shown at Art Resources Gallery in Houston.

"The ends of the table feature breadboard construction with a single center-screw fastener, to conceal the end grain and still allow for movement. The supports are joined by pegged mortise and tenon, with crosslaps where necessary. Coursey finishes with one coat of lacquer, rubbed down with fine wet/dry paper, followed by Watco oil and wax. The table has a very light, airy feel but it is practical and usable." —J.R.

Swivel bar stool in Walnut by Art (Espenet) Carpenter of Bolinas, Calif., armchair in cherry by Steven Phillips of San Francisco, shown at Los Robles Galleries in Palo Alto, Calif.

"To make a living, gallery owner M. Milton Seick sells small, affordable items in a separate department in his double gallery. This is the lucrative side of his business—he marks these items up the usual 50%. The other half of his business is fine art and furniture, on which he charges a lower commission. This way he can support and encourage the artists." —Alan Marks

Settee by Kenneth A. Lange of Port Chester, N.Y. (cherry with Indian tweed upholstery, 50 in. long, 43 in. high, 27 in. deep), shown at Westlake Gallery in September. Lange begins with square stock, cuts the blind mortise-and-tenon joints, then bandsaws each piece to its general outline before assembly. Then he rasps, files and carves the final form.

Armchair by Lawrence Mayers of San Francisco, shown last summer in an exhibition of wooden furniture at the Palo Alto (Calif.) Cultural Center.

"Mayers is starting from tubular-steel furniture and attempting to design seating for mass production—retaining the minimal mass and linear framework, but adding the esthetic and tactile value of wood. His chairs don't appear comfortable to me. He bends the wood by sawing closely spaced kerfs almost through, then he fills the voids with casting resin. The great part about the technique is that it enables anyone with a table saw to do bentwood furniture without a whole array of bending devices and steaming apparatus." —A.M.

Coffee table by John Kapel, walnut and rosewood, 23 in. high, shown at the California State Fair.

"Kapel, a commercial furniture designer and woodworker for 25 years, believes too many woodworkers use wood too lavishly, and thus simply waste it. His concern for economy produced the long, lean lines of this table. To make the drawer fronts, Kapel first cuts out a rectangle from the center of a 2-in. plank of walnut. Then he routs and shapes the rosewood finger pull, which fits the opening from the back and is retained by a lip of wood. After gluing it in place, he cuts and rasps the excess wood from the outside, leaving a sloping protrusion. Kapel also insets thin strips of rosewood called 'reveals' between the joints to blur uneven surfaces that may result from later movement of the wood." —K.P.

A Two-Way Hinge

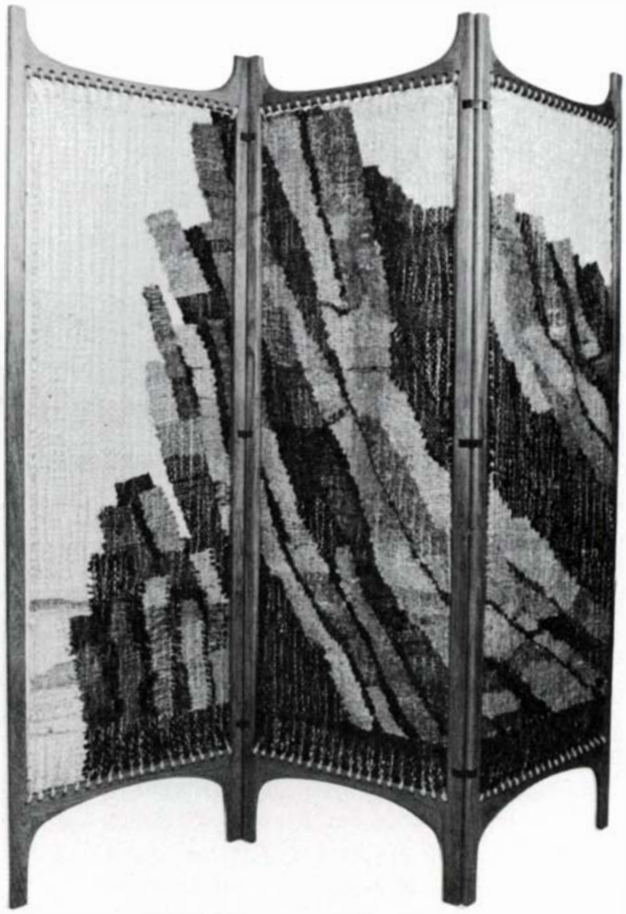
Careful routing makes screen fold

by Tim Mackaness

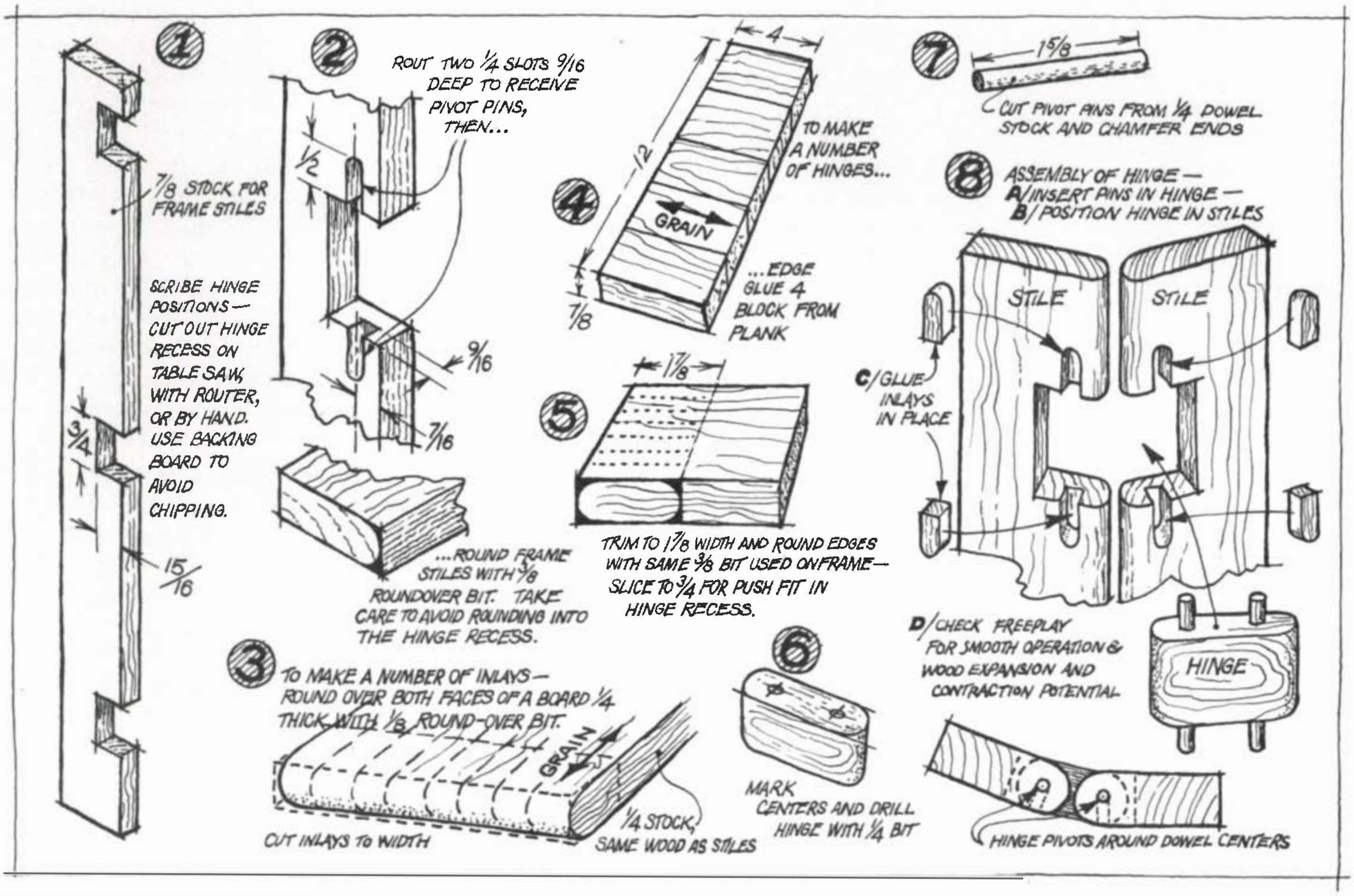
Many folding screens must be able to fold up like a concertina as well as stand alone as a triptych. Traditional hardware companies offer few acceptable hinges for the two-way folding screen. An attractive and functional concertina-type screen hinge can be made of wood by a sequence of careful but simple router cuts.

The hinge, visually symmetrical, can be de-emphasized if made of the same wood as the screen, or exaggerated to produce an interesting design detail by choosing a wood of contrasting color. Either way, a strong wood must be used. This design may be adapted to screen stiles of almost any thickness. The screen shown is made of ⅞-in. stock. I've found that wood thinner than ¾ in. is too fragile. In any case, remember that the hinge pivots about the center of the dowel pins, which are concealed by inlays.

The use of round-over bits to produce a machine fit for the inlays and to radius the hinge member is handy and yields a very precise piece, but equally fine results can be achieved by carefully rasping and sanding the radius by eye. A practice hinge made before you confront the actual screen will build your confidence, let you determine the proper tolerances and provide a handy crutch for future hinges. □

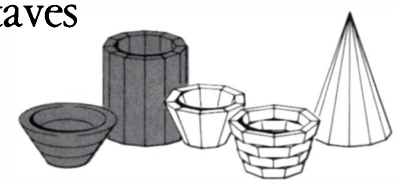


Folding screen of teak and rosewood made by author, with 'Columnar Basalt' tapestry by Judy Nylin. Dowels reinforced with mitered glue blocks join rails and stiles. Curve is bandsawn after assembly, then template-routed to make all three panels identical.



Laminated Turnings

Making bowls from stacked rings, bottles from tall staves



by Garth F. Graves

A woodturner wishing to make large bowls or cylinders will be fortunate to find a suitable piece of premium stock that has been spared from being reduced to veneer, resawn into milled boards, or subjected to the sculptor's chisel. The alternatives are unseasoned blocks that are rough-turned, set aside to dry, and final-turned again (*Fine Woodworking,* Summer '76, pp. 37-39), or shells laminated from standard stock. Turning forms may be built up from an unlimited selection of choice, seasoned hardwoods. Premium stock may be laminated into a form and size that accommodates the most ambitious project, and design opportunities in size, patterns, shapes and applications are limitless. Laminated shells are as strong as pieces turned from solid blocks, and lathe time and material costs are significantly lower.

Turning blanks may be built up horizontally, by stacking rings, or vertically, with beveled staves. Shallow containers such as bowls and trays lend themselves to stacking, while tall, slender forms usually dictate the assembly of vertical staves. Added design interest can be achieved by contradicting the common logic—there is no reason that stacked rings cannot form a tall cylinder, or that shallow, wide bowls cannot be made from vertical staves. Constructing the blanks gives the craftsman great control over the final form; subtleties often transform a nice turning into something special.

The technique of stacked rings is based on overlapping concentric rings, cut at an angle from a single piece of 1-in. surfaced stock. Experimentation with the concept can produce a fairly wide range of shapes. The surface pattern of the finished piece can be controlled to some degree, and the pattern can be accentuated by inserting alternating pieces of contrasting woods at the rim, the base, or in the wall of the bowl.

The geometry of cutting all the rings from a single source board somewhat limits the shapes obtainable (diagram on opposite page). The concentric rings, cut at a 45° angle, are laminated to form a hollow conical blank for turning. The angle of cut, the width of the rings and the thickness of the wood govern the cross section of the blank. For this basic method, any increase in depth will proportionately increase the diameter. Variations of these parameters will change the assembled profile. The practical limits are quickly reached and for more scope two source boards become necessary.

Using two or more boards for alternating rings increases the possibilities. Inserting straight-walled rings between the angle-cut rings makes the form taller and reduces the slope of the wall. But I've found that the best method is to alternate diagonally-cut rings from two source boards. This reduces the slope of the wall; the thicker walls allow greater design variation. Further variations include leaving a wide ring at the top for a flare, a flange or a handle. The pieces from which the rings are cut may be segmented and laminated in many ways or built up to almost any size.

For proper bonding, the boards used for stacking should be milled and planed truly flat and evenly thick, free of ripples, valleys, pecks and checks. The circles can be cut by hand or with a jigsaw or sabre saw. But before cutting, draw a random series of concentric circles on the underside of the stock to aid alignment during assembly. The saw blade must have a starting hole, but instead of a single large hole, which would remove too much wood, drill a series of small holes in line with the arc of cut and at the angle of cut.

Keep the grain parallel from ring to ring, so seasonal movement won't break the bowl. Allow glue joints to set under pressure, attach to a faceplate, and you're off and turning.

I've seen many otherwise fine turnings marred by screw holes in the bottom, the result of attaching the faceplate directly to the wood. Glue a square of scrap to the turning blank, separated by a single sheet of newspaper. The paper will separate when a knife blade is forced between the scrap and the finished piece, and the faceplate may be securely screwed to the scrap piece.

Laminated rings are only one way of building up blanks for turning. The assembly of a number of wedge-shaped staves to form a cylinder opens more opportunities for project design. A wide variety of shapes and sizes are possible—from large cylinders to bowls, buckets, or salad sets. All can be produced from standard milled stock of premium woods, but making cylinders of vertical staves requires care. Clean, true cuts are essential and provision must be made for fitting ends to the cylinders. The same principles apply to compound-angle forms that would result in conical blanks.

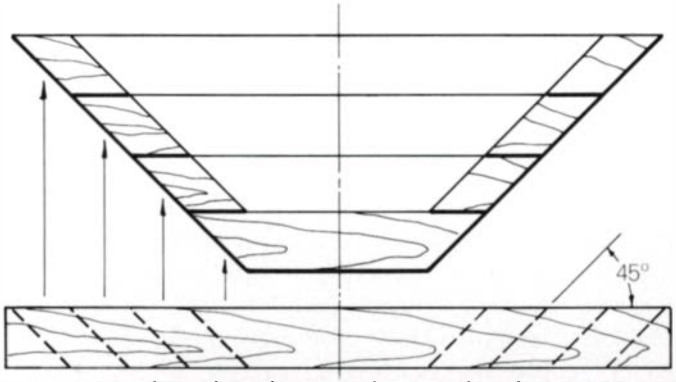
Success comes from properly joining the staves; the angles are critical. The table at right contains information on various final diameters, the number of staves required, the angles of cut, and the outside width of each. It also gives the general mathematics for any size cylinder. The thickness of the stock and the number of staves will govern the wall thickness of the finished piece. The more staves, the more circular the blank will be, and therefore the greater the usable thickness.

After the staves are cut to the proper angles they are assembled dry into cylinder form and checked for fit. Some adjustment is possible by trimming angles or adding segments, to compensate for miscalculations in the cutting angle. Remember, any error is multiplied by the two surfaces and by the number of staves used.

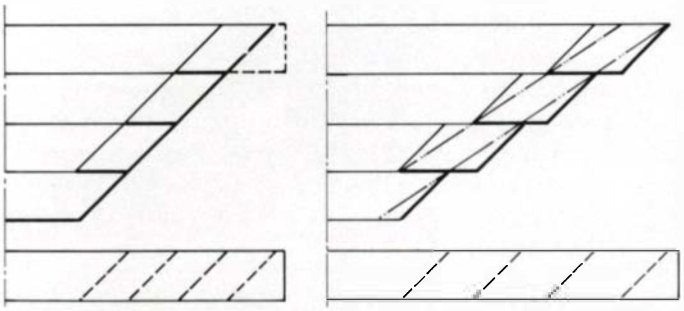
The photo sequence (turn page) highlights the application of this technique. Note that thick stock was required by the widely varying diameters of the finished pitcher; 1-in. stock would be prepared in the same way. When the shape restricts access to the inside, as in the piece shown, I find it helpful to diagram the cross section. I use inside calipers or dividers to measure along the center line at 1-in. increments, then I dia-

(please turn page)

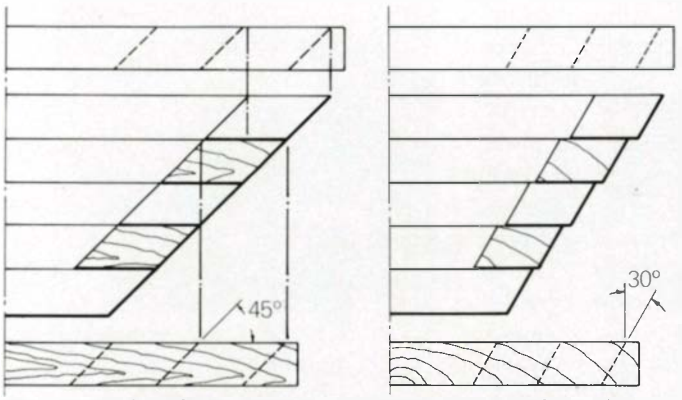
Garth Graves, 40, of San Diego, is a designer and prototype woodworker. He used to be an aerospace technical writer.



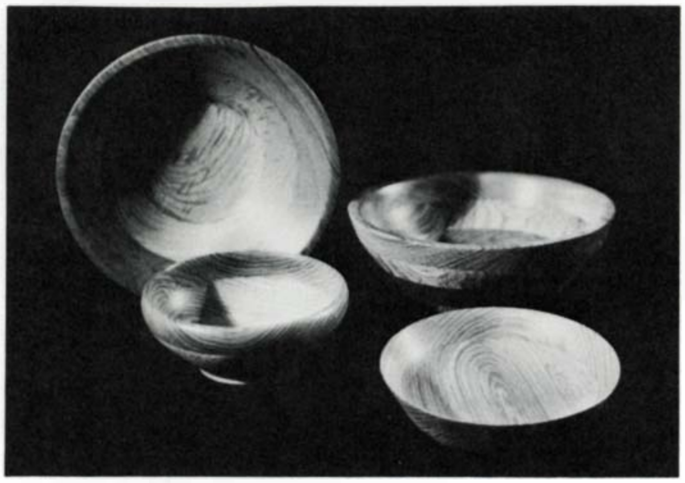
Cross section above shows how a single source board, cut at 45° into rings whose width equals the thickness of the stock, can be stacked into a conical turning blank.



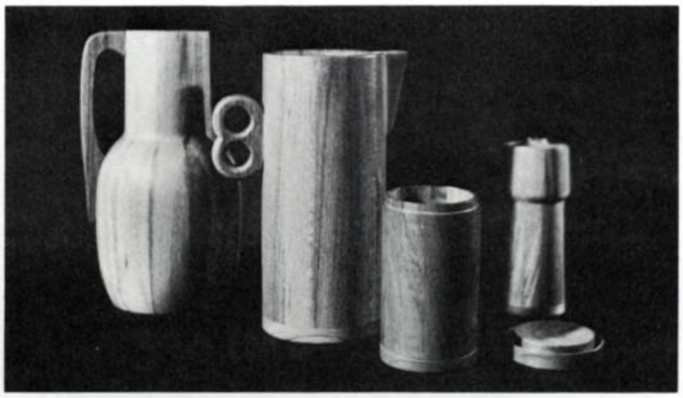
The top ring may be cut wider, left, to turn a bowl with a flaring rim. Increasing the ring width to 1½ times the stock thickness, right, permits a slightly wider bowl but possibilities are limited.



Two source boards, cut at 45° into rings twice as wide as they are thick, allow much more variation in shape. Note that the alternating rings are offset by half of their width. To make a steep bowl with thick walls, cut two boards at 30° into rings 1½ times as wide as they are thick, as at right.

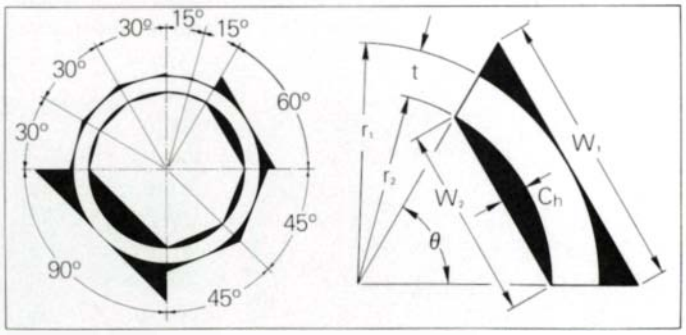


Bowls are turned from stacked rings of ¾-in. teak.



Author turns woodenware in teak from staved cylinders; decanters are about 12 in. high. Chart below relates cylinder diameter, number of staves and stave width. Half-angles are the amount of saw-blade tilt from the vertical when cutting staves.

θ Angle	N Qty. Reqd.	Half-Angle Cut	STAVE WIDTH W_1 for given diameters 3 in.	5 in.	7 in.	9 in.	10 in.
90°	4	45°	3	5	7	9	10
60°	6	30°	1¾	2⅞	4	5¼	5¾
45°	8	22½°	1¼	2⅛	2⅞	3¾	4¼
30°	12	15°	¾	1⅜	1⅞	2½	2¾
15°	24	7½°	⅜	⅝	1	1¼	1⅜



The diagram above left shows a few of the regular divisions of a circle and the relationship between the number of staves in a cylinder and the stock thickness required to produce a given wall thickness. The enlarged section through a stave, right, defines the terms for the following equations. Once you decide what you want to make, the math gives minimum dimensions. Keep angles precise but keep outside width and thickness fat, to have wood for working.

Here, N is the number of staves and θ is the included angle of each; thus, $\theta = 360° \div N$; r_1 is the outside radius of the finished cylinder and r_2 its inside radius; t is the wall thickness and thus $t = r_1 - r_2$; W_1 is the outside width of a stave, W_2 is the inside width; C_h is the chord height and thus stock thickness $T = t + C_h$.

If you have decided on the number of staves and the radius of the cylinder, solve for the width (W_1) of each stave:

$$W_1 = 2r_1 \tan \frac{\theta}{2}$$

For example, if you want a cylinder that has an outside diameter of 8 in., and it will be made of twelve staves ($\theta = 30°$), then, $W_1 = 2 \times 4 (\tan 15°) = 8 \times 0.2679 = 2.14$ in. Set the table saw at 75° (90° minus the half-angle, or 180° ÷ N), and cut each stave so it is at least 2.14 in. on its outside face.

To find the minimum thickness of the stock (T) for a given wall thickness (t), first solve for the chord height:

$$C_h = r_2(1 - \cos \frac{\theta}{2})$$

In the previous example, if the wall is to be ½ in. thick, then $C_h = 3.5\ (1 - \cos 15°) = 3.5\ (1 - 0.9659) = 0.119$ in. Since $T = t + C_h$, $T = ½ + 0.119 = 0.619$ in.

To find the width of the inside face of a stave, solve:

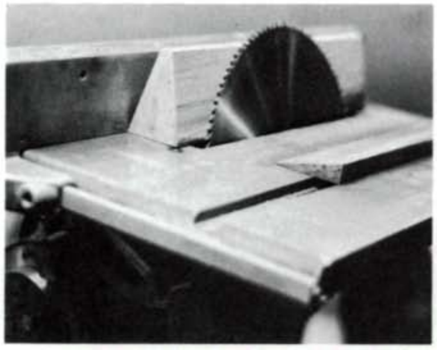
$$W_2 = 2r_2 \sin \frac{\theta}{2}$$

In the previous example, $W_2 = 2 \times 3.5 \times 0.2588 = 1.812$ in.

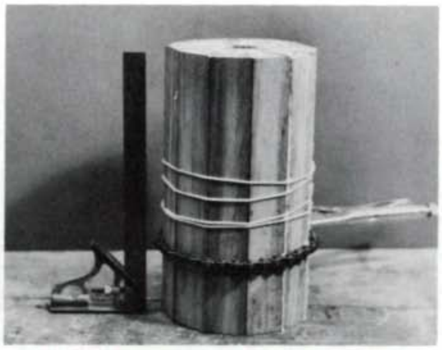
gram the measured diameters onto a cross-sectional view. This way I can determine the wall thickness anywhere. A design change in the final stages need not conform to the inside profile, as long as the wall doesn't get too thin.

A cylinder formed of staves doesn't expand and contract the same way as one turned from a solid block. Shrinkage will occur evenly around the circumference and across the wall thickness but the form won't become ovoid. If shrinkage is expected, any lids should be fitted loosely.

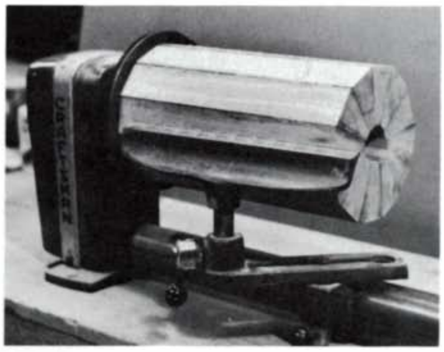
Segmenting permits variations that would not be considered if the cylinder were turned from a solid piece. I don't hesitate to embellish a segmented piece with handles, pouring spouts or whatever the design requires. One container shown earlier includes a spout. Prior to assembly, I scored the stave where the spout would go about one-half the way through, and did not glue the portion to be replaced. After the final turning, this piece was easily cut away. A rough-shaped spout, cut to the same half-angle, was glued in place for final shaping. The handle, although attached separately, could have been added in the same way. □



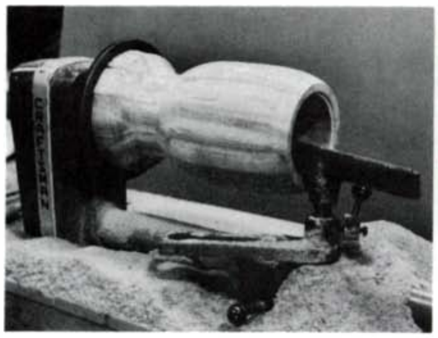
1. *Shopsmith saw table is tilted to half-angle; hollow-ground blade produces good gluing surface.*



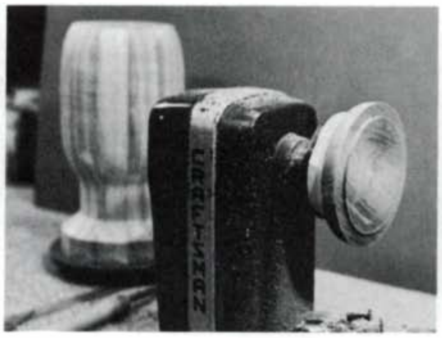
2. *Check fit dry, then clean surfaces and glue. Author supplements cord wrap with vise-grip chain clamps or band clamp. Keep the assembly vertical.*



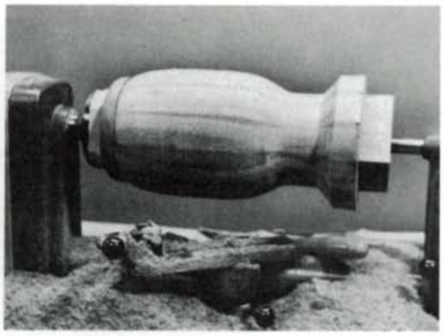
3. *With the top turned true to the sides, the cylinder is screwed to a faceplate. Screw holes will be turned away later.*



4. *First the outside diameter is roughed, then the bottom and lower inside diameter are finished to receive the base.*

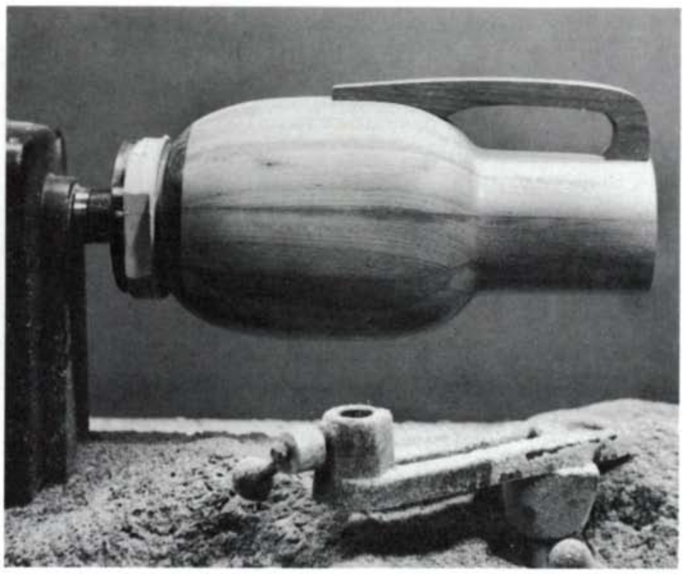


5. *Cylinder is removed from lathe and replaced by stock for base. Author usually turns a rabbet so base will plug in snugly.*



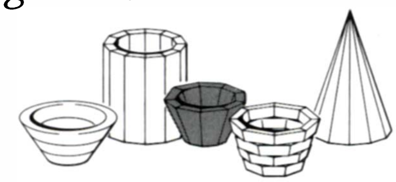
6. *Tailstock feed applies pressure for gluing cylinder to its base.*

7. *Now the inside top and the whole outside of the cylinder may be turned to their final shape.*



8. *Use the lathe bed as a holding fixture for adding handles, spouts—whatever the design requires.*

Compound-Angled Staves



The previous discussion covers building up conical turning blanks from stacked rings, and cylindrical blanks from beveled staves. The next logical step is to make a bowl-shaped blank from staves that are both tapered and beveled.

Robert M. Hewitt, 47, a structural engineer from Mechanicsburg, Pa., has developed a simple method for cutting the staves with his radial arm saw, and for clamping them together with a nylon cord.*

Hewitt's method assumes you have already determined the number of staves (N) in the bowl, and the angle α between the side of the bowl and the table. To cut the segments on a radial arm saw, you'll need to know angle a, the bevel setting of the saw blade and arbor, and angle b, the miter setting of the saw arm. The formulas are:

$$\text{angle } a = \frac{180^\circ}{N} \sin \alpha$$

$$\text{angle } b = \frac{180^\circ}{N} \cos \alpha$$

For example, a bowl with 12 staves sloping at 60°:

$$a = \frac{180^\circ}{12} \sin 60^\circ = 15^\circ \times 0.866 = 13^\circ$$

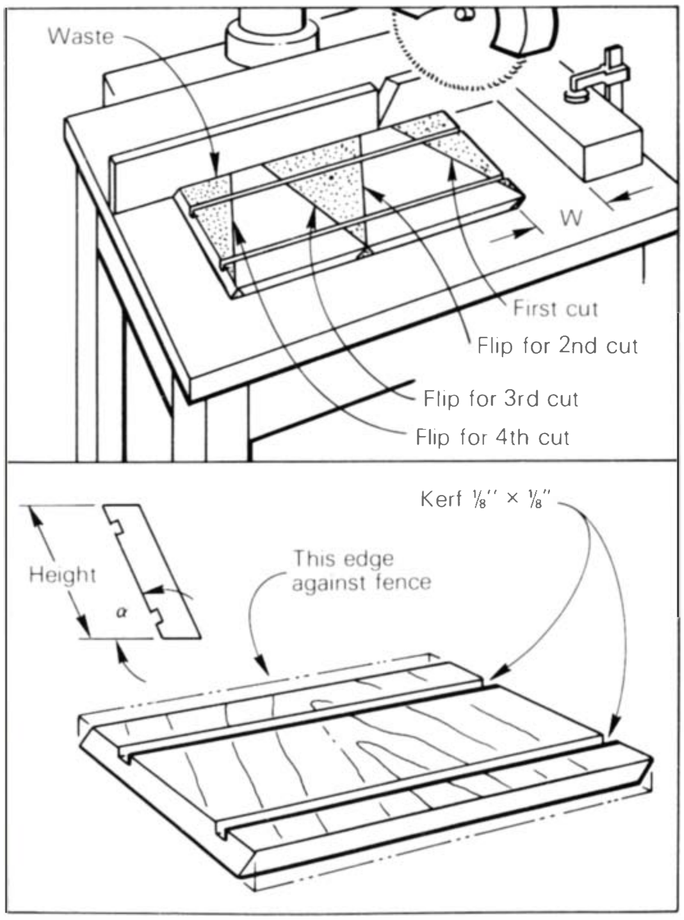
$$b = \frac{180^\circ}{12} \cos 60^\circ = 15^\circ \times 0.5 = 7.5^\circ$$

If he wants the grain to be vertical in the finished bowl, Hewitt selects a wide board at least an inch thick and crosscuts it into strips whose length equals the height (h) of the finished bowl plus an allowance for cutoffs and for truing up the bottom before gluing it to the base. He bevels the edges to the same slope α as the staves will make with the base, and saws two shallow kerfs near the edges, as shown in the drawing. The kerfs will hold the nylon cord during glue-up.

Next, with the saw blade tilted to angle a and the arm at angle b, he makes the first cut at one end of a strip of stock. Use an adjustable drafting triangle to set the saw accurately. Next he locates and fixes a stop to the table so that the dimension W is the width of a stave at the base of the bowl. This can be guessed, or calculated with the equations given on page 75. He flips the stock over, indexes it against the stop and makes the second cut, producing one of the 12 staves required. Flipping stock again, he makes the next cut, and so on until he has all 12. Hewitt leaves the saw set up, so he can adjust one stave to compensate for error and close the bowl.

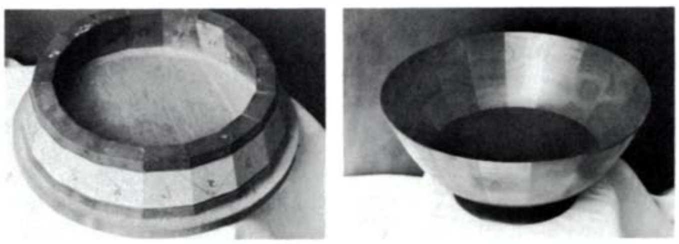
Assembling tapered staves is tricky, and Hewitt has a tricky solution. He writes "Lay the tapered staves together on a sheet of paper, face down. They will form a segment of a circle, like a pie with a large piece removed. Outline the assembled pieces, and number them so they can be replaced in the same order. Apply contact cement to the paper and the out-

*Hewitt's method was presented last March at the annual Woodturning Symposium in Newtown, Pa. This year organizers Al LeCoff and Palmer Sharpless plan two symposia, the first on March 17, 18, and 19, and the second on June 16, 17, and 18. For more information, contact LeCoff at 520 Elkins Avenue, Elkins Park, Pa. 19117.



side face of the staves between the cord kerfs, trim the paper to the outline and cement the staves to it. This will allow you to pick up all the staves at once, close the bowl and see how they fit." One stave may have to be adjusted to make all the joints close tightly and it is usually easiest to cut a new one at a slightly different bevel angle.

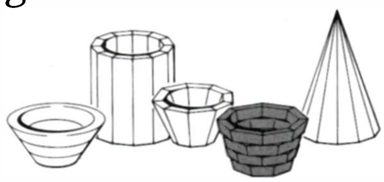
Hewitt continues, "When the staves fit, lay the bowl out flat again on the bench, cut two lengths of nylon cord and knot them into loops a bit larger than the circumference of the closed bowl. Apply glue to all the mating surfaces, close the staves to form the sides of the bowl, slip the nylon cord into the kerfs and use a dowel to twist the cord for clamping pressure." When the glue is set, Hewitt glues the top of the bowl to a disc of plywood and centers it on the lathe. Then he turns the bottom of the blank true, and glues on what will be the bottom of the bowl. He now can turn and finish the bottom and outside, mark the center, reverse and remount, and part off the plywood. The bowl is completed in the conventional manner. Sometimes he puts a contrasting veneer between staves, for visual interest. He recommends finishing with four coats of satin urethane varnish, rubbed with pumice and oil. This seals the wood completely and prevents expansion and contraction of the wood segments. —*J.K.*



Blank is glued to waste disc so foot may be trued and bottom attached. Right, cherry bowl with horizontal grain and walnut base.

Rings from Wedges

by Asaph G. Waterman



(Now imagine that a cylinder is made from very short vertical staves—no taller than the thickness of a board. The staves become wedges, and the cylinder is squashed into a ring. Several such rings can be stacked up to form the blank for a bowl. Asaph G. Waterman of Camillus, N.Y., has devised a tablesaw jig for cutting wedges, and a plywood-and-angle-iron jig for gluing them together.)

There are several advantages in using this technique: The wood need not all be the same thickness, so scraps left over from other projects can be used up; wood with nail holes and other imperfections can be used with minimum loss; no end grain has to be turned, especially important in soft woods like butternut or sumac; and striking effects can be obtained by gluing contrasting pieces of veneer between the wedges.

Accuracy in assembly is very important. The jigs I will describe are for making eight-sided (octagonal) rings, but the same principles apply to jigs for any number of wedges.

The two sliders for the table-saw jig may be made of steel, aluminum or hard wood. They should fit your table-saw grooves accurately, but must slide smoothly. Make the body of the jig, as shown in the drawing, of any stable wood ¾ thick. The angle, 67½° for an octagonal ring, must be accurate because any error will be multiplied by 16 in the finished blank. The triangular wedges for the first layer come to a point, to fill the bottom of the bowl, but succeeding rings must be wider to allow the bowl to flare, and cut off (truncated) at the point to save turning work and avoid waste. The pointer on the jig is used to gauge the width of the truncation. Face the working surface of the jig with coarse carborundum cloth to keep the wood from sliding.

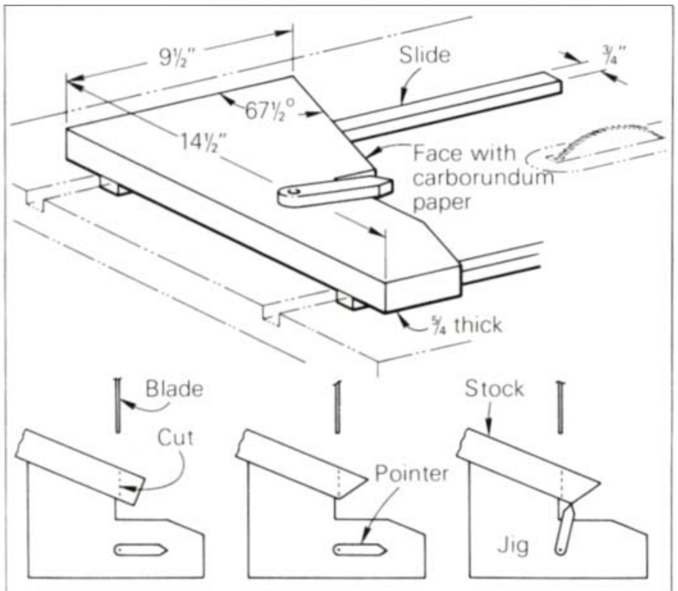
The assembly jig consists of an octagonal plywood base to which are screwed eight 2½-in. lengths of angle iron, drilled and tapped for tightening bolts. I have jigs in two sizes—one an octagon 11 in. from face to face, with sides about 4½ in. wide; the other 14½ in. from face to face with 5¾-in. sides. I use 1-in. by 1-in. by ⅛-in. angle iron. Don't use aluminum angle because the threaded holes won't stand continued use. One side of each piece of angle iron is drilled in its center and tapped for a 5⁄16-in., 16-pitch machine screw or cap screw. The other side is drilled ⅜ in. from each end and countersunk for ¾-in. flathead wood screws.

Because the layers have varying diameters, I use spacer blocks in sets of eight between the tightening screws and the wedges themselves. My jigs will make a bowl 11 in. in diameter; a larger bowl of course requires a larger jig.

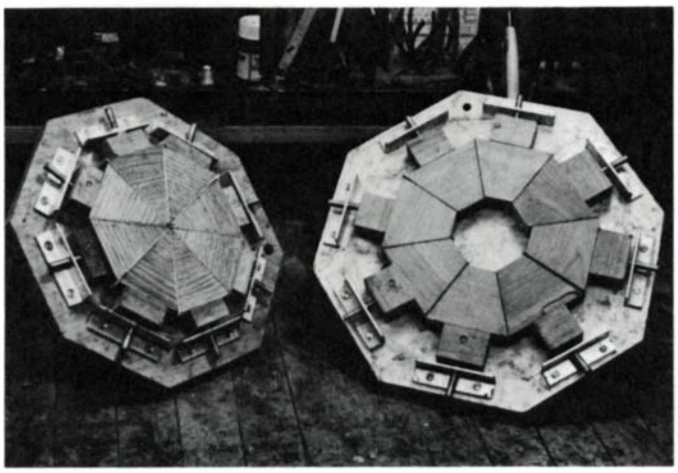
To make a bowl, I first saw eight pieces that come to a point, turning the board for each cut. Make sure the pieces fit, lightly sand each edge, and, since the main problem in this work is getting the points to meet exactly, avoid it by sanding the points off flat. Later I drill out the center of the octagon with a tapered bit and turn a tapered plug to fill the hole. I usually run grain of the plug parallel to the grain of the layer itself. Use the small assembly jig with appropriate spacer blocks to glue all the wedges together at once. Protect the jig surface with waxed paper, wipe off the excess glue and let set overnight. If the pressure of the screws forces a wedge to rise, use a C-clamp to force it back down. When the glue has set, fasten a faceplate to the layer and take a thin cut on the lathe to smooth and true the surface.

I make the wedges for the second layer the same way, except I move the pointer on the sawing jig about an inch out from the blade. When the glue has set, fasten this layer to a faceplate, placing the screws near the center so the holes will disappear during turning. Smooth one side and use C-clamps to glue both layers together, staggering the glue lines. Now true both surfaces on the lathe.

At this point a two-layer bowl can be turned or a third layer may be added. To make the larger third layer, move the arrow about 1½ in. out from the blade. You can add as many layers as you like, to get as deep a bowl as you want. □



Flip stock for each cut. . . *to make pointed wedges for base.* *Set arrow to cut wider wedges.*

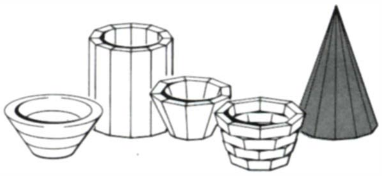


Assembly jig consists of angle iron bolted to plywood plate, drilled and tapped for cap screws. Use spacer blocks between screw and work.

Staved Cones

The general mathematics

by Thomas Webb



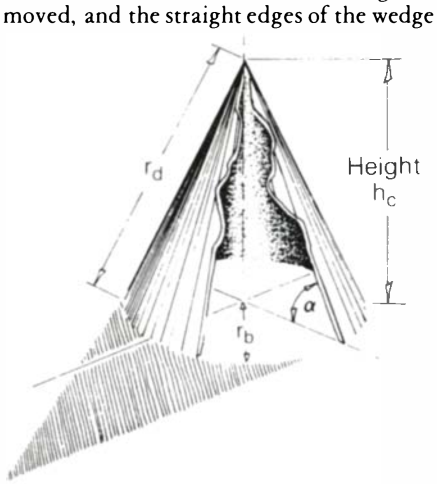
An equal miter joint for a rectangular, box-like construction will result from cutting adjoining edges of the stock at 45°. But what if we need to miter a shape that isn't rectangular? What if, for instance, the shape has seven similar sides that must lean in (or out) rather than standing parallel to one another?

Such non-rectangular forms can be thought of as sections of faceted cone-like shapes. By thinking of forms you wish to make as sections of cones, you can determine the geometry of the flat pieces needed to make those forms. You need only specify the height and base dimensions of the imagined cone, along with the number of sides you want it to have. The formulas will then tell you what shapes to cut to produce the faceted cone shape. Further alterations of the size of these pieces can produce any section of the specified cone. Combining sections of different cones can produce an infinite variety of three-dimensional shapes.

Some of the formulas look complicated, but with a table of trigonometric functions it is fairly simple to do the computations; they can be done in minutes on a calculator with trig functions.

A right cone has a circular base and is symmetrical around an axis running through the center of the base to the tip. The axis is perpendicular to the plane of the base; the length of the axis from base to tip is the cone's height (h_c). A right cone can be described in terms of its height and the radius of its base (r_b); α designates the angle between the surface of the cone and its base.

A right cone can be constructed from a flat sheet of flexible material such as paper or thin metal. The shape to be cut from the flat stock is a circular disc with a wedge removed, and the straight edges of the wedge



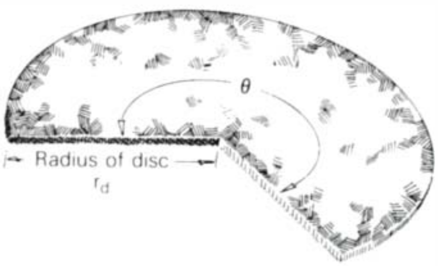
are radii of the disc (r_d). When the cut radii are pulled together, a right cone is formed; the center of the disc becomes the tip of the cone, the perimeter of the disc becomes the base and r_d becomes the length of the side of the cone.

If you know the height and radius of the base of a right cone you want to construct, the following formulas specify the size of the disc you'll need and of the wedge to be cut from it.

$$r_d = \sqrt{r_b^2 + h_c^2}$$

$$\theta = 360° \frac{r_b}{r_d} = 360° \cos \alpha$$

Since θ equals the number of degrees remaining in the disc after the wedge is removed, $(360° - \theta)$ equals the angle of the wedge itself.



In some circumstances it is useful to specify the base angle α rather than the height of the cone. In this case first solve for h_c using the following formula:

$$h_c = r_b \tan \alpha$$

then apply the previous formulas.

A right cone can be approximated with thicker, less than flexible materials such as wood by cutting compound-angled staves and assembling them around a central axis. The result is a faceted "cone;" the more staves used, the closer the approximation to a true cone.

It helps to imagine that the faceted cone just fits inside an actual cone of similar dimensions. In this way we can see the important dimensions h_c and r_b as they relate to the staves to be made. Follow these steps to determine the size and shape of the staves.

First, decide on the height (h_c) of your cone, the radius of its base (r_b) and the number of staves (N) you want to use to make it.

Compute r_d, which is equivalent to the length of the edge of a stave, by:

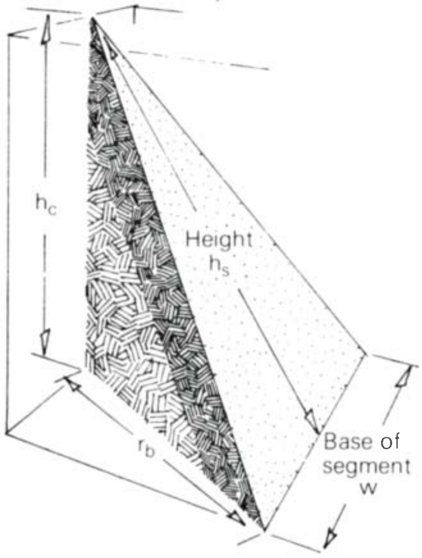
$$r_d = \sqrt{r_b^2 + h_c^2}$$

Compute the width at the base (w) and the height (h_s) of each stave by:

$$w = 2r_b \sin \frac{180°}{N} \qquad h_s = \sqrt{r_d^2 - \left(\frac{w}{2}\right)^2}$$

Knowing the height of the stave (h_s) along with its width (w) at the base, you can lay out on your stock what will be the exterior surface of each stave. Remember that the height of a stave is measured along a line that bisects its base at a right angle.

To determine the saw setting for cutting



the miter angles on the sides of the segments, first calculate angle α for the shape you are making:

$$\tan \alpha = \frac{h_c}{r_b}$$

Then use this formula to find angle Ω, the table-saw setting for the side cuts:

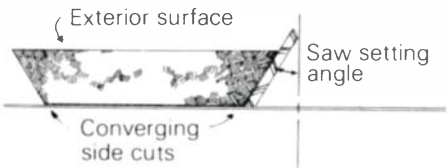
$$\tan \Omega = \sin \alpha \tan \frac{180°}{N}$$

If you are making a complete faceted cone shape, you may want to have a flat bottom on it. First calculate the base angle β relative to the exterior surface of the segment, from the formula:

$$\tan \beta = \frac{h_c}{r_b \cos \frac{180°}{N}} = \frac{\tan \alpha}{\cos \frac{180°}{N}}$$

Then find the saw setting for the base cut by subtracting angle β from 90°.

Remember that the sides and bottom of a



stave converge; the interior surface consequently is a scaled-down version of the exterior surface. □

Tom Webb, 32, is a sculptor and assistant professor of art at the University of Akron, in Ohio.

Chain-Saw Carving

Furniture and sculpture from green logs

by Jon Brooks and Howard Werner

Brooks' walnut chair (38 in. high, 33 in. wide.)

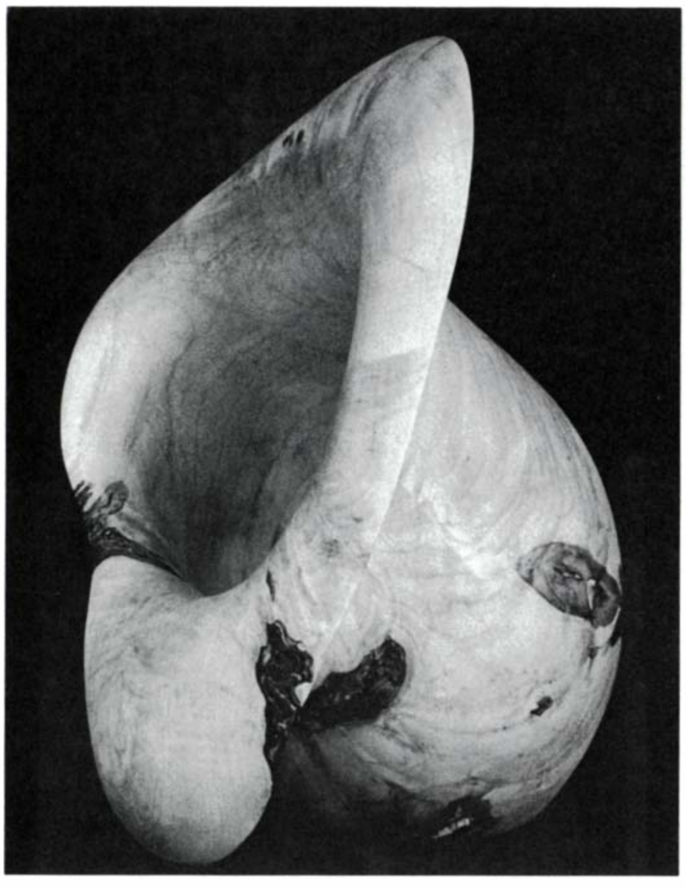
We use the chain saw to carve furniture and sculpture from green logs, roots and branches. Although we live several hundred miles apart, we've worked together on techniques for the last several years. The chain saw, although not designed for this kind of work, has become our main tool for both roughing out and final shaping.

Our furniture or sculpture often begins directly in the wood, using forms suggested by the shape of the log, or forms that are revealed as wood is removed. A contorted limb may suggest a chair, an interesting crotch or hollow may predict a bowl, or a hollow log may hint at a stool. Other times, a form is developed in the mind or through sketching. The work begins with the search for a suitable log in which to execute it. Excellent free material can be found in local tree dumps, with hundreds of logs and stumps to choose from, or at the town dumps, from tree surgeons, orchards and on private land with standing snags or fallen trees.

Almost any wood is good carving material, although apple and oak are more prone to cracking and checking than most species. Spalted wood is exquisite, but it is best to avoid pieces with soft spots or excessive rot. In most species, rot takes years to progress to this point, so many downed trees, particularly disease-killed elms, are still in good shape. Walnut checks less than most native hardwoods. Crotch sections in particular, because of their interlocked grain, hold together well against the stresses of drying. Maple and cherry, although not as stable as walnut, are still good woods for carving. Coniferous woods carve easily and oiled juniper and cedar look particularly fine. Whatever the wood, the main thing is to develop the form in the direction of the wood fibers, for strength. Experience and experimentation will show what can be done and what should be avoided.

We own both electric and gasoline-powered chain saws, but do most rough carving with the gasoline saw because it is more powerful and not tied to electrical lines. We own Stihl gasoline saws and are familiar with the range AV20 to AV45. (The AV stands for antivibration, a system that makes the saw less exhausting to handle in long carving sessions.) We've found that smaller saws aren't up to the work and larger ones are too heavy. What saw you select depends in the end on your size and the scale of work you plan to do. A Stihl AV45 weighs 15 lb., has a 16-in. bar (bars up to 30 in. long are available) and generates 4.5 hp. It can be used to carve pieces ranging in size from large bowls to 8-ft. sculptures.

A gasoline saw is very noisy—ear protection must be worn—and its exhaust fumes mean it can't be used indoors.



Left, maple bowl by Werner (24 in. high, 14 in. wide, 19 in. deep). Above, Werner's 'Double-Pocket Form' (walnut, 29 in. high, 22 in. wide, 17 in. deep).

The electric saw, quieter and without fumes, is excellent for indoor carving and is especially suited to final shaping of a piece. A Milwaukee, for example, has both a 16-in. bar and a 20-in. bar and weighs 18 lb. It is large enough and powerful enough to carve major pieces, and because it runs at a constant speed, it's easier to control than a gas saw. But it feels very heavy after a long working session. A lighter, less expensive saw is fine for small, detailed carving.

Before carving, the basic lines of the piece are marked directly on the log with chalk. It's best to strip off the bark first, since it veils the shape of the wood and often has embedded dirt, which quickly dulls the chain.

We begin, much as a whittler begins, by paring gently curved slices from the log, the way a penknife cuts shavings from a stick. These first slicing cuts are made with the center of the bar, with the tip entirely clear of the wood. For deeper cuts and tighter curves the technique is similar to chip carving—two angled cuts meet at the desired depth toward the center of the log to release a large wedge or block of wood. In this way the bulk of the excess wood can be removed, leaving an angular, faceted form.

Next, the hollows and concave areas are worked into the form. To develop a hollow, we use the tip of the saw to make a series of closely-spaced, parallel cuts. Each cut starts at the farthest side of the hollow, with the bar held at right angles to the surface and the length of the saw at an acute angle to the wood so that the bottom of the nose makes first contact. Then the saw is drawn across and the nose dropped into the wood to feel out the bottom of the hollow. A felt-tip marker line on the bar can be used to gauge depth. A deep concavity can be worked in several stages. As the cut gets deeper, the saw's speed must be increased. Working this way, the nose of the saw is never close to a 90° corner and so it won't kick back. Then another series of close, parallel cuts is made at right angles to the first set, creating a checkered pattern. The resulting squares of wood measure an inch by an inch or less and can easily be kicked or knocked away by brushing back and forth with the tip of the saw. When the squares have all been poked out, the hollow is cleaned up and and its shape is refined with the tip of the saw, scraping back and forth to make an even surface.

Extreme care must be taken in tight hollows. When the tip is near anything close to a right-angled corner, the cutters can catch on the upper wall and throw the bar back toward the operator's head and body. Always be wary, especially near a tight corner, and expect the kickback. Try to absorb and control it by holding the saw firmly in front of the body, below waist level, with the arms kept straight.

Some saws are made with an anti-kickback device, usually a lever that, when triggered, instantly stops the chain. When a kickback does occur, the operator's wrist hits the lever before the saw can rotate back far enough to do damage. However, the safety device won't trip if the operator holds the front handle on its side, rather than on top. We've also used anti-kickback chain, which has a double raker tooth, and have found that kickback occurs less frequently.

The plunge cut is another way to remove a large, mostly surrounded chunk of wood, such as that removed to form the hollow between the seat, back and arms of a chair. The wood is approached with the bar at a slight angle. As the nose begins to cut, the motor is quickly lifted and the bar is pushed straight into the log. A very sharp chain and high

From tree to finished form: Above, Werner begins with a promising walnut trunk that includes the stump of a branch. First he chalks the lines on the log and slices away the waste. Convex forms are refined and smoothed by scraping lightly back and forth with the edge of the saw bar. Deep pockets are formed with the nose of the saw by tracing a cross-hatch pattern and breaking away the waste. Top right shows the sculpture as shaped by the chain saw. Right, 'Two-Hooded Form' has been dried, finish-carved and sanded (66 in. high).

motor speed are necessary right from the start so the chain doesn't catch and recoil or jam. When the blade is plunged to full depth, the cut can be made into a slot before the saw is withdrawn. Successive slots are made around the waste wood, to free it as an intact chunk.

A large cutout can be started with a plunge cut. But thin walls and delicate pierced forms require scraping from both sides at the center of the area to be cut out to produce a small circular breakthrough that can be enlarged.

With the bulk of the waste removed, we mark out the precise lines and edges desired with chalk. The tip of the gasoline saw is used to trace over these lines carefully, repeating several times to reach the proper depth. Exact contours can be achieved by scraping the bar or tip back and forth across the wood, the face of the bar at right angles to the surface. Here the electric saw is best. A broad, sweeping motion with even saw pressure shapes large curves; a slight change in the approach angle of each sweep prevents the bar from falling into the grooves created by previous cuts. Consistent pressure with rhythmic motion produces smooth, controlled surfaces.

Grain direction is the crucial factor in determining the thickness of a wall. When a section of a carving is made up of head-on end grain, we rarely carve it thinner than three or four inches and expect it will crack. A long-grain section, on the other hand, can be as thin as half an inch and will usually remain intact. On an irregular form, most of the walls are somewhere between these two situations and one must learn through experience what's safe. If we make an error in judgment and part of a carving cracks right off the main form, the piece can be redesigned, even if only as firewood. If a lot of work has already been invested, a broken piece can be rejoined with dowels and glue, or with an inlaid butterfly key.

Many of these operations, raking and scraping in particular, are very hard on the saw bar and chain. It is necessary to keep the chain sharp at all times and the saw may have to be sharpened several times a day. A small electric sharpener works well for grinding out chips caused by dirt, stones and metal in the wood. A hand file with a chain-saw sharpening gauge is fine in the field. We usually file the teeth at a 35° bevel, switching to 30° for very hard or frozen wood. It's important to make the same number of file passes on each tooth, to keep them even. Irregular sharpening will cause the bar to wander as it cuts and control will be difficult.

When carving green wood, shield the piece from direct sun, which rapidly causes checking. The wood should be kept close to its original moisture content while it is being worked and can be shrouded in plastic to be left overnight. A large carving in green wood will inevitably crack and check. It doesn't take much experience to predict where cracks are likely to open and how serious they are liable to be. Cracks are virtually certain on end-grain sections and on surfaces containing the pith of the tree. We accept the cracks as an important part of the texture of the work; all we do is soften the edges to prevent splintering and integrate the cracks into the piece. Sometimes a crack pattern enhances the work so much that it is worth enlarging, or altering the design to play it up. But sometimes an end-grain section is too delicate to withstand checking, and the best solution is to coat that part of the wood with white glue to retard drying.

When we're done with the chain saw, the work has a rough texture but it is very close to its final form. The wood must be dried before it can be sanded and finished. We store pieces in

Elm lounge chair by Brooks (36 in. high, 54 in. long, 26 in. wide). Carving sequence is shown at right.

a shed or garage for at least four months, usually for a year, and sometimes for two years, depending on wall thickness and species. When a piece is about ready for finishing, we store it indoors for a couple of months first. We've experimented with shaping, sanding and oiling the green wood directly, thinking the oil might slow down the drying. But the escaping moisture destroys the finish and the wood surface changes too much during drying. We now season everything before the final sanding and oiling.

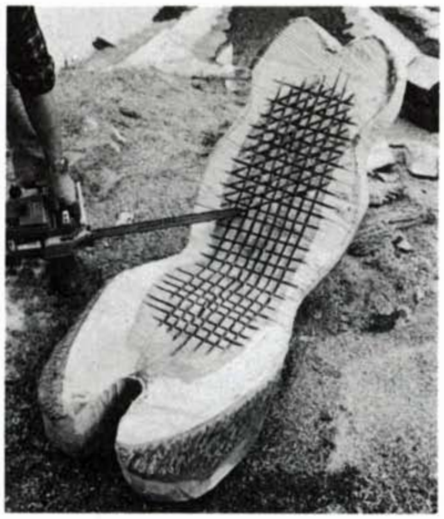
From the chain saw we go to a sander-grinder with a 7-in. disc, the type used in auto body shops. Sometimes we begin with a pad as coarse as 16 grit, but 36 grit or 50 grit is usually coarse enough to remove the chain-saw marks and refine the contours. Then we go to 80 grit and 100 grit, to smooth the surface wherever the grinder is able to reach.

We like to go directly from chain saw to grinder, but sometimes a more detailed form or the slower evolution of a design requires more refined tools. Carving gouges, a ball mill (a cutting burr about the size of a golf ball), Surforms, rasps, rifflers and files are the most useful. Standard bench planes make quick work of large convex surfaces, and violinmaker's planes also help. The Surform is especially effective in shaping difficult edge contours. When a shape cannot be achieved with one tool, we try another. Our techniques aren't rigid—they develop and change from one piece to another.

For final finishing an electric drill with a foam-backed pad is used, starting with coarse grit and working slowly up to 220 grit. These pads are small and will fit into areas the grinder can't reach. Still, there are always areas too small for the disc and they can be reached with rifflers, files and sandpaper backed with leather or Styrofoam, or wrapped around a small wooden block. On any piece, the sanding takes much more time than the carving.

Last, we sand by hand, using a leather backing pad or a Styrofoam block to remove swirls and scratches left by the disc. Then the work is ready to oil. We've used Watco oil, but we've come to prefer at least three coats of a 1-2-3 mixture of boiled linseed oil, varnish and turpentine. After the last coat has dried for at least 48 hours, we apply a good-quality paste wax and take care to avoid build-up in the cracks. □

Jon Brooks, 32, makes furniture in New Boston, N.H. This winter he is guest instructor in woodworking at Rochester Institute of Technology. Howard Werner, 26, an RIT graduate, is craftsman-in-residence at Peters Valley, Layton, N.J.



Elm lounge chair begins as a cylinder of tree trunk. First, great wedges of wood are removed to block out the chair form. Brooks pares the outline of the chair, then hollows the seat and back by cutting a crisscross network with the nose of the saw. Then he simply kicks away the waste wood.

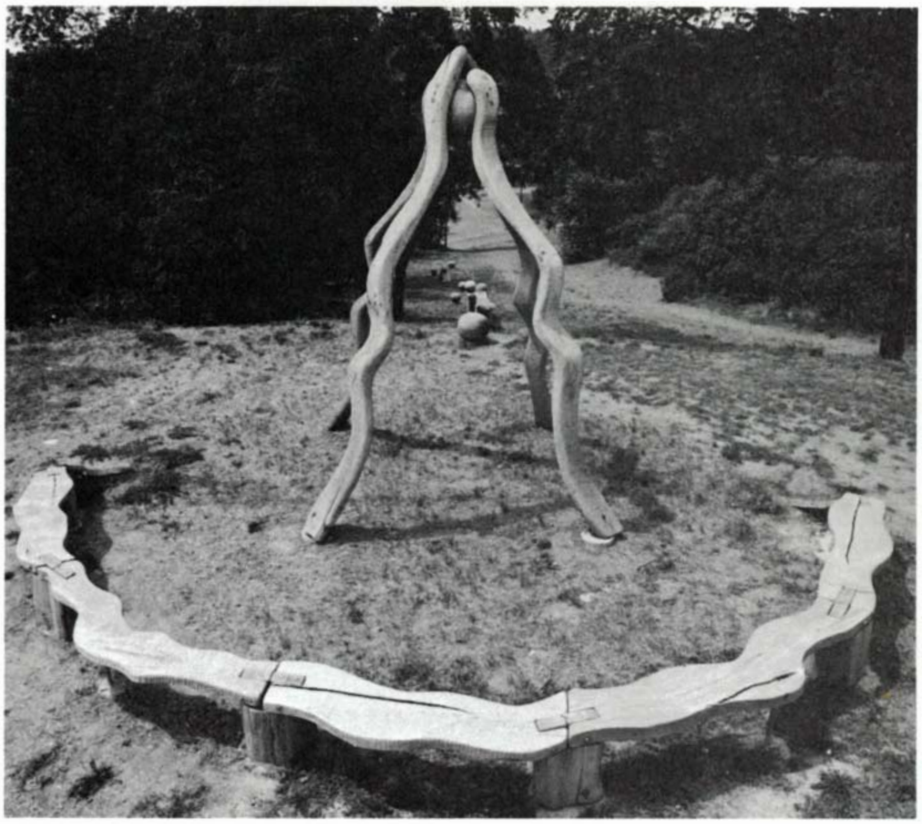
Shapes and Forms

The shapes and forms of my finished pieces can be divided into two categories. The first category has been influenced by the shape of the original found material. An example is the walnut chair, which is carved within the limits and integrity of the original crotch section of the tree. Sometimes I rough out a chair to expose the figure of the wood and leave it as a block to study. The outside shape is determined by reflecting the grain patterns—parts are emphasized or played down to get the desired effect. Root sections, curved limbs and trunks are also forms that will influence these pieces.

The second category begins with a straight, cylindrical section of wood. Then I impose a preconceived idea by working subtractively and releasing the form. Examples of this are 'Wood Falls' and the elm chair. Landscapes, horizon lines, water, cloud formations and the wood grain itself are elements which influence the form. 'Wood Falls,' conceived at Art Park in Lewiston, N.Y:, is an attempt to reflect the nearby Niagara River and to capture the feeling of wood rolling down a slope toward the river. This piece asks the viewer to become visually and physically involved by providing benches for seating while viewing the landscape and the wood forms. People have made a path beside it down to the dock on the river. The exterior shape of the elm chair is an attempt to capture the human form. I tried to create the illusion of a seated person, which a person would sit upon. It was basically preconceived as a lounge chair and carved from a cylindrical tree section.

Because wood is a warm and inviting material, it is easy for one to become physically involved when it has been sanded and oiled to a very smooth surface. The rounded forms relate to the human form and to the wood grain. Too often in viewing solid objects we tend to see only the exterior form. As wood splits in drying it reveals an inner spirit and force. Rounding the splits on the surface unites the exterior form with the internal spirit and makes it easier to look at and touch. Wood splits, warps, expands, contracts; it has lived and it is living. While working with tree sections all these characteristics are heightened. To accept and move with these forces rather than to resist them is my primary objective.

—Jon Brooks



'Wood Falls' by Brooks is 15 ft. high, 15 ft. wide, and extends intermittently fpr 100 ft. down a hillside in the town of Lewiston, N.Y. It is carved in red oak, elm, maple and walnut, and permanently bolted to buried concrete pillars.

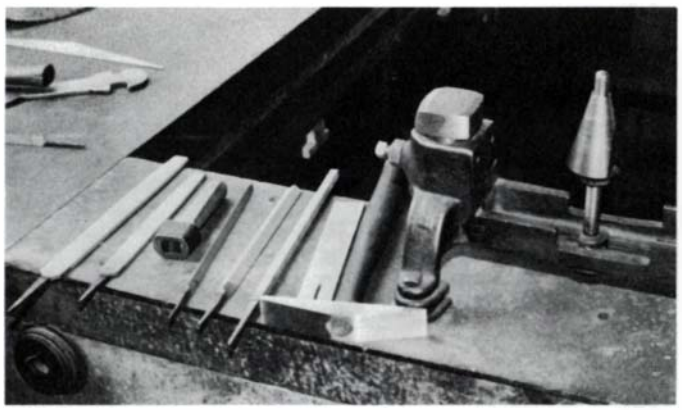
Circular Saws

How to keep them sharp and running true

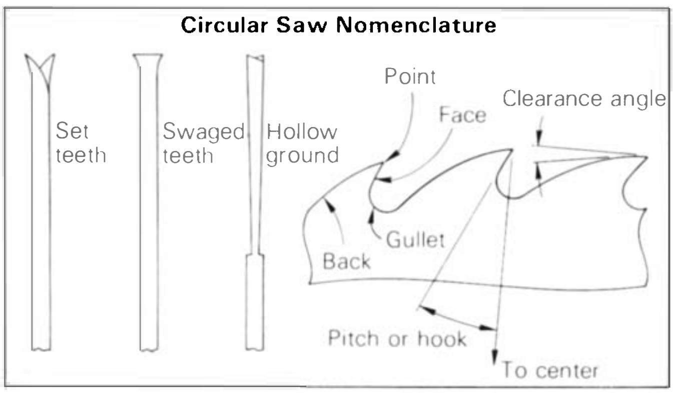
by Eugene Roth

Circular saws must be kept sharp. When a saw does not cut easily, it is usually dull or has lost its swage or set. Forcing the feed in these conditions will heat the rim of the saw, and the metal may expand and crack. The saw may also lose its tension and bend or break over the collar. A saw that wobbles and does not cut straight is dangerous to use and should be sent out for professional repair.

With practice and careful attention to detail, however, a woodworker can learn to sharpen and maintain circular saws in tip-top shape. The set and rake of the teeth can be adjusted to suit the type of work. The basic tools for sharpening are a good saw vise, which can be homemade, a setting stake and hammers, the correct files (mill bastard, round, cant, square mill and triangular tapered) and grinding wheels. The 60° triangular file is familiar to most craftsmen, but the cant saw file is not. It is also triangular in cross section, but with a 120° angle and two angles of 30°. It is used for sharpening saws with a very steep gullet angle, and for filing the face bevel of dado and combination blades. The square saw file is also used on dado and combination blades.



The saw-filing bench. Equipment shown here includes flat, triangular, cant and square files, swage (among files), setting hammer and anvil-and-stake (right). Conical stake accepts blades for various sizes of arbor, adjusts up and down, and moves along slot to position teeth over anvil.



Circular saws are usually described by the type of cut they are designed to make, as crosscut, cutoff, rip, miter, dado, combination or planer. But to prevent binding in the wood, all circular saws are widest at the very rim. This clearance is obtained in one of three ways: setting, swaging or hollow grinding. Most common rip and crosscut saws are set, which means the tips of the teeth are alternately and uniformly bent to the right and left. Cutoff and ripsaws designed for use in green lumber are usually swaged, which means the point of each tooth is spread by hammering with a small anvil. Combination and planer saws are usually hollow-ground, which means the tips of the teeth are as thick as the hub of the saw, and the metal in between is ground thinner to provide clearance. When a new blade is purchased, it is wise to trace around it, or make a carbon-paper rubbing, to serve as a pattern later on.

There are four operations in sharpening all flat circular saws: jointing, gumming, setting or swaging, and filing sharp. To know when the saw is getting dull, watch the corners of the swage or set. They may seem sharp to the touch, but close examination will reveal a slight roundness, which will make the saw feed hard and not cut properly. Although the set seems full, the saw will bind just back of its points. The saw must be jointed below the rounded corners, and each tooth brought back to a nice, keen point.

A common error is allowing a saw blade to accumulate gum and pitch on the sides, which may cause it to run hot and snake. The best way to remove the gum is to soak the saw for a while in a strong warm solution of Oakite in water, and then rub it clean in a small box of sawdust. The gum will come right off, and the Oakite solution can be kept in a covered jar and used over and over. Never scrape off gum with a sharp tool because this will mar the finish and make the blade more susceptible to buildup.

Jointing

The first operation in sharpening by hand is jointing, to make all the cutting teeth the same height. If every tooth does not do the same amount of cutting, the unequal strain on the high teeth may cause cracks. If several teeth are unusually high, they may break off upon encountering a hard knot.

Professional saw-jointing equipment includes a powered grindstone mounted with a fixed center on which the blade can pivot. Lacking such a machine, the craftsman can joint

Eugene Roth is a foreman at Huther Bros. in Rochester, N.Y., once a leading manufacturer of circular saws and carbide-tipped blades. Huther still makes and repairs special-order saws, but most of the plant is now devoted to grinding flat and circular knives for the paper, plastic and cardboard industries. The hands in the photos belong to Eric Michaud, the only craftsman left in Huther's once-bustling filing room.

right on the table saw by using a flat vitrified medium jointer stone or a piece of broken emery wheel. The blade is reversed on the arbor and revolved at full speed, and the stone is lightly but firmly pressed against the points of the teeth. Lower the blade below the surface of the table, press the stone over the slot in the table, and slowly raise the blade. Raise it enough to grind a small shiny flat at the top of each tooth.

Gumming

Repeated filing is bound to make the teeth shallow, and grinding the gullets deeper is known as gumming, although a saw does not need to be gummed every time it is sharpened. A blade is gummed on a bench grinder with a grade 1-6 VL emery wheel, with its edge dressed round, or use an 8-in. or 10-in. round second-cut file. To keep the saw in balance, all the teeth should be gummed to the same depth. It is easy to make a simple wooden compass with a dowel center to fit the saw's arbor hole, as shown in the drawing on the next page. Use a colored pencil to mark a circle the proper distance below the points; the distance can be gauged from the tracing made when the saw was new. Then grind until the bottom of every gullet just touches the edge of the circle. Generally, gullet depth is two-fifths of the distance between the points of the teeth.

When gumming, go around the saw several times so as not to crowd the wheel by taking too deep a cut. Taking out too much metal at one time will heat the gullets and stretch the rim, and the saw will then need expert hammering on an anvil to restore its original tension. Crowding the wheel will also blue and burn the gullets, and often glaze the metal so hard that a file will not touch it. From these hard spots small cracks begin, at first invisible but gradually enlarging until they become dangerous fractures.

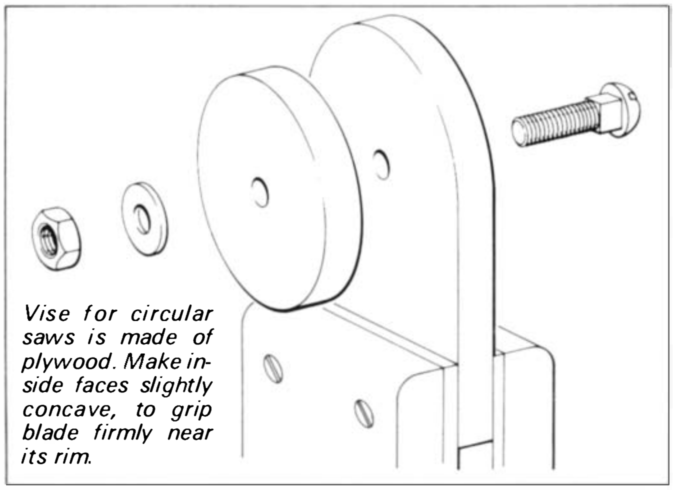
After gumming, the saw should be lightly jointed before continuing with the sharpening, to make sure it's still round.

Setting

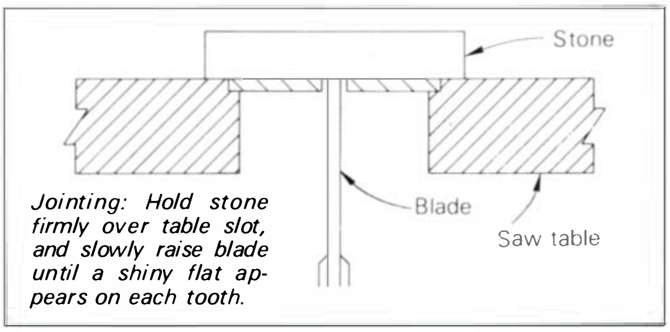
A uniform, even set is most essential for an easy-running, smooth-cutting saw. An uneven set places a greater strain on some teeth and may crack them. Too much set not only puts an unneccessary strain on the rim of the saw, which can result in cracked gullets or broken teeth, but also causes it to chatter or vibrate, resulting in a rough cut. Vibration heats the rim and gullet cracks appear. If the teeth are set more to one side than to the other, the saw will lead to the side with the heavier set and may break.

There are two ways of setting teeth: with an anvil and stake, or with a saw set. The anvil and stake consists of an adjustable, conical center post that slides on iron ways to allow the edge of the blade to rest precisely over the beveled edge of a small anvil. Different anvils may be used, depending on the size of tooth and amount of set required. A special setting hammer, which has a small, flat face, is used to bend alternate teeth over the anvil. Then the blade is turned over and the process repeated.

A saw set bends the teeth by leverage rather than by pounding. It consists of a series of slots for different lengths and thicknesses of teeth, and is mounted on a handle with an adjustable gauge for regulating the amount of set. When placing the set on the tooth, permit it to drop until the point of the tooth touches the bottom of the slot, then bend the tooth over until the gauge touches the side of the saw.



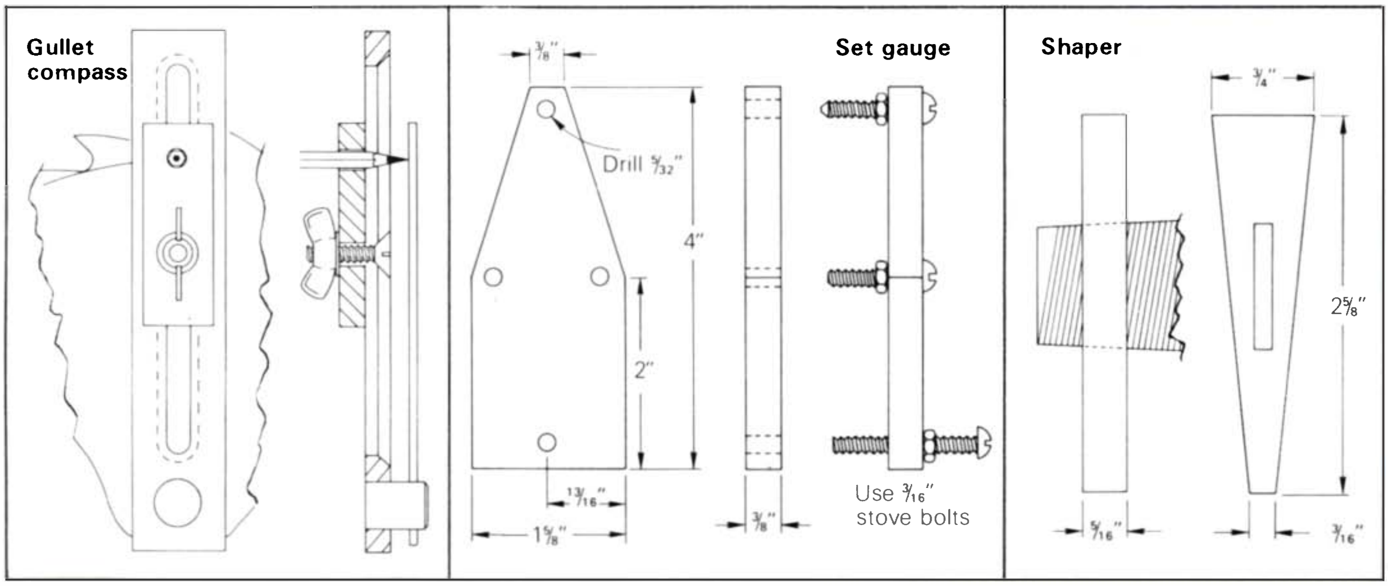
Vise for circular saws is made of plywood. Make inside faces slightly concave, to grip blade firmly near its rim.



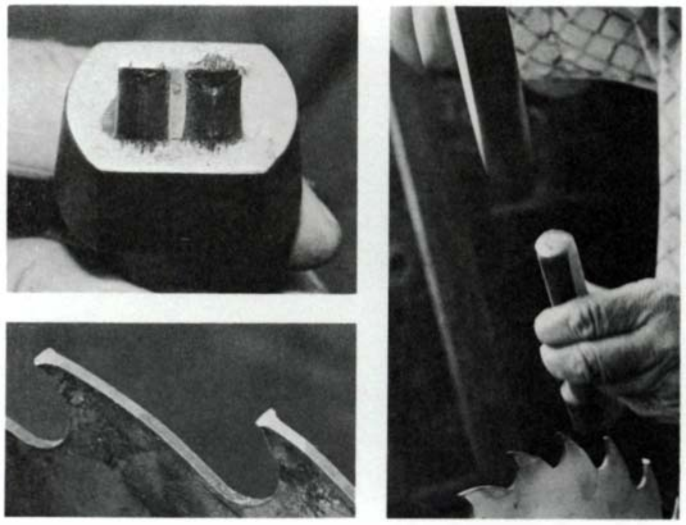
Jointing: Hold stone firmly over table slot, and slowly raise blade until a shiny flat appears on each tooth.

Thin, round-edge grinding wheel (left) is used to gum a saw blade. Balance is checked, right, by mounting blade on dummy arbor and rolling along parallel knife edges.

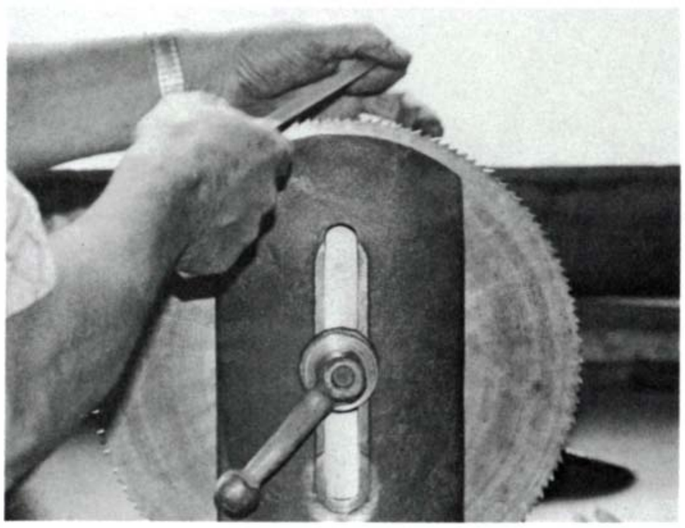
With anvil and stake, one sharp tap per tooth sets the saw.



Three saw-filing gauges. Adjustable compass, left, establishes uniform gullet depth for gumming. Set gauge, center, checks the set of each tooth. The top screw is first filed sharp, then the point is flattened to about 3/64-in. dia. Adjust the bottom screw to the desired set. Right, a shaper holds the file at the correct angle for regulating the set of swaged teeth. Its long side slides on the face of the blade.



Swage, top, is placed on each tooth of ripsaw and tapped sharply to spread point. In close-up, left tooth has been spread with convex die, right tooth has then been squared with straight die.



Filing a crosscut saw: Both hands push the file in long, rhythmic strokes powered from the shoulder to ensure uniform teeth.

Since only the points of the teeth do the cutting, the set should not extend more than one-fourth of the distance down the tooth. If the set extends too far down the tooth, the blade will vibrate and cut roughly. The amount of set, as measured from the plane of the blade, varies according to the type of wood and the smoothness of cut desired. A fine set does fine work; dry hardwood requires less set than green hardwood, and softwood requires more set than hardwood. The amount of the set is always less than the thickness of the blade, and usually less than half the thickness. For dry hardwood, the set is usually .012 in. to .015 in.; for green hardwood, .015 in. to .018 in. Electric hand saws, because of the rough work they have to do, require a heavy set—around .02 in. or even more.

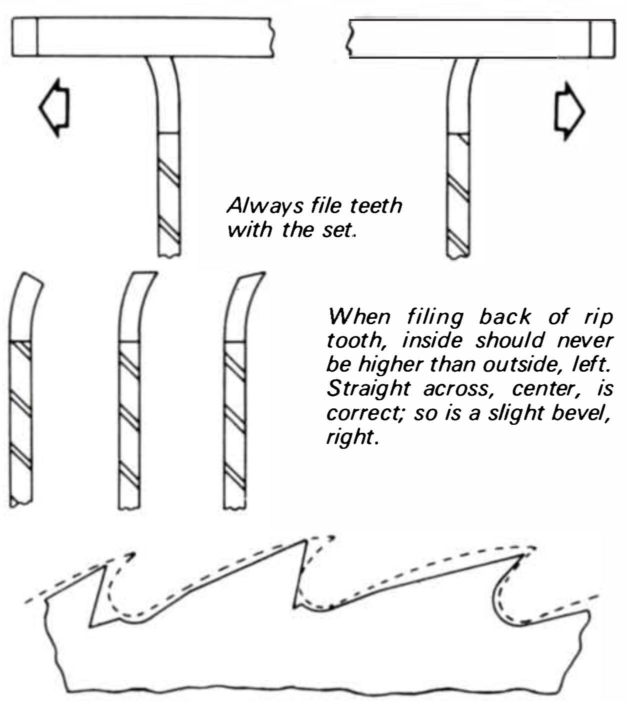
After determining which set works best for a particular type of cut, it is well to make a simple side gauge, as shown in the diagram, to check the set of each tooth.

Swaging

Swaging is spreading the point of every tooth. A swaged saw will cut more wood than a set saw because every tooth is cutting on both sides, and it will take a faster feed and more power. On the other hand, the cut is rough. Ripsaws for green lumber and production saws are generally swaged. Any type of saw may be swaged, although if the blade is too thin the swaged corners will be needle-pointed and fragile. If it is too thick so much pressure will be needed to spread the metal that it may crack.

Before swaging, joint, gum and file all teeth sharp, using an 8-in. or 10-in. mill bastard with two rounded edges. Swages, which are hand-held anvils with two dies set in the face, are sized according to the thickness of the saw blade. One of the dies is convex, one is flat. Use the convex die first and keep a drop of oil on it. Set the swage atop the point of the tooth and strike several light, quick blows with a small setting hammer. Keep the swage straight, so the die centers on the tooth. Then use the straight die to square up the cutting edge and give body to the swaged point.

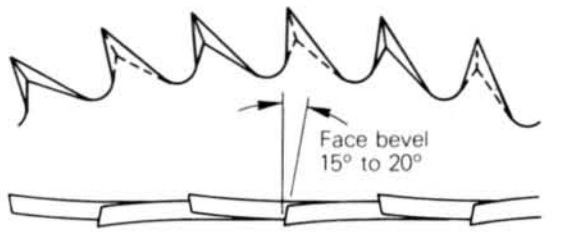
Lightly file the sides of the teeth with a shaper, to even up the swage. A shaper can easily be made from a scrap of hard-



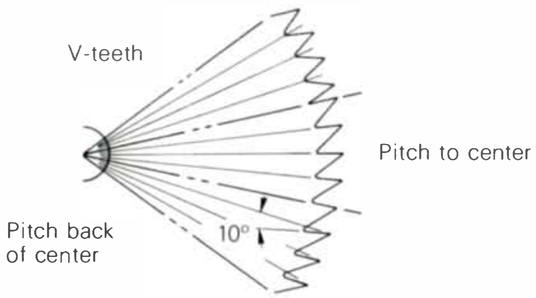
Always file teeth with the set.

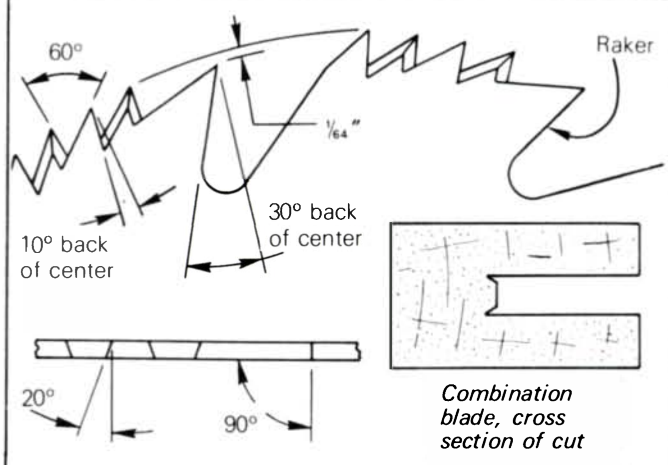
When filing back of rip tooth, inside should never be higher than outside, left. Straight across, center, is correct; so is a slight bevel, right.

Common errors: too much filing on face leaves sharp corner, left, or too little hook, center; too much filing on back, right, changes clearance angle.



Crosscut teeth are beveled on the face opposite the set, top. V-teeth, below, are best for coarse cutoff saws; pitch-to-center teeth are most common; smooth trimmer saws are hooked about 10° back of center.





Combination blade, cross section of cut

wood, as in the drawing. Its long side slides on the face of the blade, to guide the file at the proper angle. Use the set gauge to keep the swage uniform. Then file straight across the underside of the tooth and across the top, very lightly, with an 8-in. or 10-in. mill bastard. Be careful to maintain the original angle of the tooth and avoid dubbing off the swaged corners, as this will reduce side clearance and cause the saw to bind and burn in the cut. Finally, use a round 8-in. or 10-in. second-cut file to clean out the gullets.

Filing ripsaws

For a rip saw to cut fast and easily, the teeth should be hooked so that a line along the face passes halfway between the center of the saw and the rim (about 30° and known as 1/3 hook). When filing a ripsaw with set teeth, use an 8-in. or 10-in. mill bastard file, and maintain the original hook, shape and angle by taking the same amount off the back and front of the tooth. Usually the backs are filed straight across, though some prefer a slight bevel (about 5°). Too much bevel produces a lateral motion that causes the teeth to chatter and vibrate in the cut. When filing the backs, file every other tooth on one side all around the saw, with the set; then reverse the saw in the vise and file the other teeth, with the set. This is the only way to file the backs uniformly, either straight or with a slight bevel. The inside edges should never be higher than the outside ones.

Keep the gullets round with an 8-in. or 10-in. round second-cut file. Cracks are most often caused by sharp corners in the gullets.

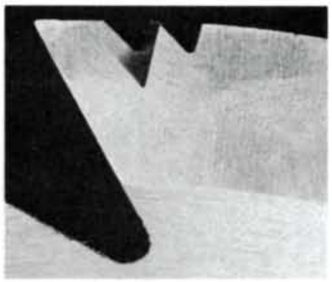
Filing crosscut saws

Joint, gum and set the saw. For coarse-tooth cutoff saws use an 8-in. or 10-in. mill bastard with two rounded edges; for saws with a pitch of 5/16 in. to 3/8 in. use an 8-in. cant saw file; for pitch 1/4 in. or finer use the cant saw file or a slim triangular file. The flat file used on large saws can sharpen only one face of a tooth at a time, but the cant saw file and triangular files catch the face of one tooth and the back of the next on each stroke. A face bevel in the 15° to 20° range is usually recommended for hardwoods. A somewhat longer bevel is sometimes used in softwoods, and a slightly shorter bevel in very hard woods. Must cutoff saws are made with pitch-to-center teeth and some are pitched slightly back of center, while others have V-shaped teeth. Try to keep the gullets round.

Planer saws

Planer saws are hollow-ground, and are designed for precise, smooth cuts both with and across the grain. Their teeth are in groups of three to six crosscut-type cutting spurs, followed by a deep gullet and a rip-type raker tooth. The raker is sharpened flat across the back, 1/64 in. lower than the cutting spurs. The spurs sever the wood fibers on each side of the kerf, then the raker comes along and cleans out the core of the cut. Flat-ground novelty and combination saws cut in essentially the same way, and it is particularly important with all saws of this type to make an accurate template when the saw is new, as a guide for sharpening.

To file a planer saw, you should have a special raker gauge to keep the rakers a uniform 1/64 in. lower than the spurs. Without such a gauge, joint the blade on the circular saw, then take the rakers down by filing the same number of strokes square across the back of each. Then file the spurs



All the spurs in a group on a dado blade, left, are alike. In blade blank above, right gullet is typical, left is correct.

with a 20° face bevel, maintaining the original hook (usually 10°), using the 8-in. cant saw file or the square mill file.

A block of hardwood can be used as a gauge to keep the raker teeth uniform. After jointing, leave the blade on the saw arbor and adjust the height until it can be locked by jamming a piece of plywood into a gullet and clamping the plywood to the saw table. The top raker should be very close to parallel to the table surface—adjust the height until it is parallel. Now make a block a fat sixty-fourth lower than the back of the raker, and rest the mill file on it to shape the tooth. Moving the plywood stop to the next gullet should index the next tooth, and so on around the blade.

Dado heads

First, joint the entire dado head, including all the inside cutters. File the spurs on the outside saws with a 10-in. square mill file, keeping the original bevels and stopping when the teeth just come to a sharp point. Then file the rakers and inside cutters across the top until the flat left by jointing is just gone, and finally take the same number of strokes on each raker and inside cutter. As with planer saws, the rakers and inside cutters should finish about 1/64 in. lower than the spurs, but the precise amount is not nearly so important as uniformity—use the whole length of the file on each stroke, and follow through from the shoulder. Do not touch the face of these teeth except to remove the burr left when the tops are filed.

Saw manufacturers and repair shops commonly joint all the spurs just enough to remove the dull points, then set the stop on their machine 1/64 in. deeper. They joint all the rakers and inside cutters just enough to remove those joint marks. After repeated sharpenings, it becomes necessary to gum the saw and reset the spur sections.

The spur sections of most dado heads manufactured for the home craftsman are ground straight across, with no face bevel. They will cut much better if all the spurs in a group between a pair of rakers are beveled about 20° one way, and all the spurs in the next group are beveled the same amount on the other side. Use the square file at a steep angle (about 30°) to the face of the blade, and be careful to keep all the teeth the same length. □

Sources of supply

Saw-filing tools are usually sold by large hardware stores and industrial hardware suppliers. For mail order, consult the catalogs of Woodcraft Supply Corp., 313 Montvale Ave., Woburn, Mass. 01801 and Silvo Hardware, 107-109 Walnut St., Philadelphia, Pa. 19106. Brands to look for are Nicholson (files), Disston (setting tools) and Simonds (all saw tools).

Louvered Doors

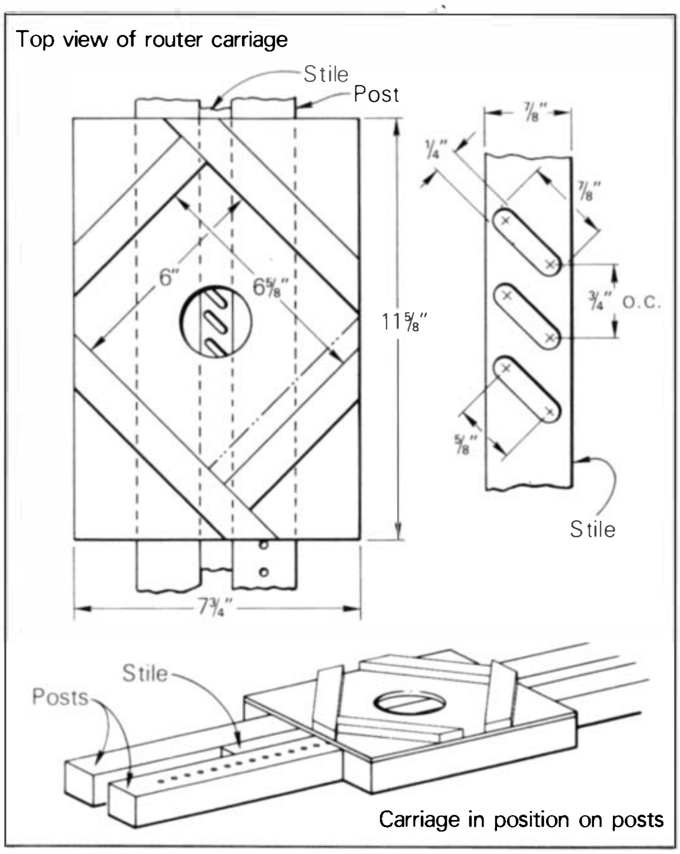
Router jig cuts slots

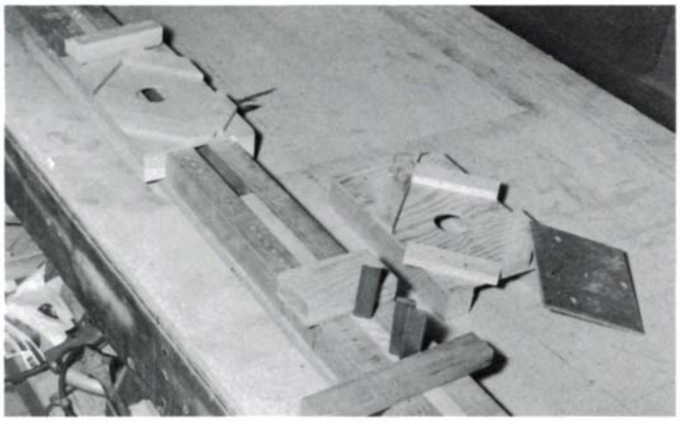
by William F. Reynolds

Woodworkers at the U. S. Capitol are often called on to match the decor of an earlier age. When the Architect of the Capitol decides that a room must be renovated or redecorated, woodworkers like Ned Spangler, a cabinetmaker for the U. S. Congress, must rise to the occasion and improvise techniques to carry out the project. An example of the challenge, and the solution, is the production of louvered doors. Before air conditioning, Washington offices were extremely humid, and louvers allowed air circulation into cabinets, which kept the contents from mildewing and prevented doors from sticking. Although louvers can be difficult and time-consuming to make, they are elegant and dignified.

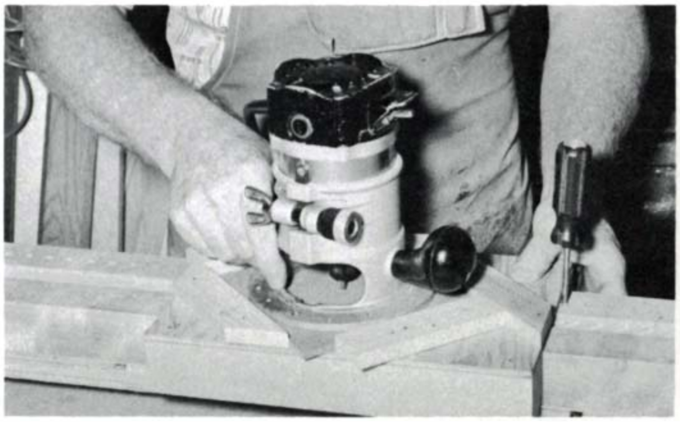
Spangler has a shortcut for making the louvered doors he is so often required to build. As Spangler says, "The job has to be done right, and right the first time." His router jig turns out slotted stiles quickly and precisely. It could be adapted to make a series of mortises, such as for crib slats.

The jig consists of two long hardwood posts mounted on plywood, a square piece of Masonite screwed to the baseplate of the router, and two router carriages that slide along the posts and guide the router as it cuts the equally spaced, mirror-image slots on opposite stiles. The jig shown here is designed for a 1/4-in. router bit, and for 7/8-in. thick stiles for a





Test slots are checked for accuracy of angle, fit.



Spangler routs a slot; screwdriver indexes carriage.

The completed door—elegant and dignified.

30-in. door, with 1-in. wide slats angled 45° and spaced ¾ in. on center along the stiles.

The posts, cut from birch or similar hardwood, should be long enough to hold the stiles firmly, with perhaps an extra foot on each end. For this jig, the posts are 5 ft. long and 1¾ in. square. They are mounted parallel to each other and ⅞ in. apart, on a plywood base, so that a stile fits snugly between them.

To mount the router, cut a 6-in. square from ¼-in. Masonite. In it drill three holes to match those for screws in the router base, and one of ¾-in. dia. in the center, for router bit clearance. Then screw the square to the base of the router.

Next, drill holes in the posts for stops for the router carriages. These equally spaced holes determine the spacing of the slots, and therefore of the louvers. Drill 1-in. deep holes, ¼ in. in diameter, down the top of either post, starting and ending 8 in. from each end. Space the holes for minimum clearance between louvers, in this case ¾ in. on center.

The two router carriages slide along the posts. At each stop, they allow the router to travel the exact length of the 45° slot it must make for the louver. To make these carriages, cut two pieces 7¾ in. by 11⅝ in. from ¼-in. plywood and lay out a 2-in. diameter hole at the center of each. These holes will help align the louver slots and allow clearance for the router bit. Cut four pieces, 2 in. by 1¾ in. by 11⅝ in. Nail two to the underside of each plywood plate, to form the carriage sides and keep it centered as it moves along the posts.

Four pieces, each 1 in. wide by ½ in. thick, position the router base plate atop the carriage and allow it to travel only far enough to cut a slot. Starting from the center of the uncut hole, measure to each side and lay out a rectangle 6⅝ in. by 6 in. at 45° to the sides of the plywood. The router base will travel within this rectangle. For the second carriage, the long sides of the rectangle should slope 45° to the other side; thus the two will produce mirror-image slots. Make sure that this is so before nailing the pieces in place to frame the rectangles. Then cut the 2-in. center holes. With this setup, the router travels ⅝ in. to make a slot ¼ in. by ⅞ in. long. If you use a bit larger than ¼ in., adjust the router travel distance to the length of the slot minus the diameter of the router bit.

To cut the first slot, set one stile between the posts and place the carriage on top. Mark the stile where you want the cut to end, perhaps an inch from the end of the stile, with the router travel from lower right to upper left. Stand a sample slat, cut short, on the stile inside the hole in the jig and align the sample so it marks the area for the first slot. Put a ¼ in. screwdriver in the post hole nearest the point where it will hold the jig in place while the slot is being cut. It may be necessary to move the stile slightly, leaving the screwdriver in the selected hole, to achieve perfect alignment.

Set the router bit to make a test cut, on this or on a test stile. Cut to the required depth, usually ⅜ in. to ½ in. Successive cuts are located by advancing the screwdriver to the next post hole and moving the carriage along.

To cut the slots in the opposite stile, use the second carriage. Always make a trial cut to check for alignment. If the first slot matches the one on the mating stile, then the others will too. If you have measured exactly, the job should go quickly and the louvers should fit the first time. □

William F. Reynolds is a Washington-based free-lance journalist and an amateur woodworker.

Small Workbench

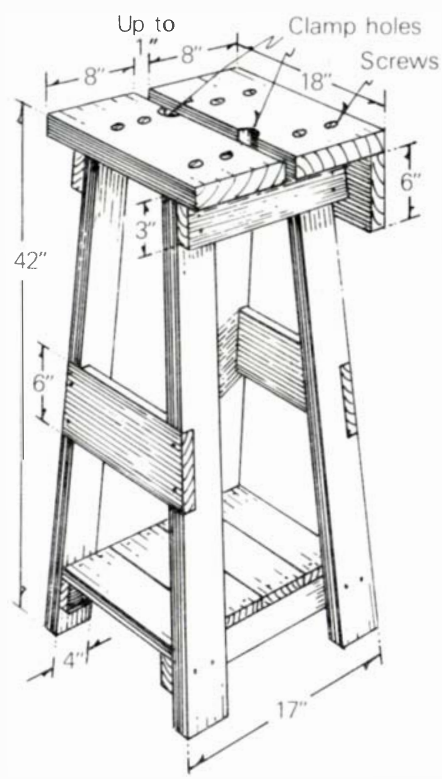
A simple and versatile design

by R. Bruce Hoadley

Everyone knows a workbench should be rugged and massive, "the bigger the better." But some years ago I set out to build a firm yet semi-portable stand for teaching and demonstrating. The little workbench that eventually evolved is now an indispensable part of my workshop. At first glance it looks like a traditional sculpture stand, and one might hastily conclude that it is too small, too frail and too tippy to be of general use to the woodworker—it simply doesn't look like a workbench. However, it does offer some noteworthy advantages.

First, it is tall. Most benches are 36 in. high or lower, but many—if not most—hand operations are more comfortable at a higher level. For me (I'm 6 ft.), a 42-in. bench makes all those little jobs like letting in an escutcheon plate, carving out a fan, or cutting a dovetail, much easier.

For woodcarving, a top surface of 12 in. by 12 in. is ideal: small enough to work all around, yet large enough to handle a sizable sculpture. For general woodworking the dimensions can be increased to about 16 in. by 18 in. (as shown). Getting much larger subtracts more than it adds.



Mini-bench with typical dimensions: Base frame of 2x4's supports hardwood top.

Making the top in two halves minimizes warping. High-density hardwoods such as oak, birch, maple and beech about 1½ in. thick are suitable. A one-piece top of 1-in. hardwood plywood might also do nicely. Cross support cleats should also be hardwood and the top should be fastened with heavy wood screws, lag screws or carriage bolts. Be sure fasteners are well counterbored below the surface. On my first model I set the screws flush with the surface and frequently hit them with carving chisels until I finally set them deeper.

The dimensions given here are only suggestions and can be modified for each person's specific needs.

The key feature of the top is plenty of clamping edges all around. The middle area has holes to stick C-clamps or quick-set clamps up through. Making the top surface in two halves with an ample slot down the middle adds to this versatility. A carving screw can be put anywhere along the slot, or the slot can be widened in places for clamps. Any number of holes or recesses can be added to accommodate your favorite vise, bench stop or holddown.

A vertical apron on one side might be bothersome to the carver, but helpful to the cabinetmaker for clamping stock to work on edges. Put rows of holes in the apron for support pegs.

The base frame must be stable and rigid, and 2x4's or similar lumber will do nicely. Splaying the legs adds stability but is not absolutely necessary. I try to make the frame with as much unobstructed interior space as possible and with a bottom shelf as low as possible for piling weight on. The first bench I built is at home, and I weigh it down with bricks and stones because I happen to have them: bricks in the cellar shop, stones when I move the bench to the garage or backyard to carve in the summer. Lead would be ideal ballast.


Wet sand anchors outdoor bench.

Behind our little summer house on Cape Cod, my favorite carving place, I have another bench, built from wood recycled from the town dump. I enclosed the entire bottom assembly with plywood and once it was set in location, filled it with sand for ballast. Then I slowly poured in as much water as the sand would absorb. The bench has been in place for four years and is now settled in rock solid. Occasionally I water it. A plastic trash bag keeps the top dry when the bench is not in use.

At the laboratory where I work, I have a third bench, as a teaching aid and for research setups. To weigh it down, we pile the base with assorted scrap metal.

This mini-bench will never replace traditional workbenches, but it might well be a good first bench for the woodworker with limited space. Once you've built and used such a bench, complete with your favorite accessories and modifications, you'll understand why it's the "teacher's pet." □

R. Bruce Hoadley, a carver, is a wood technologist at the University of Massachusetts and a contributing editor of Fine Woodworking.

Woodworking Periodicals

We've been collecting magazines, journals and other periodicals of interest to woodworkers. The listings here give the name of the periodical, frequency of publication, price and subscription address. This is followed by the date and number of pages in the issue we skimmed, a word about its printing, and a description of its contents. We browsed as you would at a newsstand, looking for stuff about woodworking and noting what else was there.

Rates are per year for the U.S. subscriber. Most magazines offer reduced rates for longer subscriptions and charge extra for foreign ones.

This list is not exhaustive—we've left out some interesting magazines that publish only an occasional article about woodworking, as well as many membership journals of statewide craft and carving associations. You can uncover the ones in your state, if any, through their parent organizations. We hope readers will tell us about other periodicals they find useful, for listing in the future.

Craft professional

Crafts: bimonthly, $12.25/yr., 28 Haymarket, London SW1Y 4SU, United Kingdom; British equivalent of *Craft Horizons*.

Sept./Oct. '77, 72 pp., color: news, calendar of events, reviews of current exhibitions; articles on weaving in Cornwall, degree shows at college crafts programs, glass-blowing technique; photos of college crafts, items made for Queen's jubilee, prize-winning silver; directory of craft shops.

Craft Horizons: bimonthly, $18/yr. (with membership in American Crafts Council), 44 W. 53rd St., New York, N.Y. 10019.

Dec. '77, 86 pp., color: reviews of crafts film festival, books on pottery and weaving; letters; articles on health hazards in woodworking, European glass show, six ceramists, akari lamps, Andean weaving, taxation and home craft businesses, early Irish art, cloisonne, modern Spanish tapestry; photos of wearable crafts and table utensils; notes on current craft exhibitions nationwide, coming events, workshops, opportunities to show. Includes *Craft World*, news bulletin for professional craftsmen.

The Crafts Report: $13.50/yr., 700 Orange St., Wilmington, Del. 19801, "newsmonthly of marketing, manangement and money for crafts professionals."

Jan. '78, 8-page tabloid: letters, news; listings of galleries wanting crafts, exhibitions, competitions, shows and fairs; articles on two recent studies of craft economics, the various meanings of "discount," craft photography, display ideas, marketing techniques.

The Goodfellow Review of Crafts: bimonthly tabloid, $8/yr., 2839 Forest Ave., Berkeley, Calif. 94705, for and about craftsmen, all media.

Nov./Dec. '77, 24 pp.: letters, news, book reviews, listing of shows, fairs, classes; articles on Berkeley Potter's Guild, flute design, woodcut printing, Baulines Craftsman's Guild, taxes, running a crafts business, the arts explosion, federal crafts purchasing, traditional crafts in Gambia, preserving indigenous crafts.

The Working Craftsman: 5 issues per year, $9/yr., Box 42, Northbrook, Ill. 60062, for crafts professionals, all media.

Fall '77, 39 pp.: letters, columns by craftsmen on making a living, health hazards, fiber art, juried shows; brief book reviews; articles on American Crafts Council conference, how to sell fiber art to architects, how to get publicity; many pages listing coming craft fairs, shows, competitions, workshops, conferences, courses, new galleries, opportunities and information.

Woodworking

Chip Chats: bimonthly, $5/yr. (with membership in National Wood Carvers Association), 7424 Miami Ave., Cincinnati, Ohio 45243.

Nov./Dec. '77, 31 pp.: letters, book reviews, news about NWCA members and chapters, calendar of meetings and shows; articles on carving miniature sleighs, design ideas for woodcarvers, Alaskan wood carving, whittling; plan for Christmas-tree decorations.

Forest Products Journal: monthly, $35/yr. (with membership in Forest Products Research Society), 2801 Marshall Court, Madison, Wis. 53705, a scientific journal for wood technologists.

Dec. '77, 64 pp.: news, new products and literature, referral service, current patents, coming events; articles on guiding public research in forest products, utilization efficiency in harvesting, making lightweight panels from red oak bark, lumber truss design, durability of Douglas-fir heartwood, waterborne preservatives for western hemlock, comparison of lag screws and threaded nails in a typical structural joint, computer study of value yield in sawing logs.

National Carvers Review: quarterly, $5/yr., 7821 South Reilly, Chicago, Ill. 60652.

Fall '77, 44 pp.: letters, shop tips, new products, book reviews, calendar; articles on Florida carver Dick Snidow, carving during retirement, fruit-seed carving, ice sculpture, whittling, finish-carving a face, pad-cut marquetry, chip carving, turning lids, quality in carvings; plans for fish plaques, a walnut-shell turtle, boat scoop canape server, pretzel holders, a cowboy to adorn a mailbox, sleigh table ornament, painted watermelon plaque, arrow puzzles.

Newsletter of the Marquetry Society of America: monthly, $10/yr. (with membership in the society), from Lionel Kay, 355 E. 72nd St., New York, N.Y. 10021.

Jan. '78, 20-page mimeo: notes on executive committee meeting, regular membership meeting, with minutes; chapter reports, show committee report, award winners and president's annual report, beginners page, Q&A, tips, pattern of the month.

The Scale Cabinetmaker, a Journal for the Miniaturist: quarterly, $12/yr., Dorsett Miniatures, P.O. Box 87, Pembroke, Va. 24136. "...miniatures should be modeled from the standards established by some existing, full-scale prototype."

Fall '77, 64 pp.: letters, listings of classes, suppliers and dealers; plans and instruction for four 18th-century toys, marbled book paper, needlework rugs, miniature woodturning in the metalworking lathe, carving ball and claw foot, Chippendale tea table, arm chair, wing chair, sofa, farm kitchen, caned Empire couch, all at scale of 1 in. to 1 ft.

WoodenBoat: bimonthly, $12/yr., Box 78, Brooklin, Maine 04616, "for wooden boat owners, builders and designers."

Nov./Dec. '77, 116 pp., color: boating news, letters, book and music reviews, new products, Q&A; articles on knot tying, Polynesian canoes, building the Banks dory (series), taking the lines of an existing hull, marine glues, planking techniques, report and photos on a wooden boat festival, economics of boatbuilding, keel construction, one-man boatyard; short essays on a variety of boats, many with detailed line drawings and addresses for purchasing plans.

Woodworker: monthly, $12/yr., Box 35, Hemel Hempstead, Herts HP1 1EE, United Kingdom. "The magazine for the craftsman in wood."

Dec. '77, 52 pp.: articles on making a skateboard, carved chess set and table, layout of geometric motifs, memoir by an antique restorer, shop test of spindle shaper, 18th-century moldings, an antique plane, plans for Welsh dresser; continuing series on tree species, turning, making flutes; coming events, new products, Q&A.

The Woodworker's Journal: bimonthly tabloid, $7/yr., Sunset Lane, Washington Depot, Conn. 06794.

Jan./Feb. '78, 16 pp.: letters, tips, workshop income column; articles on sharpening planes, chisels; plans for Colonial dry sink, gossip bench, bookcase night table, all in pine; Shaker portable chest; Victorian washstand and mirror in mahogany; contemporary vanity mirror and aquarium stand; rustic wall plaque.

Workbench: bimonthly, $4/yr., 4251 Pennsylvania Ave., Kansas City, Mo. 64111. "Do-it-yourself professional guidance."

Feb. '78, 100 pp.: letters, books, shop tips, new products; articles on router template, vapor barriers and insulation, framing a room addition, prefab fireplaces, slab-top tables, plans for slide projector hideaway, flat-plate solar collector, big dominoes, upholstered sofa and chair, stool with Punjabi weaving, tape-deck cabinet.

Special interest

The Chronicle of the Early American Industries Association: quarterly, $8/yr. (with membership in association), write John S. Watson, Bldg. 8, Rotterdam Industrial Park, Schenectady, N.Y. 12306. For historians, collectors and users of antique tools in wood, metal, leather and other early trades.

G.A.L. Quarterly: $10/yr. (with membership in Guild of American Luthiers), 8222 South Park, Tacoma, Wash. 98408. News and information of interest to makers of stringed musical instruments. Each mimeographed issue contains several technical data sheets.

Industrial Education: monthly, $12/yr., 262 Mason St., Greenwich, Conn. 06830. "For teachers and administrators of industrial arts, vocational-industrial and technical education;" usually an article for the woodshop.

The Old-House Journal: monthly newsletter, $12/yr., 199 Berkeley Place, Brooklyn, N.Y. 11217, "renovation and maintenance ideas for the antique house," supplier listings.

School Shop: monthly, $10/yr. (controlled circulation), P.O. Box 8623, Ann Arbor, Mich. 48107. For high school industrial-technical teachers; usually an article for the woodshop.

World War I Aeroplanes: 5 issues a year, 15 Crescent Rd., Poughkeepsie, N.Y. 12601, supported by voluntary contributions and published "to bring builders and restorers of aircraft of the period up to the end of World War I together with parts, information, drawings, engines, and if possible whole aircraft."

Trade Journals

(Each of the following magazines is edited and published for a particular branch of the wood products industry. They all contain news and coming events, new product information, articles on industrial management, marketing and sales, production and new technology, and advertising by suppliers of materials and machines. Instead of detailing their contents, we've followed the publisher's address with the magazine's own description of itself, if any.

All of these magazines have controlled circulation, which means they are available free to people who work in their field. Write to them on your business letterhead to ask for a sample copy.)

Furniture Design and Manufacturing: monthly, $12/yr., 222 S. Riverside Plaza, Chicago, Ill. 60606.

Furniture Production: monthly, $10/yr., 804 Church St., Nashville, Tenn. 37203. "Edited for design, management and production executives in furniture and general woodworking."

National Hardwood Magazine: monthly, $10/yr., 1235 Shady Grove, Memphis, Tenn. 38134.

Plywood and Panel Magazine: monthly, $6/yr., 1100 Waterway Blvd., Box 567-B, Indianapolis, Ind. 46206. "Serving the world of plywood, veneer, particle-board and hardboard... manufacturing, marketing, industrial utilization."

Wood and Wood Products: monthly, $12/yr., 300 W. Adams, Chicago, Ill. 60606. "The national magazine of news and technology for the wood industry."

Woodworking and Furniture Digest: $18/yr., Box 3004, Wheaton, Ill. 60187. "America's leading woodworking and furniture manufacturing magazine since 1898."

Bent Wood

Steven Foley likes to bend wood. He uses the traditional techniques of steaming and laminating, and recently has added green steamed lamination to his bag of tricks. Green wood straight from the tree can be sawn into thin strips, steamed and bent around a form, and left to set overnight. The laminates are removed and force-dried for several weeks, then returned to the form and glued together. Foley reports that green wood steams and bends much more easily than kiln-dried hardwood, and it dries quickly without degrade when sawn to ⅛ in. or ¼ in. thick. The hanging swing shown here was finished six weeks after felling the tree.

Foley also uses a number of ingenious and elaborate bending jigs. One consists of a central mast with any number of adjustable pipe arms, each arm ending in a swiveling wooden pad. With it, he can obtain a rigid clamping surface anywhere along a curve in space. Foley's designs begin as pencil sketches and usually progress to a precise ¼-scale model in the same wood as will be used for the work itself.

Foley, 31, lives in Lake Oswego, Ore. He's been a professional woodworker for eight years. His bentwood furniture was shown last fall at the Contemporary Crafts Gallery in Portland, a large and beautifully lit place dedicated to promoting professional crafts.

—*Tim Mackaness*