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Issue No. 34 September/October 1993
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MAKING PRACTICE A PLEASURE

Whatever the sport—baseball, football, basketball or golf—no serious athlete would dream of playing an important game without training first. Woodworking is no different. You can't expect to produce quality work unless you practice the basic techniques. No gadget, no jig, no slick power tool can make up for a lack of basic knowledge and knack gained through hands-on experience. There aren't any shortcuts.

But let's face it: few people *like* to practice—it sounds too much like work. If you're one of those woodworkers who wants to get better but can't motivate yourself to practice, here's a little trick you can play on yourself to make practicing fun. I call it productive puttering.

The next time you're in between projects, just killing time in the shop, try doing something new, just for fun. Experiment—for example, if you've never flattened a board by hand, grab a plane and a scrap board and give it a try. Since you're not actually trying to *make* anything, you have nothing to lose but the wood and your time. It doesn't even matter whether you're successful or not. You win either way because you've

gained a little bit of hands-on experience that you didn't have when you started. It's a low-risk, high-reward situation.

Productive puttering has taught me a lot about woodworking. I like to experiment with finishing materials to see what works and what doesn't (remember chemistry sets?). I learned French polishing just by playing around with the materials and procedures I'd read about. I tried soaking wood in fabric softener and cold water to see if it would bend (it didn't). Sometimes I fiddle with antique molding planes to get the hang of sharpening and using them properly. I try cutting unusual joints just to see how it's done. I don't have much to show for these puttering sessions, but I have lots of fun, and I learn something. The skills that I perfect through my puttering often show up later in real projects.

So, if you want to improve your woodworking skills but you can't bring yourself to practice, try a little productive puttering. Don't worry about the results—just enjoy the process. Who says learning shouldn't be fun?

David Sloan
Editor & Publisher

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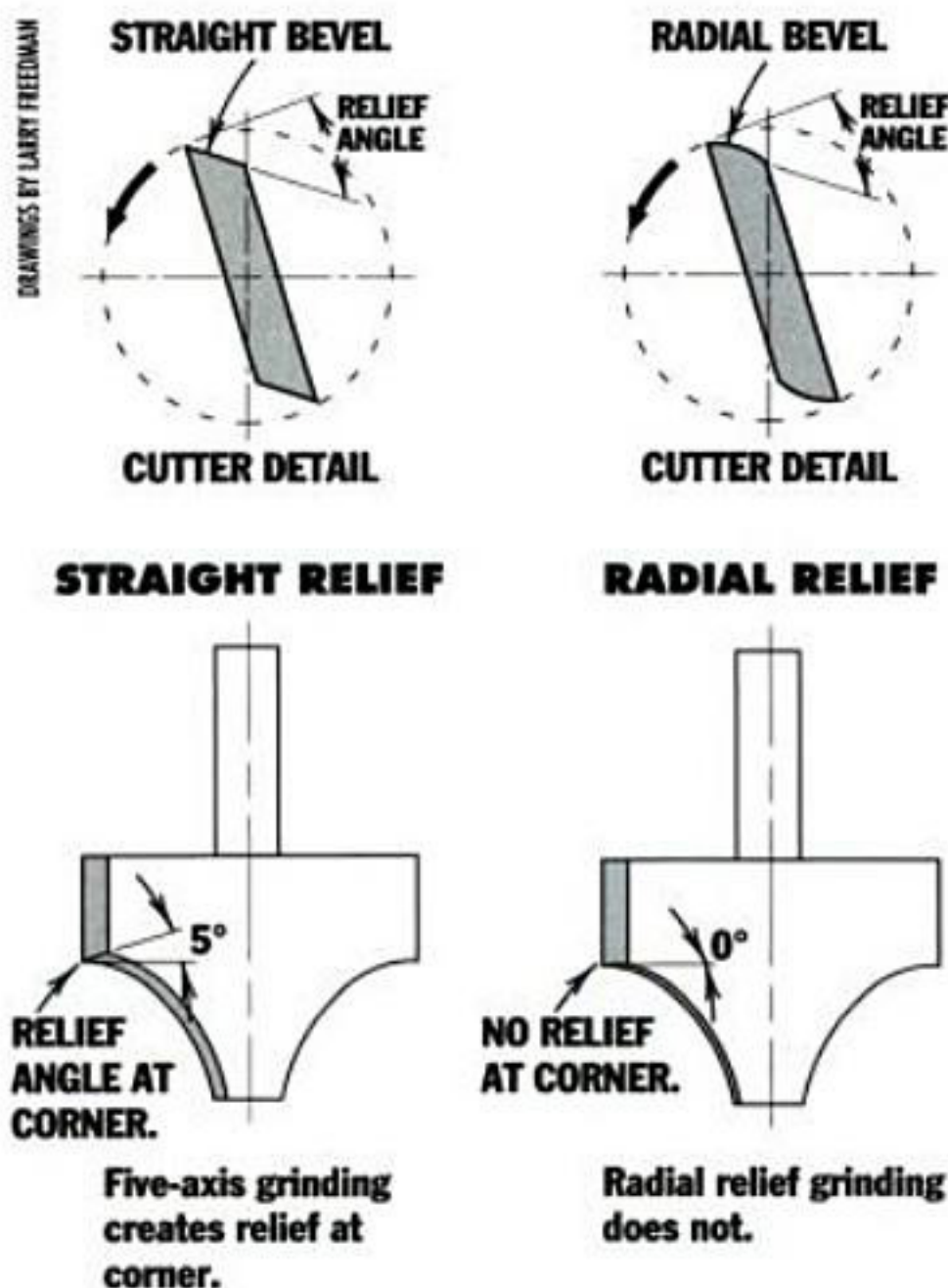
LETTERS

Radial Relief Rebuttal

Re: "Buyer's Guide to Router Bits" (AW #33). I feel there is a need for a clarification on "radial relief" in router bits and how this works. The article [implies] this type of grinding should be associated with higher quality bits, whereas it is a very well-known fact among manufacturers that the advantage of radial relief is the short time it takes to put a profile on a carbide tip. This is because a grinding wheel can be shaped as a mirror image of the bit profile to be machined, thus producing the final profile on the bit in a single pass. As good as this is for the manufacturer, for the end-user the story changes.

On any profile where there is a corner or changing radius

DRAWINGS BY LARRY FREEDMAN



(example: a roundover with a fillet) you will need a relief [behind the cutting edge] to avoid burning and/or poor finish in the curves or corners of the profile. (See drawing.)

Radial relief grinding cannot provide [this relief]. That is why, after having tested the performance of both systems, we decided to profile our Freud bits on much more expensive five axis grinding machines [which] ensure proper and, above all, constant relief in all curves and corners. This results in a clean cut for a long time.

Please let's not endorse a manufacturing shortcut as a "refinement to look for in a high quality bit."

Giorgio Pozzo
Freud
High Point, NC

Anti-Kickback Bits Bite Too

Re: "Anti-Kickback Bit" (AW #33). I'm concerned with Ellis Walentine's statement, "...should you run your finger into one of these bits, the limited depth of cut can mean the difference between losing an entire finger or just a couple of millimeters of the tip." The anti-kickback feature of these bits will do nothing to keep human flesh and bone from feeding itself into the sharp cutting edges of a bit, right up to the elbow if the bit is big enough and it keeps on spinning. The cutters will just keep on shaving little tiny pieces, and the victim probably won't feel a thing until it is too late.

Dixon Peer
Summit, NJ

Reusing Paint Thinner

After reading your article on hazardous waste in the shop ("Just Finishing," AW

#31) I feel I should tell you what I do. I use four jars, such as mayonnaise jars, with paint thinner in them, and two tin cans—a clean quart paint can and a smaller bean can. I pour the top two-thirds of the thinner from the first jar into the paint can and the bottom one-third, which tends to be dirtier, into the bean can. After squeezing out as much of the paint onto newspapers as I can, I slosh the brush in the thinners in the bean can. Then I pour these thinners back into the jar and pour half the thinners in the paint can into the bean can and repeat the process. After cleaning the brushes a third time with the last of the thinners in the paint can I repeat the whole process with the second and third jars.

The thinner in the third jar is almost colorless by the time I finish. If it has any color I wash the brush in a little of the thinner in the fourth jar.

Occasionally I dig out the settled solids from the bottoms of the jars, but I have not thrown out any thinners in years and I have been using the same paint brushes for years, as they come out as clean as new.

William J. Mamber
Lakewood, PA

Down on Honing Guides

Re: "Low-Tech Honing Jig" (Tech Tips, AW #33). Howard Ires has come up with a good jig [for honing chisels and plane blades], but using a jig doesn't give you a good feel for how to sharpen and you won't get a good edge with a flat grind. I was taught to first hollow-grind my blades and then hone with the blade at 90° to the length of the stone, carefully using only the outer one-third of the stone. I used this method when I worked in

LETTERS

a cabinet shop and it produced blades so sharp that I had almost no hair on my left arm from testing the finished product.

Lawrence Howard
Deming, NM

Any flat-ground bevel fans care to debate?

Miter Saw Limited Tool

Sliding compound miter saws do not perform most radial arm saw functions, as asserted in AW #31 ("Buyer's Guide to Sliding Compound Miter Saws"). The radial arm saw would suffice for the construction of your entire chop saw station; the miter saw would not. As for saving space, your chop saw station occupies twice the area needed for a regular radial arm saw.

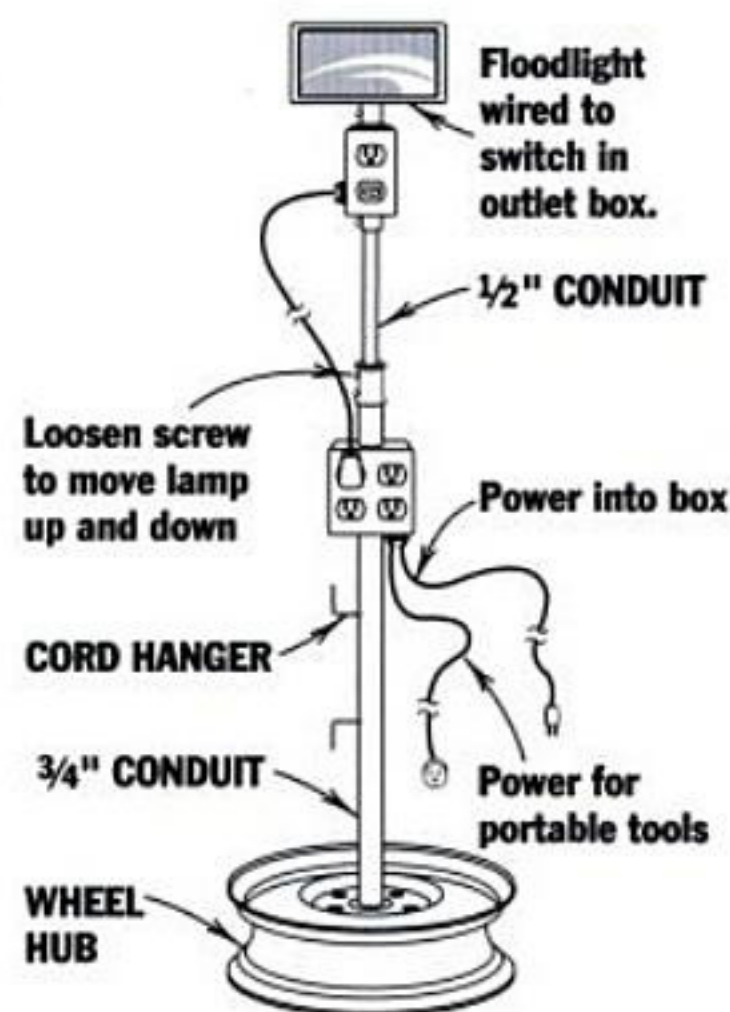
Robert E. States
Toronto, Canada

Bright Light Idea

After reading Scott Landis' article, "Shedding Light in the Shop" (AW #30), I decided to send a sketch of this work light that my dad and I made. The light consists of a quartz-halogen floodlight connected to a standard metal surface-mount outlet box. This assembly is connected to a 6-7 ft. piece of 1/2-in. conduit. The unit slides up and down inside a 4-5 ft. length of 3/4-in. conduit welded to an old automotive wheel hub.

This light is portable enough to be taken to a job site. Also, the upper assembly can be removed from the base and inserted into a socket on a bench or on a power tool like a miter saw.

Allen M. Chamber
Syracuse, UT



DRAWING BY LARRY FREEDMAN



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LETTERS

Fixing Drills Isn't Rocket Science

Your response to Kevin Matthews ("Junking Cordless Drills," Q&A, AW #33) was accurate but not very satisfying. The idea of trashing a perfectly good tool just because the batteries are dead just galls me. And while "internal batteries are not designed to be consumer serviced," it's not rocket science either. I replaced the batteries in my two cordless drills with \$30 in "C" NiCads (five batteries for each drill) from Radio Shack...two hours' work gave me a nice pair of rebuilt drills.

Ron Tye
Yorba Linda, CA

Invitation to an Accident

I can't believe a magazine that promotes safety as yours does would pic-

ture a panel-raising bit in a hand-held router. ("Buyer's Guide to Router Bits," AW #33.) A big bit like that would be tough to control by hand and you'd just be inviting an accident if you tried to.

Vernon Lathrop
Rockville, CT

Oops. You're absolutely correct. It's dangerous to use such a large bit in a hand-held router, and we don't advocate it. Our photographer picked a large panel-raising bit for dramatic effect in the photo and none of us caught the mistake.

Contest for Kids?

I am a 15-year-old woodworker and a faithful subscriber who has been woodworking since I was seven years old. I have wanted for some time to

enter your Excellence in Craftsmanship competition, but there is no category for younger woodworkers. I think there should be. You could award the same prizes, so [young winners] could at some time attend a woodworking or furniture design school.

Keep on publishing the excellent information; it really helps me pursue my woodworking dreams.

Gregory Gilbert
Lafayette, IN

What's on your mind? We value your comments, complaints and corrections. Send your letters to: "Editor," AMERICAN WOODWORKER, 33 E. Minor St., Emmaus, PA 18098, or telephone your message to us at 215-967-7776. FAX: (215) 967-8956.

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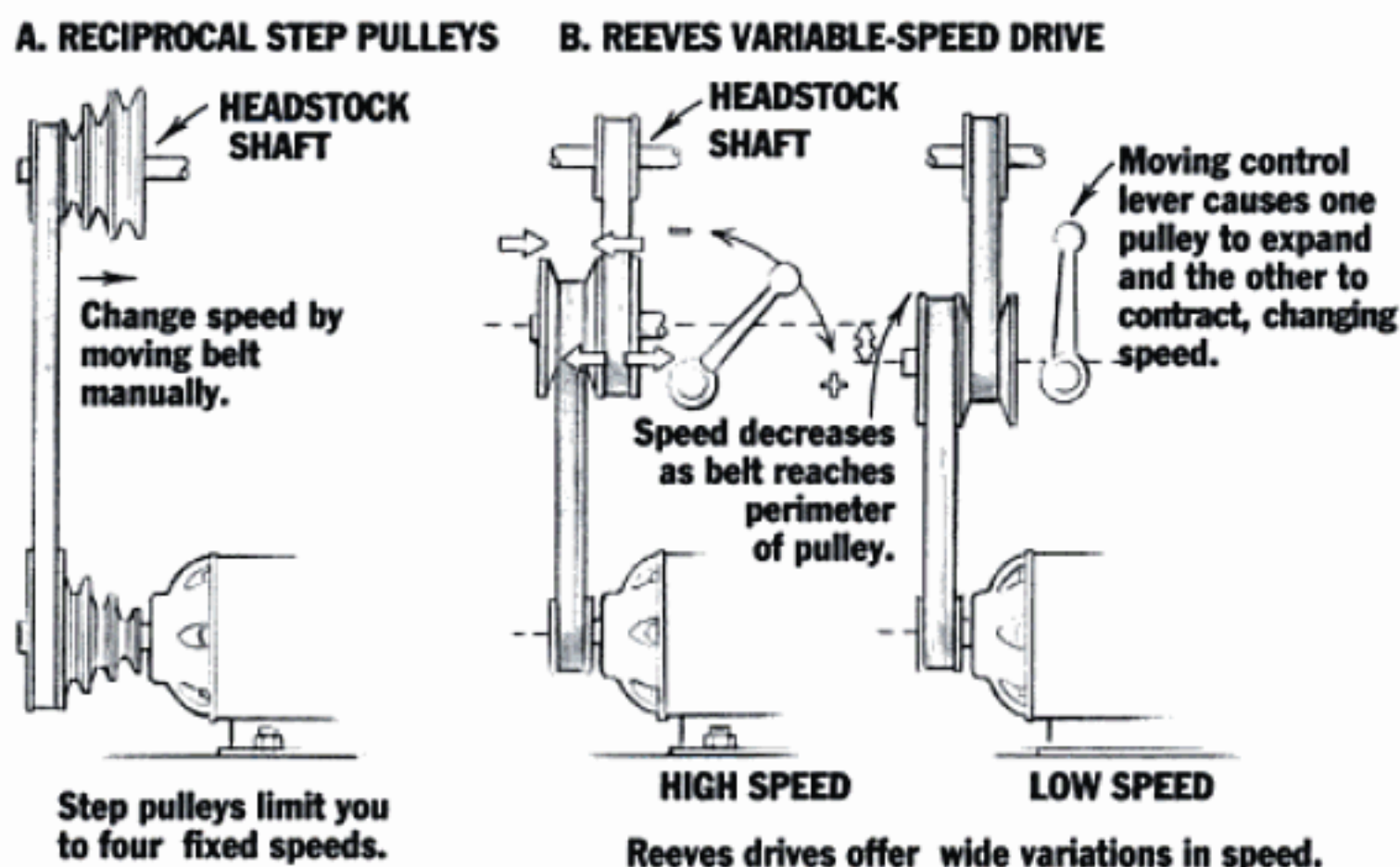
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SPEED-CHANGING ON A LATHE



DRAWING BY BOB LAPORTE

Speed-Changing on the Lathe

Q I'm scouting the market for a lathe and want to know which system for changing speeds is best. Any suggestions?

Chris Franznick
Oakland, CA

A There are two common types of belt drives for lathes: reciprocal step pulleys and the Reeves variable-speed drive. (See drawing.) Both have their pros and cons. (There's also a third option worth examining: lathes equipped with variable-speed DC motors. See the article on page 68.)

The step pulley system is the simplest and least expensive design. To change the speed, you move the drive belt to a different set of pulleys. But with this system you have to stop the motor to change speeds, and speeds are limited by the number of step pulleys (usually four).

The Reeves variable-speed drive system offers greater speed variation, and you can change the speed while your workpiece is turning—a nice feature, especially for turning bowls. But there are shortcomings here too: variable-speed lathes are noisy and tend to

vibrate. Also, you'll spend more time making adjustments to tune up the system, and at low rpms the belt has a tendency to slip, causing loss of power. Finally, you can't adjust your speed once the lathe has stopped. This can be a pain if you forget to lower the speed before mounting a heavy bowl blank.

My advice is to stick with a step pulley arrangement if you're doing mostly spindle turning. If you need more than four speeds, look for an older Delta lathe with an idler arm and extra pulley—this system gives you 16 speeds. If you like faceplate work, look for a lathe with Reeves variable speed, but be prepared to spend some time getting used to it.

Steven Blenk
Woodturner
Sequim, WA

Outside Finishes

Q I'm looking for a clear, non-yellowing exterior finish that will prevent the woods I work with (especially colorful exotics) from going to gray. Anything out there?

G. R. Ilmanen
Riverside, CA

A There are several two-part polyurethanes available at marine supply stores that work well. One is WEST SYSTEM 1000 Varnish by Gougeon Brothers, Inc., and another is Interthane Plus by Interlux Yacht Finishes. Though expensive, these finishes are non-yellowing and will keep the sun from fading your woodwork.

All exterior finishes on wood are maintenance finishes, meaning that an annual or twice-yearly program of refinishing is necessary for the finish to last. (Check the label for the product you're using.) The good news is that these finishes are designed to wear from the outside first—not at the wood line—so regular scuffing and recoating is all that's necessary. If you want to preserve the colors further, keep the pieces out of direct sunlight.

Michael Dresdner
Finishing consultant
Nazareth, PA

Working Without a Tablesaw

Q What's the best way to square up the ends of a 3-ft. by 6-ft. tabletop if you don't own a panel-cutting tablesaw?

Bert Rinkle
Laurel, UT

A I use a circular saw and a router to square up work wider than 30 in. First, mark one end square to the sides with a framing or T-square, and use the circular saw to cut on the waste side, leaving no more than 1/8 in. beyond the line. Then clean up the cut with your router by clamping a straight guide board to the top and cutting to the line. (I prefer a 3/8-in. downcut spiral bit for a smoother cut.) With one end square, measure to the other end for the finished length and repeat the procedure.

Kelly Mehler
Furniture maker
Berea, KY

Walking Bench Grinder

Q I recently bought a new bench grinder. When I

Q&A

switched it on, there was so much vibration that it started to walk off the bench and stuff began falling off the shelves. What should I do?

Sean McBride
New Haven, CT

A First dress both wheels with a carbide, star or diamond wheel dresser. If the problem persists, either the rotor is out of balance or one or both grinding wheels are. To check the rotor, remove the abrasive wheels and run the rotor without them. If the machine runs smoothly, the trouble is in the wheels. Replace one wheel, turn the machine on again and check the vibration; then switch wheels. Be sure to replace the guard around the wheel before turning on the power! If you find that one wheel is grossly out of balance return it to the supplier and have them replace it.

If both wheels are slightly out of balance, draw reference lines, then rotate one wheel 15° in relation to the other. See if the vibration is better or worse. Continue until you find the spot with minimum vibration.

Simon Watts
Contributing editor

Chilled Glue

Q I glued up a project with Titebond when the temperature in my shop was about 50° F. The dried glue has a chalky appearance. How does this affect the strength of the joint?

Paul Ballard
Denver, CO

A When any white or yellow glue dries chalky instead of clear, the glue hasn't cured properly and the glue bond will be weak. You

should never use white or yellow glue in cold weather, just as you shouldn't use latex paint or water-based finish in chilly conditions.

The exact temperature cutoff is difficult to pinpoint, and brands of glue vary. Chalking usually occurs in white glue when the temperature is in the middle to upper 40s (F). For yellow glues, you can expect chalking when the temperature is in the upper 30s or lower 40s. An exception is Titebond II, which requires a minimum working temperature in the lower 50s.

Don't be fooled by appearances: while chalking is visual evidence that the glue hasn't cured properly, there is always a risk of a weaker glue bond if the temperature is below 60°F.

Bob Flexner
Woodworker and furniture restorer
Norman, OK

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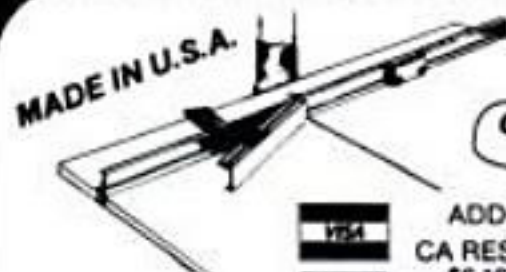
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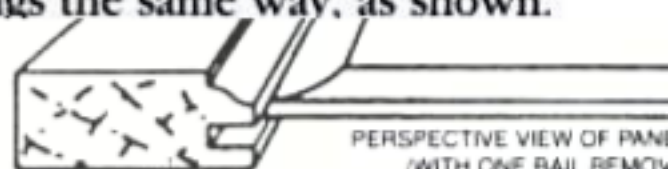


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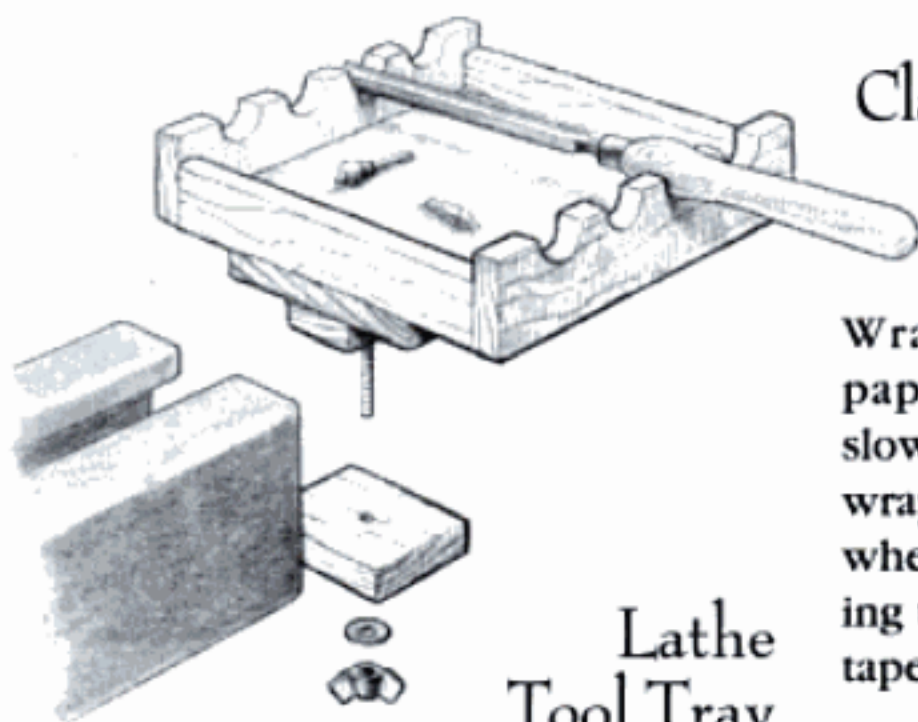


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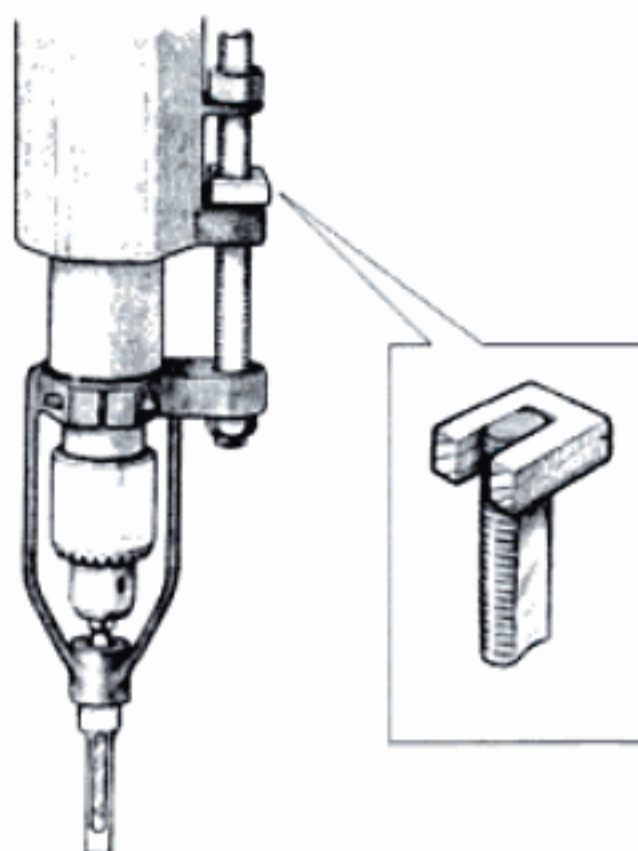
TECH TIPS



Lathe Tool Tray

Wood waste builds up quickly when turning and can soon bury small tools and even chisels. A tool tray keeps tools, calipers, etc. organized, visible and handy. It can either be placed at the end of the lathe bed as shown or between the two centers. The size and shape will depend on your lathe and how many tools you need to accommodate.

Percy Blandford
Stratford-on-Avon
England



Quick-Step Depth Stop

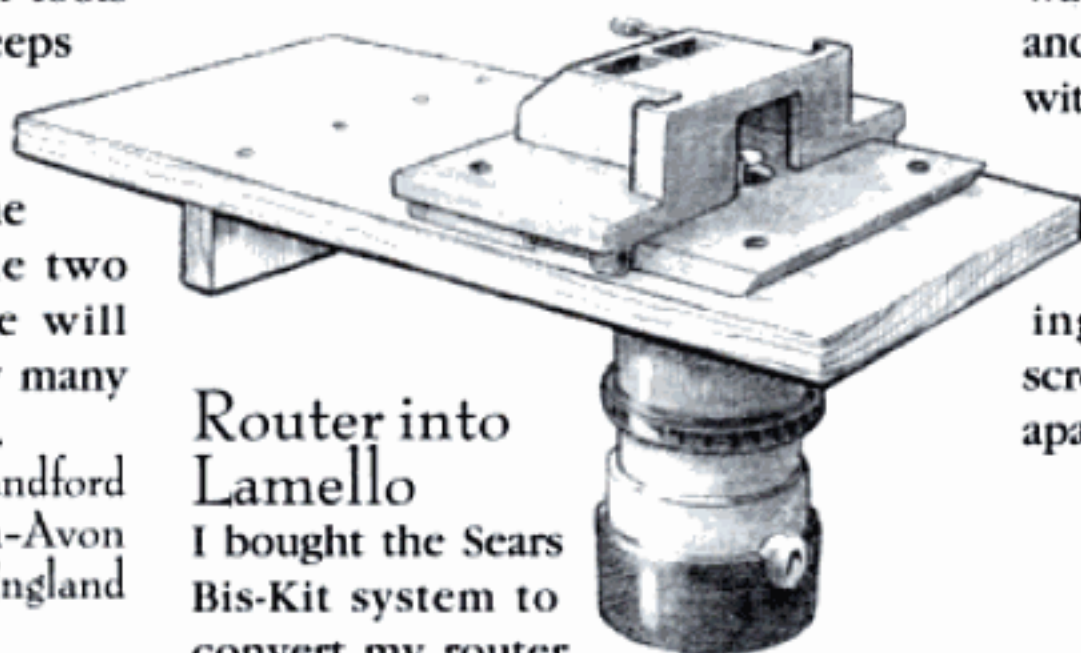
This is a useful gadget for anyone cutting haunched mortises on the drill press with a hollow chisel mortiser. Make a U-shaped wood block that fits loosely around the depth stop rod as shown. After cutting the deep mortise, slip the block around the stop rod and then cut the shallower, haunched part.

Ben Erickson
Eutaw, AL

Clamp Wrap Protects Wood

Gluing up panels with black iron pipe clamps can cause serious stains, especially with oak. Wrapping the wood with waxed paper or plastic under the clamps slows glue curing. A better way is to wrap the pipe itself with waxed paper wherever there's a danger of it touching the wood. A few strips of masking tape hold the waxed paper in place.

Howard Hagemann
Austin, TX



Router into Lamello

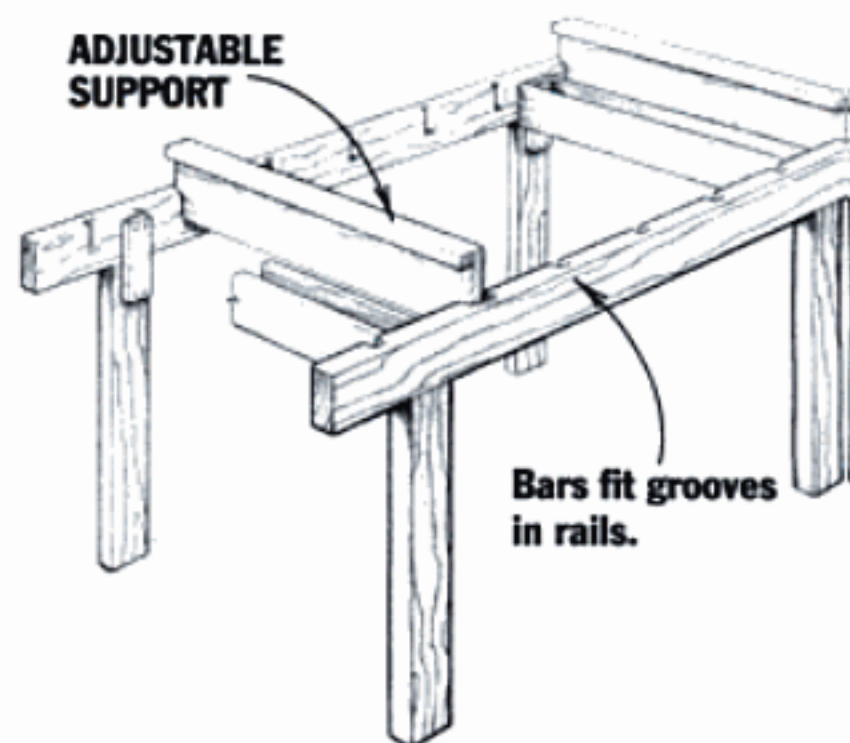
I bought the Sears Bis-Kit system to convert my router to a biscuit joiner but found it too clumsy to use with a hand-held router. So I mounted the Bis-Kit system and router to a piece of $\frac{3}{4}$ -in. oak and clamped it in a vise as a stationary machine. This gives me better control because I can use both hands to hold the work. I dedicate an extra router to biscuit joinery so I don't have to disturb the setup.

Neil Stoyanovich
Windsor, Ontario

Flush-Trimming Pegs & Plugs

I use a router with a straight bit to flush-trim pegs and plugs. I set the bit a hair above the surface of the board and I get a consistent, clean cut that needs little or no sanding. If the pegs are spaced so closely that they interfere with the router base, I just plug and trim one at a time.

Mike Swenson
Bow, NH



Multi-Purpose Bench

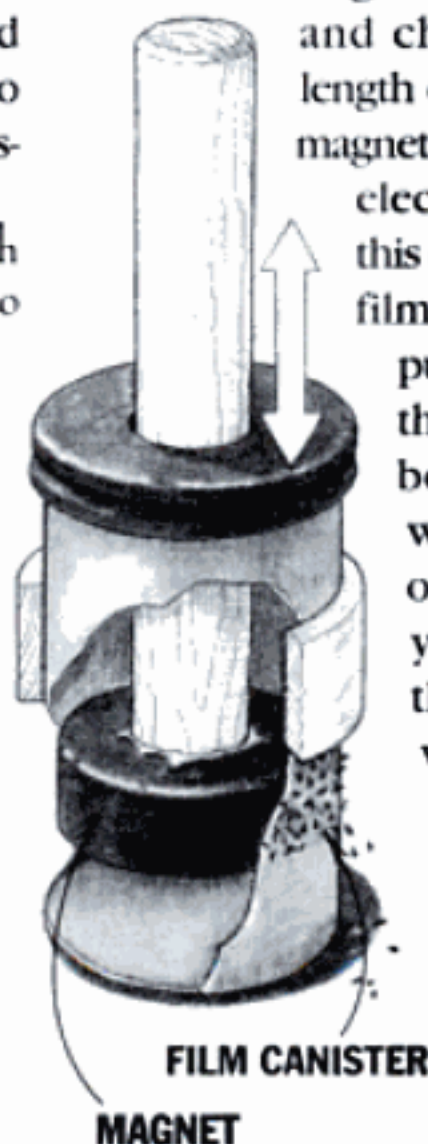
I use this low bench in a number of ways: as an assembly table; for sanding and routing; and for cutting plywood with a Skilsaw. I also find it useful to support cabinets or other projects at a convenient height so I can work on them. Since the fastenings are all bolts and sheetrock screws, the bench can readily be taken apart for moving or storage.

Donald Taylor
Deer River, MI

Magnetic Pick-Me-Up

Cleaning up metal shavings or sorting brass screws from brass-plated steel ones can be a chore. A magnet will pick them up, but then how do you get them off the magnet? My solution is simple and cheap.

Epoxy a short length of dowel onto a round magnet (available at your local electronics store) and fit this device inside an empty film canister. When you push the magnet down, the metal particles will be attracted to it and will stick to the outside of the canister. When you raise the magnet, they'll fall off. Add a wooden ring to prevent the shavings from walking up the sides of the film canister.



Bud Morang
Riceville, TN

TECH TIPS

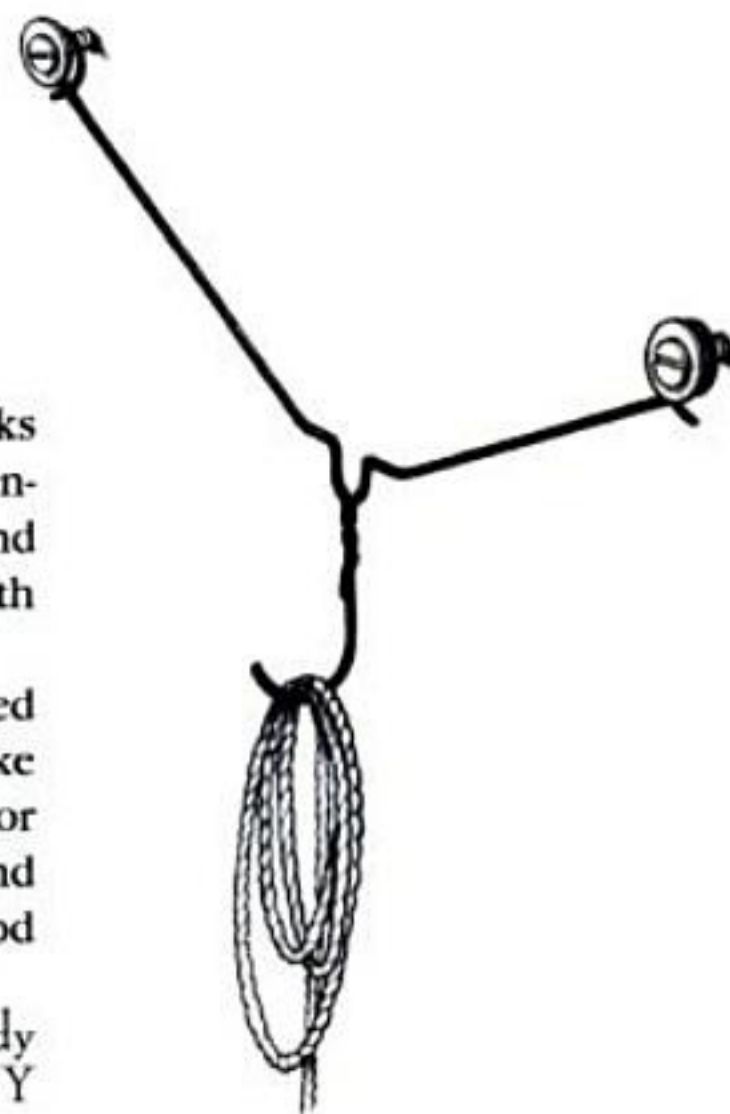


Hang-ups in the Shop

Old coat hangers make great heavy-duty hooks around the workshop. I use them to hang extension cords, work clothes, etc. Just cut and bend them as shown and attach them to the wall with round-headed screws over washers.

I've also found a use for mouse traps. Mounted on the wall near a machine or bench, they make excellent holders when working from sketches or from a magazine. Just remove the wire trip (and cheese, if any) and drill holes through the wood platform for mounting screws.

Howard Moody
Upper Jay, NY



Padding the Clamps

I used to hunt around for scraps of wood to protect my projects from iron clamps. Then I tried cutting out pieces of green felt to match the clamp pads and attaching them with double-sided tape. Now I've switched to pressure-sensitive Velcro, which works even better. I cut the Velcro to size, strip off the paper backing and apply it to the clamp pads.

Mike Paliotta
Horseheads, NY



Be Kind to Your Nozzles

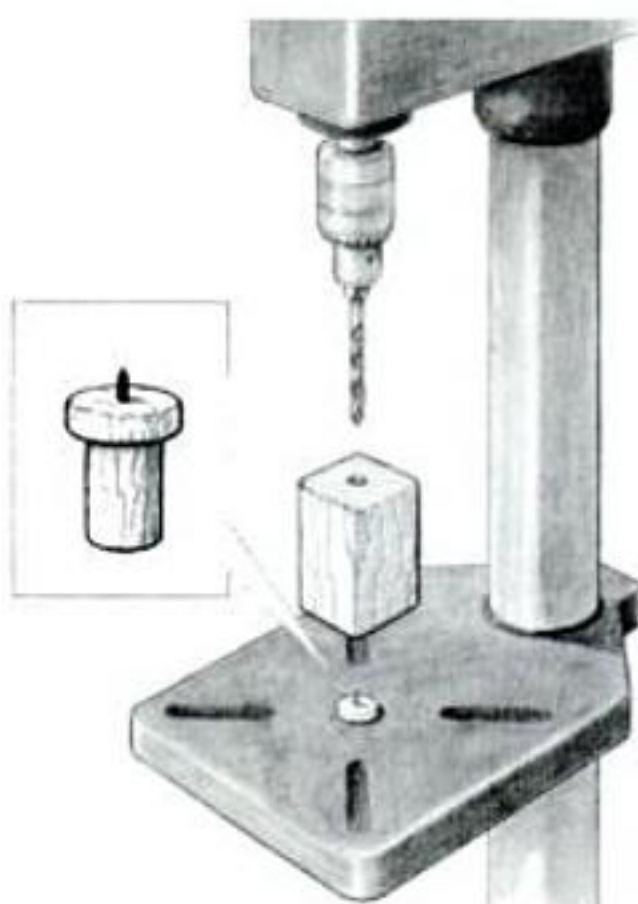
I use a variety of spray finishes and adhesives in my business, and I can't afford clogged nozzles and splattered finishes. So, I have devised this simple solution: I save the small, plastic nozzle cap that comes with each can and pour in just enough paint thinner to cover the nozzle. When I am through spraying, I don't need to clear the nozzle but just invert it and push it down onto its cap. The can stays there, upside down, until the next time I need it.

Norm Fried
Oceanside, CA



Keeping Holes in Line

It can be difficult to drill a deep hole and have the bit exit where expected. My solution is to turn a wood insert to fit the hole in my drill-press table. In the exact center of this insert I place a nail with the point sticking up about 1/4 in. Then I chuck a brad-pointed bit of the size I want and swing the table so



the point of the nail and the tip of the bit are in line. I mark the centers of the work at both ends and then drill the hole with the drill press. I stop just short of the nail and finish drilling the hole at the bench.

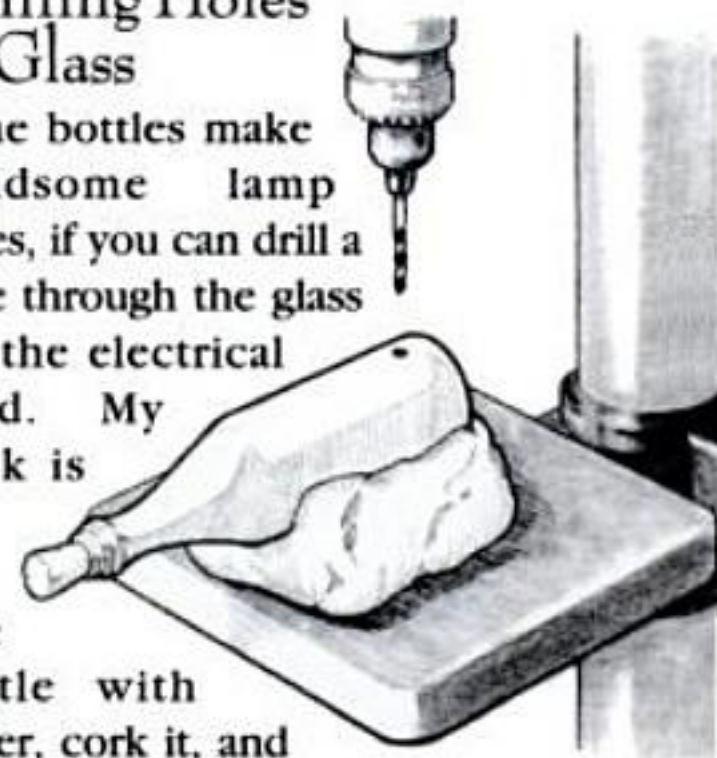
Ron Pavelka
Orange, CA

Drilling Holes in Glass

Wine bottles make handsome lamp bases, if you can drill a hole through the glass for the electrical cord. My trick is to fill the bottle with water, cork it, and cradle it in a sandbag set on my drill press table. Then I drill with a carbide-tipped cement drill bit. (500 rpm is about the right speed.) The water dissipates the heat so the glass won't crack.

To drill a hole in sheet glass, use a putty dam to retain the water, or put the glass in a shallow tray with a piece of plywood underneath as backing.

Donald Kinnaman
Phoenix, AR



Know a better way of doing something? Designed a clever jig? Send your woodworking tips, along with a sketch or a snapshot to: "Tech Tips," AMERICAN WOODWORKER, 33 E. Minor St., Emmaus, PA 18098. We'll pay you \$50 if we publish your tip.

A GUIDE TO GLUES

Choosing the Right One Needn't Be a Sticky Proposition

BY W. CURTIS JOHNSON

You've probably done it more than once—wandered up and down the glue aisle at the hardware store, trying to find the perfect glue for your masterpiece. White glue, yellow glue, plastic resin glue, epoxy...which glue's for you?

Unfortunately, there is no perfect all-purpose woodworking glue. But there are a lot of very good ones, each of which creates a bond stronger than the wood itself. The glue you choose depends on the requirements of the job, as well as a few other variables like the temperature of your workshop. Before we examine specific glues, let's take a look at glues in general.

The first glues were made from natural materials. Hide glue, the best-known natural glue, is made by extracting a protein called collagen from hides and other animal parts. Casein glue, made from milk, is still used for laminating interior structural beams, and rabbit-skin glue is an adhesive used by gilders. While animal glues remain widely used in industry, modern synthetic adhesives have largely replaced these natural glues in woodworking applications.

How Do Glues Work?

Most adhesives are composed of long molecule chains called polymers. Polymers give glue its internal *cohesion*—the ability to stick to itself. The bond between the glue and the wood is *adhesion*, a different type of bond based on a molecular attraction between the glue and the wood. In order for these molecular attractions to take place, a joint must be clean, snug, and gap-free, as discussed in the sidebar on page 30. Some mechanical bonding also occurs between the glue and the wood fibers, but the molecular attraction contributes far more to the strength of the bond.

Most woodworking glues cure in three basic ways. First, glues like white and yellow polyvinyl acetate (PVA) glues cure when the solvent evaporates, leaving behind a solid glue line. Second, two-part glues, such as plastic resin or epoxy, cure when a chemical reaction takes place and the glue polymerizes, or forms new polymers.

Third, some glues, like hot-melt glue, are thermoplastic: they flow when melted and bond as soon as they cool.

Also, Titebond II, a hybrid glue, cures in two ways: through evaporation like the PVAs and through a chemical reaction like the two-part glues.

In general, glues that cure by loss of solvent can be redissolved in that sol-



When choosing a glue, note how quickly it will set, since this affects the time you have to assemble and clamp your joints.

vent. This is why white and yellow glues—which contain water as their solvent—aren't waterproof. But the glues that cure by a chemical reaction change permanently, and the cured glue is usually resistant to solvents.

When choosing a glue, it's important to consider the glue's constraints on assembly time. You need enough time to get each joint together and clamped before the glue starts to set. The *open assembly time* is the maximum time left for joint assembly once you've applied the glue. The *closed assembly time* is the maximum time left to clamp a joint once assembled. Assembly times vary from one type of glue to the next. Temperature also has an effect on open time—most glues set faster in warmer temperatures.

Many glues have a limited shelf life, notably the PVAs, whose shelf life averages 12 months, and the liquid version of hide glue. Few containers are dated, so it's often impossible to know how old the glue is when you buy it. (Titebond glues are dated.) It's a good idea to buy your glue at a store with high turnover and mark the date of purchase on the container.

Also, some adhesives like cyanoacrylates and contact cements are prone to drying in the container once opened.

Types of Glue

Here's a rundown on the wood-working glues available today, with a closer look at the working properties of each type.

The white and yellow varieties of **polyvinyl acetate (PVA) glue** are the closest thing to an all-purpose wood-working glue. Both types are good for furniture making and general indoor woodworking applications. They are inexpensive, non-toxic, and easy to use.

PVA glues are an emulsion of polyvinyl acetate in water. The tiny PVA particles coalesce into a rubberlike solid as the water is lost to the surrounding wood, leaving a semitransparent glue line that remains flexible. Clamping time for PVA glues is short, but it takes at least 24 hours for the water to evaporate from the surrounding wood and for the glue to reach full strength.

The difference between white and yellow glue is a source of confusion among woodworkers. White glue, the

original PVA adhesive, is somewhat runny and tends to dribble out of a joint. Because heat softens white glue, it gums up sandpaper quickly.

Yellow glue, also known as aliphatic resin glue, is a PVA that has been modified to give it different working characteristics from white glue. Yellow glue is thicker and sands more easily than white glue because the dried glue is more heat resistant. However, white and yellow PVAs are about equally likely to fail under wet conditions.

An exception is Titebond II, which passed the American National Standards Institute's (ANSI) tests for water resistance. It can be used for outdoor furniture or even cutting boards—something I'd never try with regular white or yellow glues—yet it's as easy to use as conventional PVAs.

Yellow glues are available in a variety of formulations. Franklin International makes over 50 different industrial PVAs, plus consumer PVAs such as Titebond and Super Titebond. Garrett Wade (161 Ave. of the Americas, New York, NY 10013, 800-221-2942) sells four PVAs: one for lamination, a slow-set glue, a gap-filling glue, and a general-purpose glue. And while they contain the additives that distinguish them as "yellow" glues, these PVAs come in a variety of colors. Borden sells a brown "yellow" glue for use on dark-colored woods.

A newcomer to the PVA scene, Liquid Nails for Furniture, is a white glue with working characteristics more like yellow glue. Its high solids content makes it much less likely to dribble when squeezed on or out of a joint.

PVA glues have a lot going for them, but they do have disadvantages. For one, open time is short, usually only about five minutes. Freezing ruins PVA glue, so you have to store your glue with care. Low water resistance makes PVA glues, except Titebond II, a poor choice for panels that may get wet.

Furthermore, the PVAs' flexibility means that joints which aren't mechanically solid without glue may shift under a sustained load or even from natural wood movement. Also, the glues themselves can *creep*—swell and migrate toward the surface. This can be a significant problem, especially in bent lamination where you don't want to call attention to the glue lines.



Polyvinyl acetate (PVA) glues are good for indoor woodworking, but only one type, Titebond II, withstands wet conditions.



Plastic resin glues are highly resistant to cold water, but they will soften in warm water.



Epoxyes are waterproof and are ideal for projects subjected to extreme temperatures.

Resorcinol glue will hold up under water and is perfect for outdoor work.



GLUE CHARACTERISTICS

Adhesive	Working Temperature (°F)	Water Resistance	Working Characteristics
PVA, White	60°-90°	Fair	5 min. open time; 1 hr. clamp time; moderate gap filling; non-toxic; cleans up with water
PVA, Yellow	50°-110°	Fair	Moderately fast tack; 5 min. open time; 30 min. clamp time; moderate gap filling; non-toxic; cleans up with water
Cross-Linking PVA (Titebond II)	55°-85°	Excellent	Moderately fast tack; 5 min. open time; 1 hr. clamp time; moderate gap filling; non-toxic; cleans up with water
Plastic Resin (Powder)	70°-100°	Excellent	Mix powder with water; 20 min. open time; 12 hr. clamp time; poor gap filling; fast-cure with heat or radio frequency gluing machine; cleans up with water
Plastic Resin (Powder/Resin)	65°-95°	Excellent	Mix powder with resin; 15 min. open time; 3 hr. clamp time; good gap filling; fast-cure with heat or radio frequency gluing machine; cleans up with water
Epoxy	35°-200° depending on formula	Waterproof	Mix liquid resin with liquid hardener; open time varies with formula—fast and slow-set epoxies available; no clamping required; excellent gap filling; cleans up with lacquer thinner
Resorcinol	70°-120°	Waterproof	Mix powder with resin; 15 min. <i>minimum</i> open time; 10 hr. clamp time; good gap filling; cleans up with water
Cyanoacrylate	-65°-180°	Excellent	Bonds within 30 sec.; no clamping required; thick and thin formulas available for porous or nonporous material; thick formulas good for gap filling; accelerators available to speed bond; gluing oily woods difficult
Hot Hide Glue	140°-212°	Poor	Mix dried glue in water and heat to 160°; fast tack; temperature-dependent open time; no clamping required; moderate gap filling; non-toxic; mixed glue can spoil after 3 weeks; cleans up with water
Liquid Hide Glue	70°-90°	Poor	10 min. open time; 12 hr. clamp time (longer in high humidity); moderate gap filling; non-toxic; cleans up with water
Contact Cement	65°-180°	Excellent (Fair for waterborne)	Apply to both parts, allow to dry 5 min. to 1 hr., then assemble; parts bond on contact, no clamping required; solvent-based and water-based formulas available
Hot-Melt Glue	32°-160°	Good	Heat glue sticks in glue gun to apply; 5-10 sec. open time; good gap filling; non-toxic

Plastic resin glues, also known as urea-formaldehyde glues, are my personal favorites for cabinetmaking. Their high water resistance makes them good for jobs like tabletops, cutting boards or laminated countertops.

With the plastic resin glues, you mix a powder with a catalyst—either water or resin—to form a rigid polymer in the joint. When dry, the glue is similar to hard plastic. It is strong and impervious to cold water; however, it's also brittle, and hot water will eventually soften the cured glue. Uncured glue cleans up with warm water.

The common variety of urea-formaldehyde glue is a powder that you mix with water. Its long open time (about 20 minutes at 70°F) makes it easy to assemble your project. On the minus side, its clamping time of 12 hours is one of the longest of all the glues. (See chart above.)

Newer, two-part glues such as Unibond 800 (available from Vacuum Pressing Systems Inc., 553 River Rd., Brunswick, ME 04011, 207-725-0935) come as a powder you mix with a



Hide glues are a good choice for joints that you may want to disassemble later.

resin. They reduce clamping time to a couple of hours, depending on air temperature and humidity.

Both types of plastic resins sand well and are good for lamination because there is no creep. Plastic resin's rigidity when cured and its reasonable assembly time make it my choice for veneering, and I prefer the powder/resin variety. It has good gap-filling ability and shrinks less than the powder/water type when curing.

The powder in plastic resin glue comes in several shades of brown from light to dark, allowing you to tailor the glue to the wood's color. The resin can also be tinted with dye stains to make additional hues.

The open time and curing time for plastic resin glue varies significantly with temperature—the warmer it is, the faster it sets. Unfortunately, these glues won't cure in a cold shop, because the chemical reaction won't take place if the room is below 70°F (65°F for the two-part variety). I know several woodworkers who buy a cheap electric blanket and throw it over the assembly to help speed curing in a cold shop. Another method is to bombard the joint with radio frequencies (RFs). RF gluing machines are used in industry, and smaller machines are made for small-production shops.

Exposure to the formaldehyde in plastic resin glue is negligible, but the glue can cause skin irritation. Wear a mask to avoid breathing the powder as you mix, and protect your hands with rubber gloves.

Cured Characteristics

Transparent, flexible glue line; clogs sandpaper; subject to creep

Semitransparent, moderately flexible glue line; subject to moderate creep; sands better than white glue

Semitransparent, moderately flexible glue line; subject to moderate creep

Hard, opaque, tan-colored glue line; sands well; no creep

Hard, opaque, light to dark brown glue line; sands well; no creep

Transparent; sands well; cured glue can be filed or machined

Hard, opaque, red-brown glue line; withstands most solvents; sands well; no creep

Transparent glue line; resists most solvents

Hard, semitransparent glue line; sands well; cured glue remains water soluble

Hard, semitransparent glue line; sands well; cured glue remains water soluble

Rubbery glue line; resists heat; subject to shifting; water-based is slow drying

Semihard, semitransparent to opaque glue line; cured glue softens when heated; weak adhesive bond

Applications

General interior woodworking

General interior woodworking

General interior woodworking; outdoor furniture

General woodworking; bent laminations; structural uses

General woodworking; veneering and bent laminations; structural uses

Boatbuilding and outdoor applications requiring a waterproof glue; bonding wood to glass, metal, etc.; mixing with sawdust for gap filler

Boatbuilding and outdoor applications requiring a waterproof glue

Bonding wood to nonporous materials; small repairs; model making; mounting blanks and controlling checks for bowl turning

General interior woodworking; antique restoration; instrument making; hammer veneering; joints that may require later disassembly

General interior woodworking; joinery requiring long open time; antique restoration; instrument making; joints that may require later disassembly

Bonding plastic laminates to wood or man-made boards

Temporary tacking; model making

Cautions

Freezing destroys glue

Freezing destroys glue

Freezing destroys glue

Contains formaldehyde; uncured glue toxic to skin; use adequate ventilation

Contains formaldehyde; uncured glue toxic to skin; use adequate ventilation

Uncured glue and vapors toxic; use adequate ventilation; repeated exposure can cause allergic reaction

Contains formaldehyde; uncured glue toxic to skin; use adequate ventilation

Bonds skin instantly—clean up with manufacturer's solvent or acetone; vapors irritating; use adequate ventilation

Don't heat glue above 212°

None

Solvent-based formulas are extremely flammable and vapors are toxic; use adequate ventilation

Some oil finishes may cause glue to break down

Epoxys are two-part glues that are waterproof and solvent resistant, have very low creep, dry without shrinking and do not require clamping. Epoxy's non-shrinking characteristic makes it an excellent gap filler. You can mix epoxy with sawdust and/or tint it for use as a wood filler.

General-purpose epoxies are available in either quick-set or slow-set formulations. The quick-set varieties harden in anywhere from one minute to 10 minutes and cure in a few hours. Slow-set epoxy can take up to 24 hours to harden and a week to completely cure.

Quick-set and slow-set epoxies aren't equals when it comes to water resistance. According to Ernie Liporto of Devcon, a large epoxy manufacturer, Devcon's slow-set 2-Ton Epoxy is completely waterproof. Devcon's quick-set 5-Minute Epoxy and their newer 1-Minute Epoxy are water resistant, not waterproof, and shouldn't be used on objects that will be immersed in water for long periods.

Shop temperature is critical with some epoxies, and you should always



Cyanoacrylate glues are extremely fast-bonding and are the woodturner's first choice for filling cracks.

check the container label for the recommended temperature range. Some epoxies are specially formulated for cold temperature use. System Three Resins, Inc. makes T-88 Epoxy, which works down to 35°F (available from Flounder Bay Boat Lumber, 1019 Third St., Anacortes, WA 98221, 800-228-4691).

Other specialty epoxy formulations are also available. My local boating sup-

ply store stocks the line of WEST SYSTEM Brand Epoxy (available from Gougeon Brothers, Box 908, Bay City, MI 48707, 517-684-7286). This epoxy consists of a base resin which can be mixed with three varieties of hardeners, from fast to slow, so you can control open time and working temperature. Gougeon Brothers also sells pumps that siphon pre-measured

GETTING GOOD GLUE JOINTS

The key to a strong glue bond is a well-prepared joint, and that starts long before you pick up the glue bottle. The strongest joints have a glue line just a few thousandths of an inch thick—even in hidden joinery



such as mortise-and-tenon joints, where any gaps between the mortise and tenon cheeks may seriously weaken the joint. Most glues shrink as they dry, and internal stresses in thick seams of glue cause it to fail. Some glues, like epoxy, are gap filling, but even so, if the joint doesn't fit well dry, don't count on glue to hold it together.

Here are some tips for better gluing:

The strongest glue joint is between two long-grain surfaces. A joint between two pieces of end grain is only about 25 percent as strong as a long-grain-to-long-grain joint.

Moisture content (MC) is important. (See "Wood Movement", page 38.) Although an adhesive like epoxy will bond wood up to 20 percent MC, the stresses incurred later when the wood dries are likely to break the glue joint. Kiln-dried lumber between 6 and 8 percent MC yields the strongest bond.

The wood surface is another important factor. A good surface is smooth, flat and free of debris, enabling close contact over the entire area. Hand planing is an excellent way to achieve this. Machining is another option, as long as you don't crush the wood fibers by using dull planer, jointer or saw blades. You can glue sanded surfaces, too, but be sure to finish with 50 grit or finer, and remove the dust before gluing.

Watch out for woods that exude oils and resins, like teak and rose-

wood. These substances tend to migrate outward to a freshly cut surface and will inhibit a good bond. Most oily woods need to be glued as soon as possible after machining. It also helps to clean the wood with acetone shortly before gluing.

How much glue to use? Aim for uniform coverage, and apply enough so that the glue is still wet when the joint is assembled. You want a little excess glue to squeeze out upon clamping, but not enough to make a mess. Flexible plastic spatulas for applying auto-body filler are excellent for spreading glue, as are old credit cards. Mail-order catalogs sell a variety of squeeze-bottle applicators and rollers that also work well.

In order for glue to work, make sure that the glue wets *both* surfaces to produce the required intimate contact between adhesive and wood. The easiest way to do this, particularly when edge gluing, is to coat both surfaces.

In closed joints such as the mortise and tenon or dovetail, glue can cause the parts to swell, making it impossible to assemble the joint. On these joints, glue only the leading edges and let joint assembly spread the glue.

The purpose of clamping is to spread the glue equally across the surface of the joint. Don't use the Arnold Schwarzenegger approach—it's more important to apply uniform pressure over the entire bond than to wrench a few clamps tight.

—W.C.J.

amounts for mixing the components.

Uncured epoxy cleans up with denatured alcohol or lacquer thinner. Once dried, however, epoxy is insoluble, which makes it difficult or impossible to disassemble a joint for repairs.

Epoxy is the most expensive of all woodworking glues, particularly when you buy it in the little tubes and dispenser syringes you find at the hardware store. If you use a lot of it, it's cheaper to buy larger containers.

Toxicity is another disadvantage. Long-term exposure seems to sensitize some people so that they develop an allergic reaction to epoxy. To protect yourself, avoid contact with skin and wear chemical-resistant gloves.

Resorcinol glue is a two-part adhesive consisting of a resin and a hardener. It's completely waterproof and can withstand long-term immersion in water. Resorcinol glue is ideal for boat-building or outdoor construction projects, but its dark red color limits its use on fine furniture.

Once mixed, resorcinol has a long pot life—three to four hours at 70°F—but the adhesive needs at least 70°F to cure properly. It has a long open time; in fact, you have to let it thicken for 10 to 15 minutes before applying it to nonporous woods, so that it won't be squeezed out of the joint.

Like plastic resin glue, resorcinol can cause skin irritation, so wear gloves. Once mixed, it gives off a small amount of formaldehyde gas, a suspected carcinogen. Wear a mask when mixing, and make sure there is good ventilation.

Hide glues have been used at least since the days of the Pharaohs. Until the advent of synthetics in the mid-20th century, hot hide glue was the only adhesive for woodworking, and every shop had a glue pot cooking away in a corner. These days, hide glue comes in two forms: a ready-to-use liquid glue, and hot hide glue, a solid that must be dissolved in water, heated in a glue pot and applied hot. (In England, hide glue is also sold as a wiggly, gelatinous block called "Scotch Glue".)

Hot hide glue is prepared by soaking the solid glue in water overnight and then heating the mixture no hotter than 212°F, usually in a thermostatically controlled electric glue pot. This glue has a very fast tack once the glue

cools below 140°F, so the joint must be assembled while the glue is still hot, ideally around 160°F. The hard, brittle glue is easy to sand and the tan color blends well with most woods.

There's a lot of mystique surrounding hot hide glue. Musical-instrument makers like it because it dissolves easily in hot water, making it easy to disassemble a joint, and some claim that the tonal qualities of the glue itself are ideal. Also, hot hide glue is the only glue that works for hammer veneering. (For more on this technique, see AW #16, October 1989.)

But hot hide glue is also a little bit finicky. In addition to the glue temperature, room and wood temperature are critical: both must be 70°F or above to work the glue. Shelf life for hot hide glue is indefinite, but once hydrated, it should be heated daily to prevent mold growth. Once mold has formed, the glue will spoil, and the smell is reminiscent of a road kill on a hot August day.

Liquid hide glue is not as strong as the hot version, but it's still much stronger than the wood it holds together. It has a long open time—10 minutes or more—so it's good for complicated joinery. It cures glass-hard and is very rigid, so joints won't creep. Like hot glue, liquid hide glue requires shop temperatures of 70°F and above. It, too, is easily dissolved in water, so you can steam or soak apart a joint that needs repair. Unlike hot glue, liquid hide glue has a shelf life of one year.

Cyanoacrylate glues, also known as "super glues", are clear glues that dry in the joint within seconds, without clamping. Turners and carvers use cyanoacrylates to repair tiny pieces that have broken off their work, and luthiers use it for fastening inlays.

Remember the man in the hardhat hanging from an I-beam? The original-formula super glues are thin and work well on nonporous surfaces that mate perfectly, but few of these thin formulations join wood well. Recently, manufacturers like Devcon and Borden (the maker of Krazy Glue) have introduced higher-viscosity glues that will bond to wood. However, these gel formulations take about 30 seconds to adhere.

Satellite City, Inc., (659 Laguna Dr., Box 836, Simi, CA 93062, 805-583-0994) manufactures cyanoacrylates in



Contact cements are the first choice for bonding plastic laminates over large surfaces.



Hot-melt glues are just right for temporary work like fixing workpieces to jigs.

several different viscosities. The thicker formulations have gap-filling characteristics for wood and for gluing parts that don't fit perfectly.

In addition to these glues, Satellite City makes accelerators which reduce the glue's setting time to a couple of seconds—very handy in production situations. The accelerator can be sprayed on one part before assembly or on the glue line after assembly.

Cyanoacrylates are famous for gluing fingers together, but the glue dissolves readily in acetone or nail polish remover. (Satellite City also makes its own solvent.) The fumes from cyanoacrylates can cause nose and eye irritation. Accelerators may cause headaches and nausea. Use these glues in shops with adequate ventilation.

Contact cements are mainly used for attaching plastic laminates to countertops and cabinets. Some woodworkers use contact cement for veneering,

but in my opinion, its low strength and high flexibility make it a poor choice for veneering.

Contact cements are made of neoprene rubber either dissolved in solvents or emulsified in water. The glue is rolled, brushed or sprayed on both surfaces and allowed to dry. When the glue is no longer tacky or wet to the touch (five to 60 minutes, depending on glue type), you join the two pieces. The bond is instantaneous, and repositioning is impossible.

Contact cement is available in three varieties: flammable-solvent, non-flammable-solvent and waterborne.

Both solvent-based cements are toxic to handle and breathe, and the flammable formulas are *extremely* flammable—especially the vapors. The vapors accumulate near the floor, and the slightest spark can ignite them. Work outside if possible, or use adequate ventilation, and wear a face mask rated for organic vapors.

The waterborne variety is the most recent addition to the contact cements. It's non-toxic and thus the safest contact cement, and it offers better coverage and rivals the bond strength of the solvent-based cements. However, waterborne cement can fail if allowed to freeze, and it has the longest drying time. It's also the priciest.

Hot-melt glues are thermoplastic adhesives which you apply with a glue gun. Once they are heated, they cool quickly, and you only have a few seconds to join the surfaces together after the glue is applied.

Hot-melt glue is weak, the glue lines are thick, and there is no way to get complicated joints together before the glue sets up. But since there's no need to clamp, hot-melt glue is handy for temporary work—such as attaching workpieces to jigs and assembling prototypes—wherever sound joinery is not an issue. ▲



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MAKING A BEDROOM SUITE

A Cherry Nightstand with Understated Elegance

PHOTOS BY MITCH MANDEL

From its recurved feet to its undercut top edges, this nightstand projects the subtle Chinese influence which unites the entire suite (inset).



BY SCOTT COOPER

When I visited China eight years ago as part of a college language program, I absorbed a love of Chinese furniture design that will long outlive my vocabulary lessons. But it was only years later, as I tried to design pieces with the same flavor, that I began to pin down the separate elements about this furniture which joined to uplift my spirit.

I finally concluded that the most memorable pieces combined solidity of purpose with lightness and poise—like a ballet dancer on her toes. I've tried to achieve that same feel in my nightstand design.

Like the bed that appeared in the first part of this series (see AW #33), the cherry nightstand relies on traditional joinery. The rails are mortised into the legs, while the panels on the sides and back ride in frames formed from the rails and legs. (See Fig. 1.) Also, the bed and table share curved rails and short vertical members. But on this piece I

extended the graceful feel of the curves by rounding the feet and relieving the underside edges of the top.

Since construction of the nightstand involves many of the same techniques as on the bed, I won't detail techniques I described in the first article but simply mention them here.

Machining the Stock

I started with 8/4 cherry for the legs and 4/4 cherry for the rest of the parts and milled it to the sizes shown in the Bill of Materials, producing drawer rails and top rails that are the same width as the legs. This way, the front faces of the rails line up with the faces of the legs, making it less of a chore to machine matching tenons, mortises and grooves. Then for visual interest, just before glue-up I planed the face of each rail to produce a 1/16-in. relief between the rails and the legs. (See lead photo.)

The curved rails come from this same 4/4 stock, just turned on edge to get sufficient depth to cut the curves. Don't shape the curves at this point, however. It's easier to cut the joints while the rails are still straight.

When making the legs, I first chose and marked the stock to take advantage of the best grain orientation. Then I laid out and cut the rail mortises. Note that for strength, I haunched the top mortise in each leg.

To hold the legs so I could cut the recures in the feet, I made a simple U-shaped jig from some extra leg stock. As shown in the photo above, I clamped the jig to my drill press table, then inserted a leg and drilled a hole with a 3/8-in.-dia. Forstner bit that was centered on the edge of the leg. This created one half-hole in the leg, and a second in the jig. The half-hole in the jig made it easy to position this leg and the other three for subsequent drilling. Each leg was drilled twice, on the adjacent inside faces.

Next, I shaped each leg on the bandsaw and carefully worked the surfaces with plane, spokeshave, files and scraper. By the time everything is clean and square, you should end up with a leg whose top is 1 1/4 in. square. It's a good idea to lay out the panel grooves clearly on the legs now, as a double-check and cross-reference when cutting the matching grooves in the rails.



A U-shaped jig supports and locates the leg when drilling the foot.

I used the foot template shown in Fig. 1 to transfer and cut the tiptoe profile on each foot. Then I shaped it with spokeshave, files and scraper.

The rails were next. I cut the tenons on the tablesaw using a dado blade and an auxiliary fence. Later, when fitting the tenons, I mitered their ends so the tenons won't touch inside the mortise. (See Fig. 2.)

After completing the tenons, I routed the panel grooves on both the legs and rails. As with the bed, I cut these with a piloted slotting cutter on my router table and squared the ends of the grooves with a chisel.

As shown in Fig. 1, all the top rails and the front and back middle rails have an additional groove cut on the inside edge. These inner grooves support the drawer runners and kicker, as well as a bottom dust panel made of plywood. They also provide a conve-



To bring the drawer handle up to a comfortable working height, the author holds it in a clamp in his vise.

nient grip for the buttons that secure the top. I centered these grooves on the rails and while the router table was still set up, I made the drawer runners and cut their grooves and tenons. The drawer runners have stub tenons which fit in the grooves in the front and back middle rails. The kicker has the same tenon, so it made sense to cut it at the same time.

The curved rails came next. I laid these out according to the templates shown in Fig. 1. But before cutting the curves, I marked and cut the mortises for the decorative vertical members as detailed in Fig. 1. After I bandsawed the curves and cleaned them with a spokeshave, I laid out and cut the matching mortises on the middle rails.

Trial Assembly

Next, I dry-fitted the entire assembly, and once it was square, I measured and cut the panels, dust panel, vertical members, drawer front and tabletop. I made the drawer later, to fit the actual opening. The approximate dimensions for all these parts are listed in the Bill of Materials, but it's best to measure and cut these parts to fit.

After the parts are cut to size, mark the best grain orientation on all panels so you won't install one upside down at glue-up. You'll also need to rabbet the panels' inside edges and the back edge of the drawer bottom to fit the 3/16-in. grooves in the rails. (See Fig. 1.)

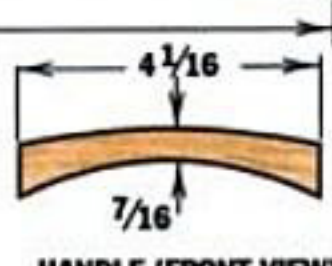
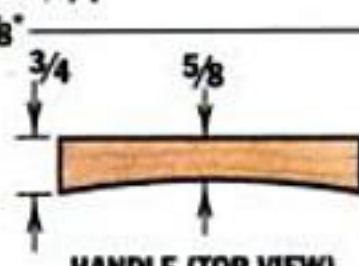
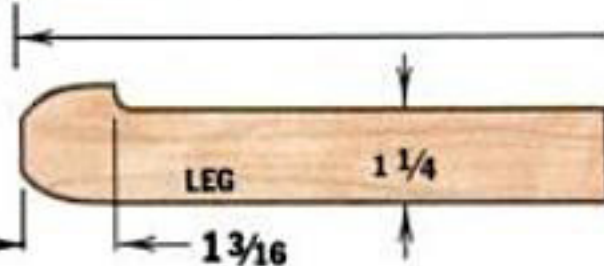
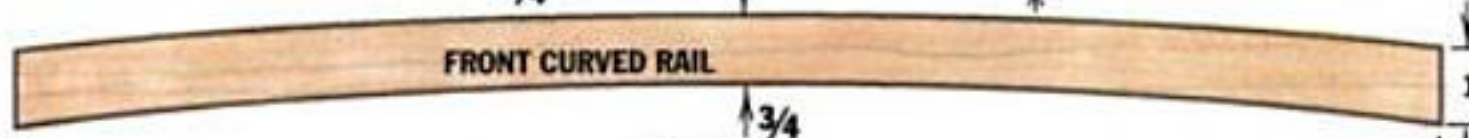
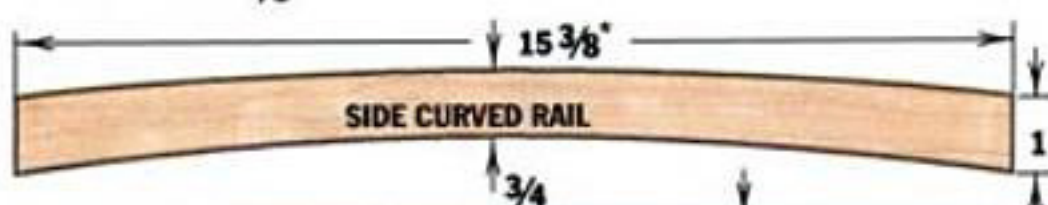
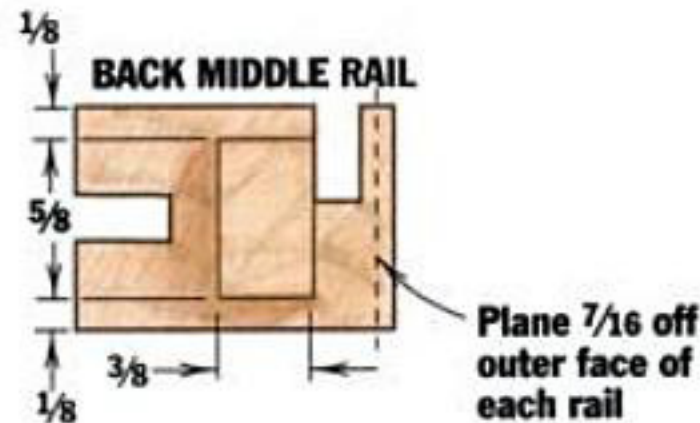
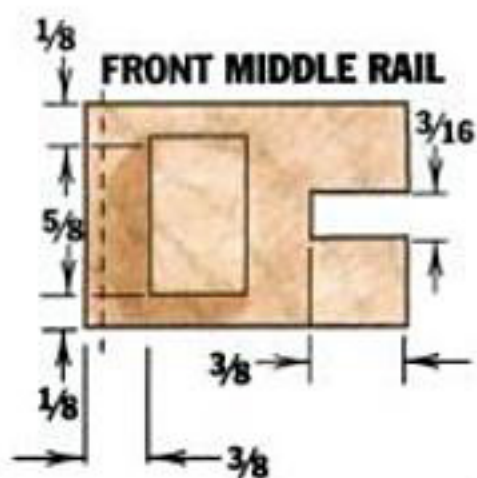
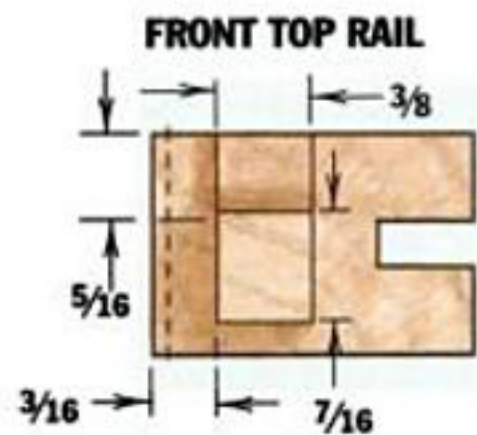
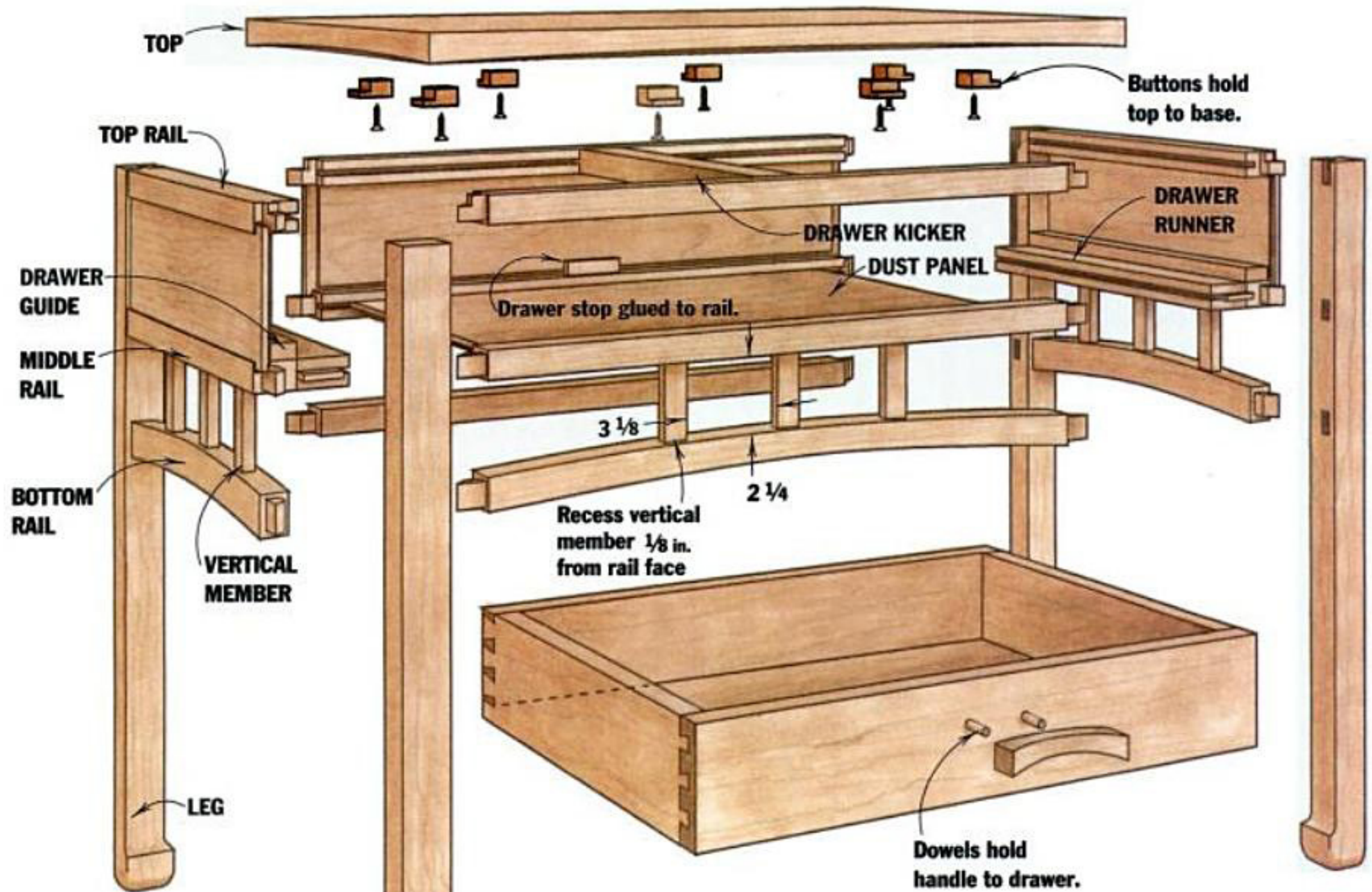
The top's overhanging edges are relieved and lightened by an undercut edge. (See lead photo.) You can rough out the undercut now with a spokeshave (my choice) or a belt sander, but I'd delay final shaping until after glue-up, because the effect is best judged when you can see it in relation to all the other parts.

Now disassemble the frame and reduce the width of all the rails by 1/16 in. on the outside face to produce the proper shoulder relief, as I explained earlier. (See Fig. 1.) As a final preparatory step, I hand planed until the wood shone.

Starting the Glue-up

I found it best to assemble the sides first, then glue them to the parts in between. With clamps at the ready, I assembled the side rails, panel and vertical members in position to form a

FIG. 1: NIGHTSTAND ASSEMBLY



* Length includes tenon

BILL OF MATERIALS

PART	QTY.	DIMENSIONS*
Leg	4	1 1/2 x 1 1/2 x 23 5/8
Side Curved Rail	2	7/8 x 1 5/16 x 15 3/8
Front Curved Rail	1	7/8 x 1 7/16 x 21 5/8
Back Bottom Rail	1	7/8 x 1 1/4 x 21 5/8
Vert. Members	9	3/8 x 3/4 x 2 7/8
Side Drawer Rail	2	7/8 x 1 1/4 x 15 3/8
Front and Rear Drawer Rail	2	7/8 x 1 1/4 x 21 5/8
Drawer Runner	2	7/8 x 1 1/2 x 14 3/8
Dust Panel	1	1/4 x 14 3/8 x 17 5/8
Drawer Guide	2	3/8 x 1/2 x 13 5/8
Drawer Stop**	1	3/8 x 1/2 x 2**
Drawer Kicker	2	7/8 x 1 1/2 x 14 3/8
Drawer Front	1	7/8 x 3 3/8 x 19 7/8
Drawer Back	1	7/8 x 2 7/8 x 19 7/8
Drawer Side	2	7/8 x 3 3/8 x 13 5/8
Drawer Bottom	1	1/4 plywood, size to fit
Drawer Pull	1	7/8 x 7/8 x 4 1/8
Top Side Rail	2	7/8 x 1 1/4 x 15 3/8
Top Front and Back Rail	2	7/8 x 1 1/4 x 21 5/8
Side Panel	2	1/4 x 4 x 14 7/16
Rear Panel	1	1/4 x 4 x 20 5/8
Top	1	7/8 x 17 3/8 x 24

*Where appropriate, lengths include 7/8-in. tenons for mortises or 3/8-in. tenons for grooves. Plane rail faces back 1/16 in. before glue-up. **Cut to fit.

unit, and glued the rail tenons to the legs, squaring the assembly as necessary. Remember, neither the panels nor the vertical members are glued.

When the sides were dry, I assembled their connecting rail assemblies in the same way and glued these, the drawer runners and the dust panel to the side assemblies. It's not necessary to glue the drawer runners along their length; simply glue their tenons into the grooves in the front and back rails.

To simplify things, don't try to fit the kicker and the side drawer guides while you're clamping everything else together. Add them later, sizing them for the best action at the same time you make and fit the drawer.

Making the Drawers

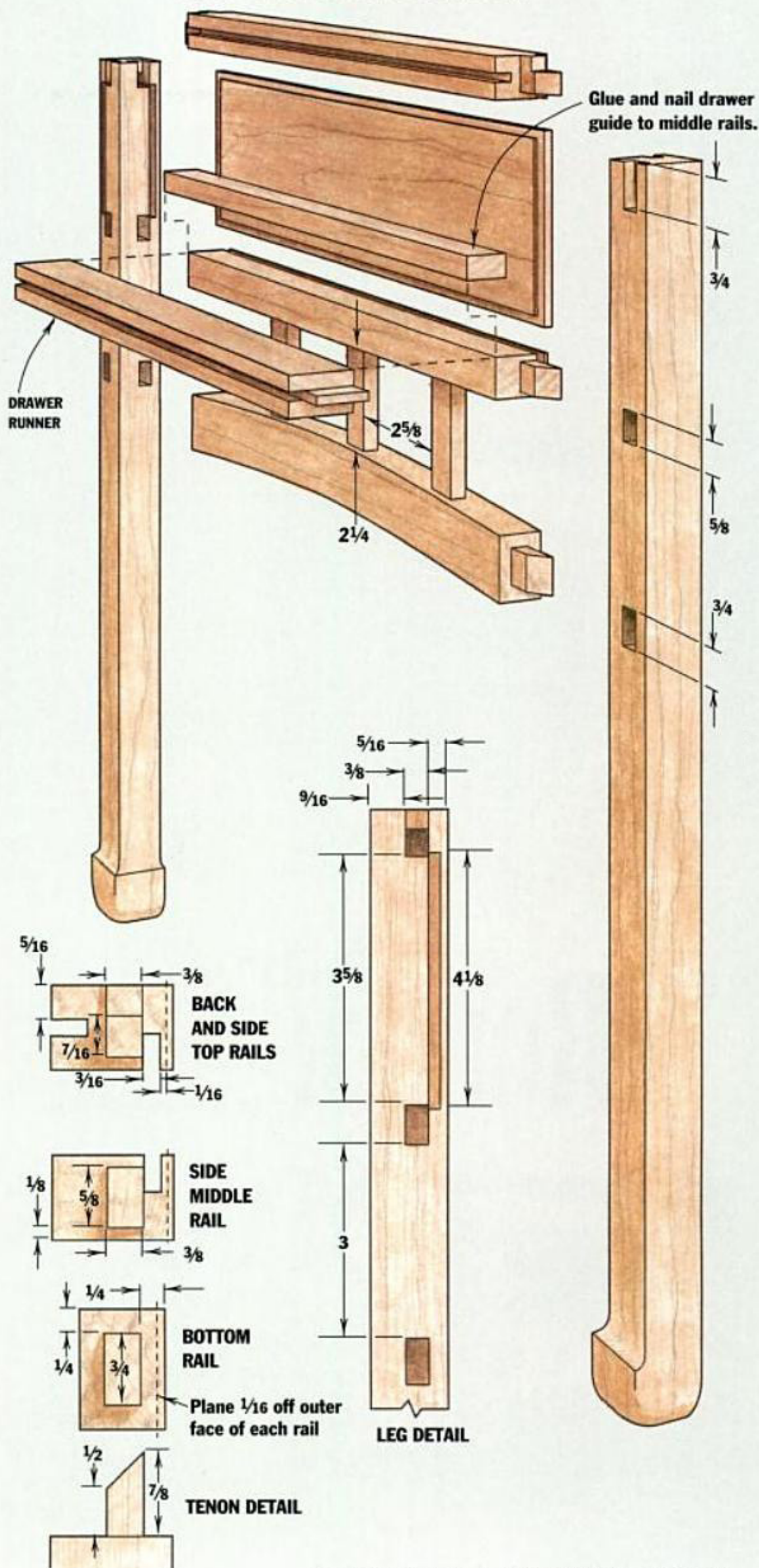
I used half-blind dovetails for the front of the drawer and full dovetails on the back. Two cherry dowels hold the drawer handle to the drawer front, while the drawer bottom fits in a groove in the sides and is held in place at the back with a few brads. (For more on drawer construction, see AW #22.) Drawer fitting is best done before the top is attached, while you can still see everything.

Also at this time, I glued and tacked a drawer stop to the back middle rail, so when the drawer was closed, the front would produce the same $\frac{1}{16}$ in. reveal as on the rails and panels.

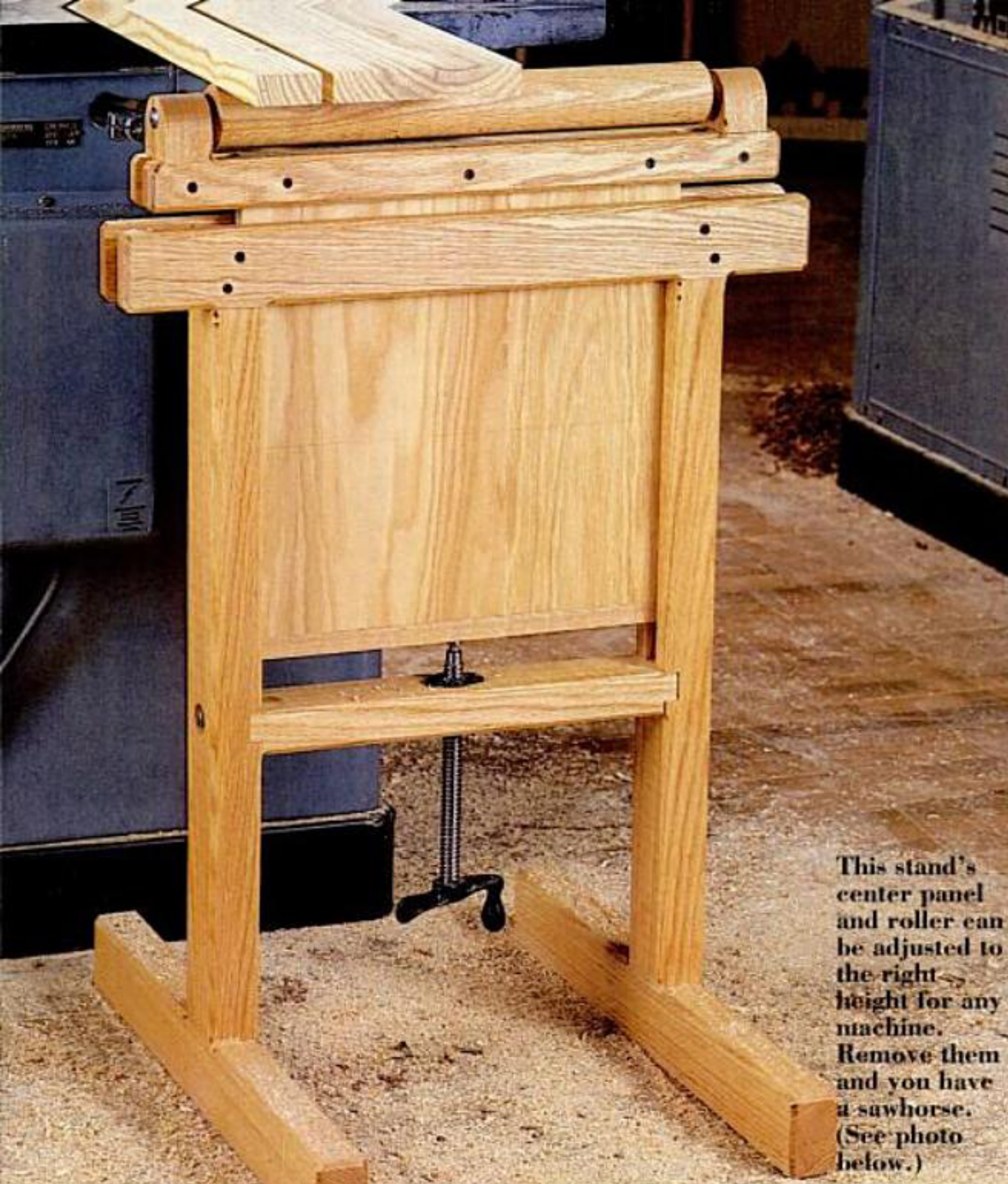
When attaching the buttons to the top, you'll need a stubby screwdriver. If you don't have one, you can improvise by borrowing a bit from your electric drill or power screwdriver and tightening it into a spare Jacobs chuck from your radial arm saw or lathe.

I used an oil finish on this suite because of its clarity. As a bonus, oil creeps in around the unglued vertical members and "welds" them in place. If your vertical members need more reinforcement than that, you can pin them in with small dowels. ▲

FIG. 2: SIDE ASSEMBLY



SCOTT COOPER
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PHOTOS BY MITCH MANDEL

DUAL-PURPOSE ROLLER STAND

BY GLENN GORDON



Change The Height With a Turn of the Screw, Or Convert It Quickly to a Sawhorse

Machining long or wide stock can be awkward if you work alone, and even with a helper, dancing with long boards can turn to slapstick before you know it. To solve these problems, I designed this adjustable roller stand/sawhorse. You can position this stand quickly on the infeed or outfeed end of a machine, and if you build a pair of stands, which I recommend, you'll have one for each end. You can also convert the stand into a sawhorse by simply pulling out the panel. (See inset photo.)

The Design

Roller stands often tend to tip over in use because they're not heavy enough or because they're too narrow at the base for stability. To counteract that tendency, I designed this stand to have a broad footprint, and I built the frame from heavy 8/4 stock. I used some oak salvaged from truck pallets for my stands, but beech, maple, or another stable hardwood would work as well. Just be sure to use dry, straight-grained wood; warped stock could cause the movable plywood panel to stick in its grooves.

This stand operates simply. The roller-and-panel assembly travels in grooves machined on the inside faces of the posts, and it's raised and lowered by a 9-in. Jorgensen veneer-press screw (available from Constantine's, 2050 Eastchester Rd., Bronx, NY 10461, 800-223-8087) which runs through a nut set into the stand's stretcher. (See drawing.) The roller height is easily fine-tuned through the action of the screw. Also, the screw's acme threads stay put wherever you've left them, so there is no need for a wing nut or clamping knob to lock the setting.

The stock Jorgensen press screw comes with a swiveling nose pad which really isn't needed in this design. I removed the pad to expose the conical tip machined at the end of the screw, then used a countersink to drill a matching dimple into the bottom edge of the movable panel. (See drawing.) I used Baltic birch plywood for the panels, but any 3/4-in. hardwood plywood would work well. Just glue a hardwood strip to the bottom to withstand wear from the screw tip.

The length the panel travels up and

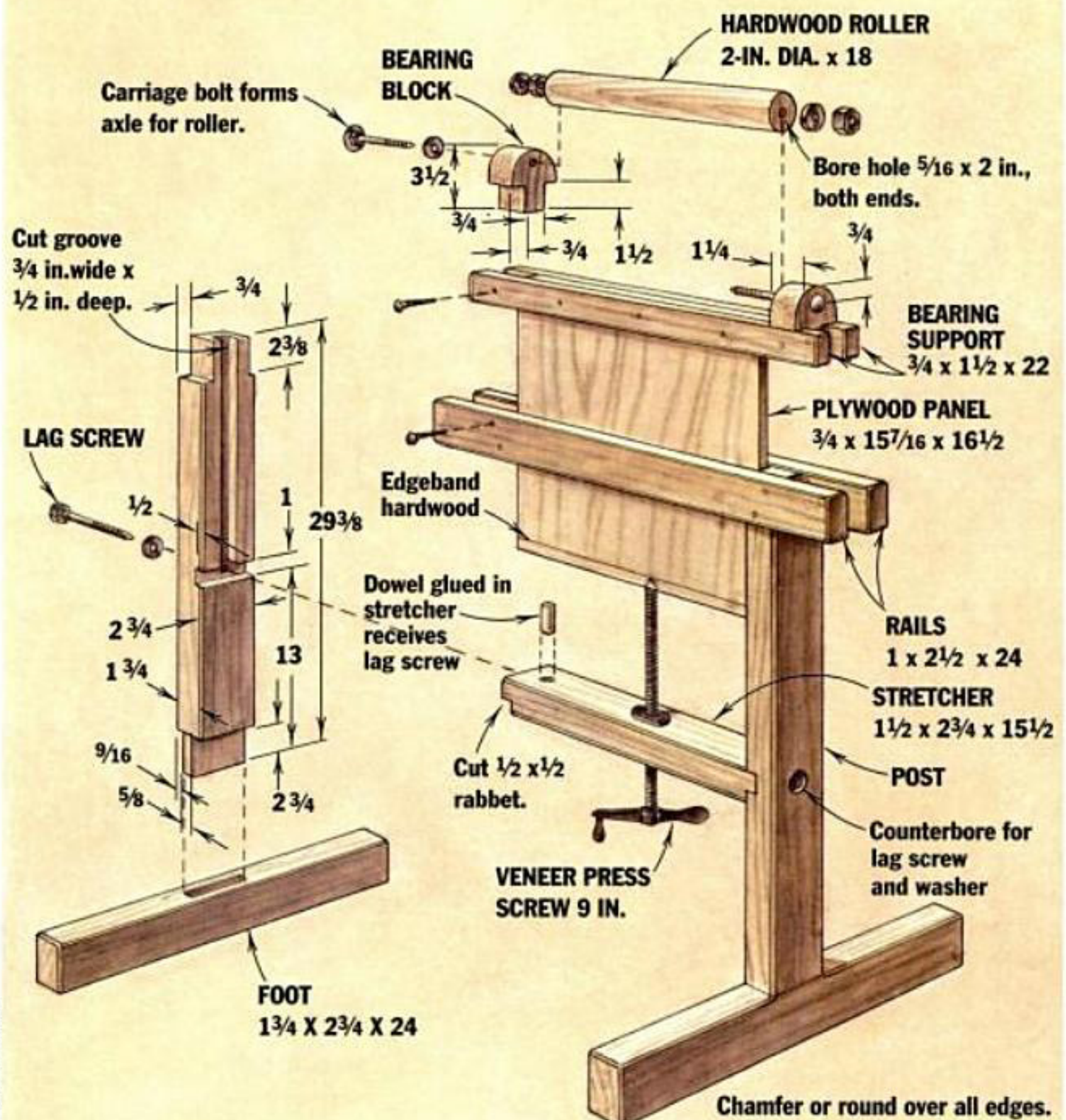
down in the grooves ought to cover the range of table heights of all your machines. If that range exceeds the 6½-in. working range of a 9-in. press screw, you can use a 12-in. press screw instead (working range, 9½ in.). When the press screw is backed all the way down, the total height of the stand, roller included, should be ¼ in. to ⅜ in. lower than the height of your lowest machine. This is so it can be adjusted to receive stock that bows downward, as sometimes happens, for example, coming off a tablesaw.

The dimensions of the stand as drawn here will work for the equipment in most shops, but they aren't carved in stone; you can modify them to suit your machines. If these dimensions won't give you a low enough stand, simply shorten the length of the posts and reduce the height of the panel accordingly. However, if you have to do this, only cut the posts from the top end, because you need to maintain the 13-in. dimension from the floor to the stretcher to make room for the press screw.

To allow the plywood some play, the grooves on the posts should be machined just a little bit wide. Also lubricate them with paraffin, so the panel can slide smoothly even when high humidity swells the wood. A loose fit also allows the panel to tilt a few degrees each way, so the roller can align itself to stock coming off a machine.

You can turn the roller on a lathe, or you can use one of the metal or rubber-covered rollers available from mail-order houses. But you don't have to use a cylindrical roller at all; the stand is designed to accept interchangeable fixtures. For example, a panel can be capped instead by a flat bar of wood embedded with a row of Acme casters (available from Grizzly Imports, Inc., P.O. Box 2069, Bellingham, WA 98227, 800-541-5537). Unlike a cylindrical roller, Acme casters (no relation to the acme thread of the press screw) allow a load to roll equally well in any direction; they are better at handling wide sheets

ROLLER STAND



of plywood, MDF, etc. Another option is simply to cap a panel with a plain flat bar—no rollers on it at all—making a height-adjustable support for long lengths of stock at a drill press or radial arm saw.

Notes on Construction:

The drawing shows you all you need to know to construct the stand, but here are a few more suggestions:

- Extending the rails a few inches beyond the posts will furnish broader support when you use the stand as a sawhorse.
- Adjustable levelers will compensate for uneven shop floors and save wear on the skids.
- Chamfering or rounding over all the edges will prevent them from tearing when the frame is subjected to the dents and dings of normal use.
- To provide clearance above and below the roller, the bearing blocks must be

lower than the top edge of the roller, and they should still leave about ¼ in. of space between the bottom of the roller and the top of the panel.

• To make the roller panel, first glue and screw the bearing supports to the top edge of the panel, then make and position the bearing blocks to suit the roller.

• Finally, an oil finish will protect the stand from stains and glue. ▲



GLENN GORDON
is a writer and gypsy furniture maker currently living in St. Paul, Minnesota.

COPING WITH WOOD MOVEMENT

*How to Build
Furniture That Won't Crack or Split*

BY JIM CUMMINS

The breadboard end glued firmly to this tabletop restricted wood movement across the grain, eventually causing the top to split.

MITCH MANDEL

When I was just barely out of my teens, I laid a floor for a neighbor who told me, nail by nail, exactly what to do. At 96 years of age, he didn't "take no advice from nobody," and insisted on using some wide pine boards he'd had drying for 30 years in a covered shed. "Dry," he said. "This stuff is as dry as wood can get." That winter, his folk wisdom took a hard knock, because half-inch gaps opened between every board.

Neither he nor I knew at the time that air-dried wood in the Northeast remains at a moisture content around 15 percent, no matter how long it dries. So when arid winter heating brought that air-dried lumber down to 6 percent, it shrank a lot.

Similar perils lurk in the wings for any woodworker. The box top curls. The case side splits. The drawer won't open. The chair falls apart. Wood warps, splits, winds, twists and kinks. It not only moves—some days the stuff

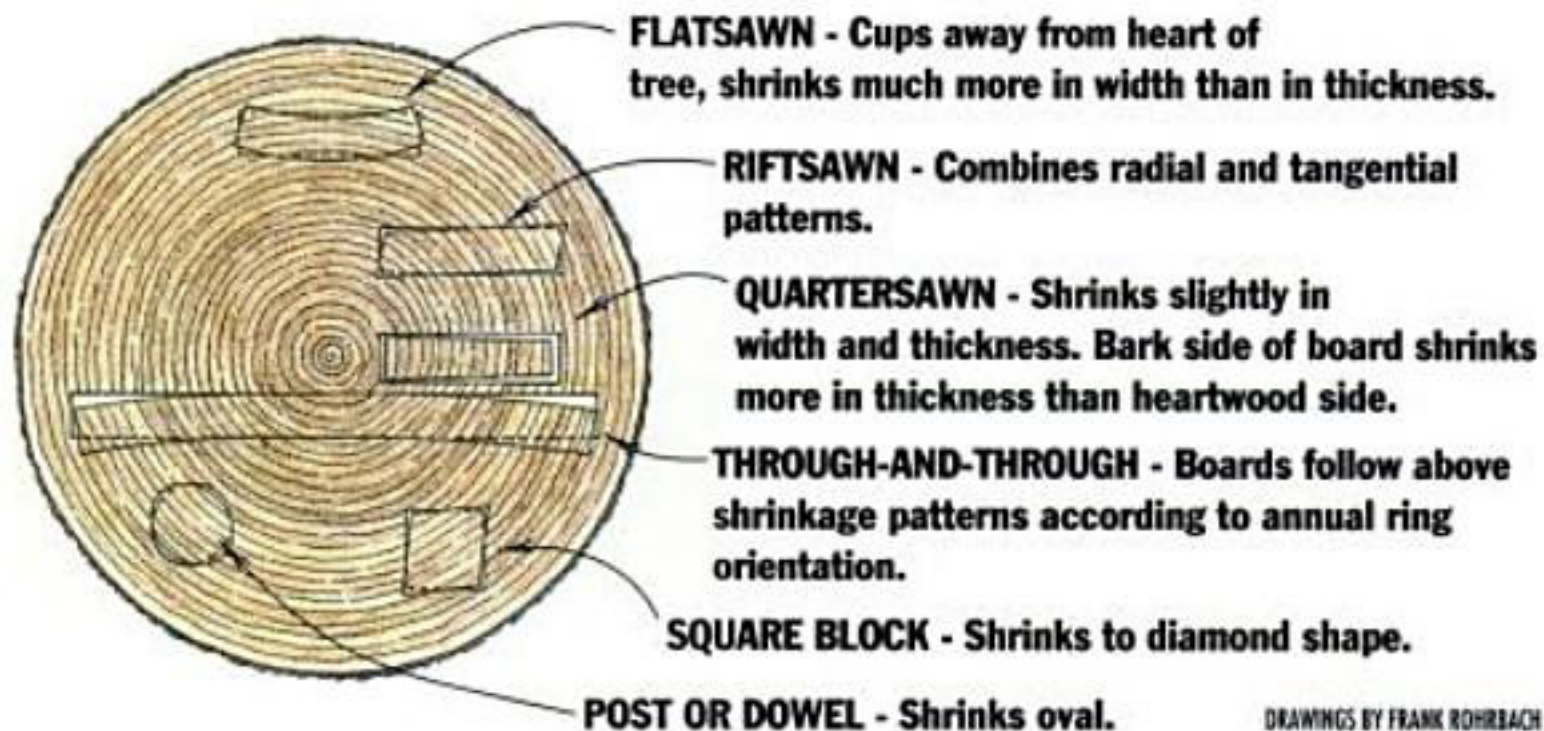
seems to jump up and run around. But wood has its reasons for moving, and when we understand them, we can design around them.

Why Wood Moves

First of all, wood shrinks and expands as its moisture content

changes. We all know that. And most of us know that this movement is primarily across the width of a board rather than along the board's length, which hardly changes at all. Further, how wood shrinks or expands depends on what part of the tree it came from and how it was sawn. Fig. 1

FIG. 1: HOW WOOD MOVES



DRAWINGS BY FRANK ROHRBACH

sums up most of this, and there's a wealth of folk wisdom and tradition to back up the science behind it all.

To explain why boards cupped, old-timers used to say, "The annual rings try to straighten out." This is useful to remember, as is the reverse—when modern kiln-dried hardwood rebounds from a 6 percent or 7 percent moisture content to a more normal 8 to 12 percent, the annual rings tend to curl again.

I'll invent an additional "old saying" to explain why flatsawn boards shrink more than quartersawn boards: "As wood dries, the annual rings get shorter." This rule also explains why turned bowls dry oval. Just look at the end-grain side of the bowl, then shorten the annual rings in your mind.

Abnormal Wood

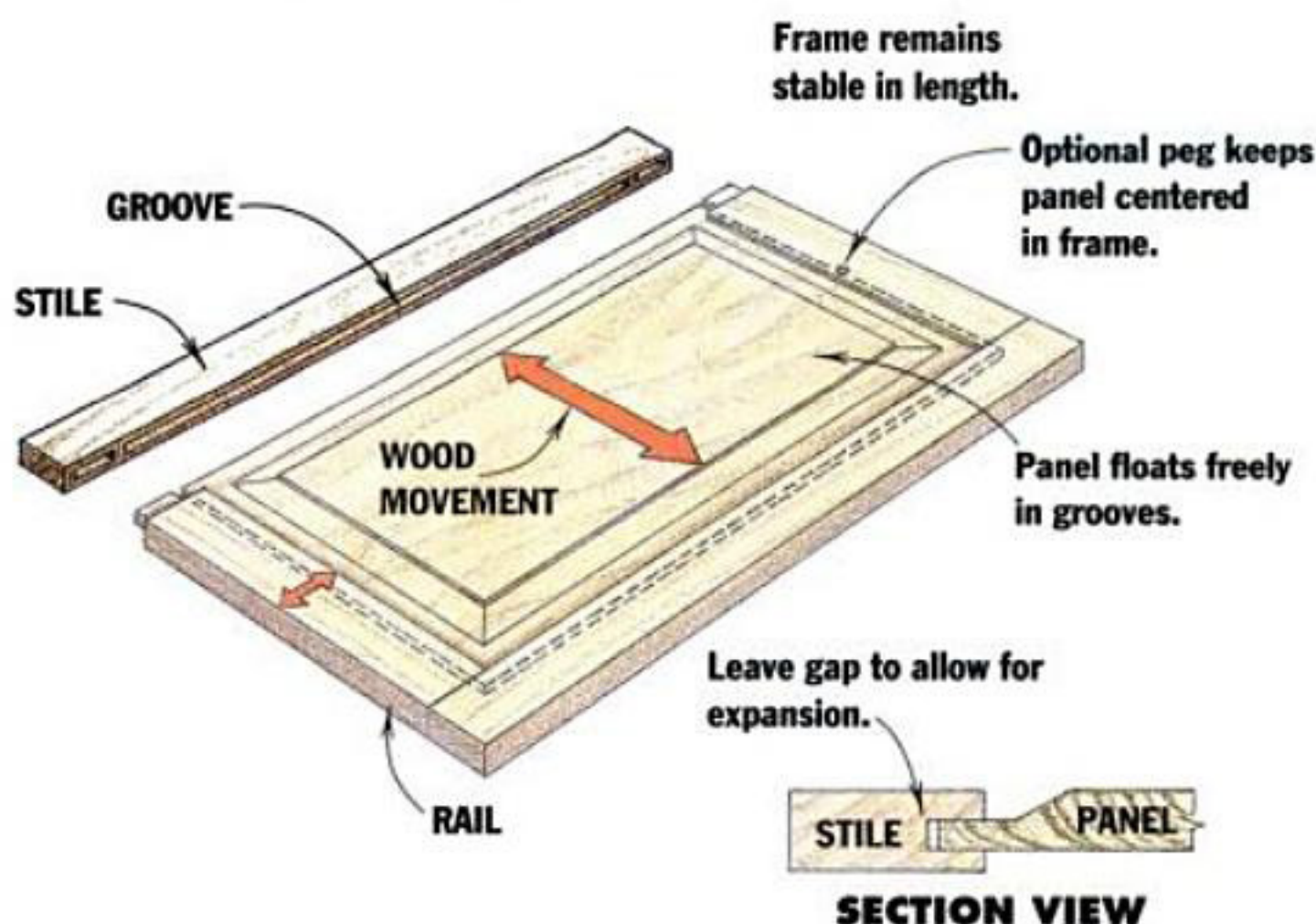
As a rough rule of thumb, wood changes width by about 1 percent for each 2 percent change in its moisture content. And most traditional furniture design comfortably allows wood movement over a swing of several percentage points. If we use properly kiln-dried wood for our indoor furniture, we should be all right.

But there is one major complication—not all wood behaves according to the rules. As testimony, consider the following example. Last year while repairing a factory-made oak chair seat that had split along a glue line front to back, I found that one side of the seat had shrunk in length by a full one-sixteenth of an inch! Wood isn't supposed to shrink lengthwise, but in this case I was dealing with abnormal wood.

Prime lumber comes from the trunks of straight trees. This wood grows mainly as very long, narrow cells that conduct water from the roots up to the leaves. We consider such wood "normal" because it behaves predictably. Yet leaning trees and branches grow a different sort of wood whose main purpose is not to conduct water, but to resist gravity. This abnormal wood, called reaction wood, *will* shrink in length.

If a board contains some abnormal wood, it may appear to dry normally in a kiln. However, it will have built-up internal tensions because of uneven shrinkage. An offcut ripped from such a board will twist, curl and corkscrew.

FIG. 2: FRAME & PANEL CONSTRUCTION



The board will bow when planed, and may eventually split right down the middle or pop its glue joint like my unfortunate oak chair seat.

To spot abnormal wood, I look for identifying signs, such as sudden changes in luster or grain direction; offcuts that twist; surfaces that won't machine or sand smooth; unusually wide and narrow grain in the same board; wavy or curling grain; unusually heavy, light, or sappy boards; boards with the heart off-center; boards near the pith; boards with wood that grew near knots; and boards that have moved strangely already.

There is no way to plan ahead for abnormal wood movement, so if your instincts tell you there's something wrong with a piece of wood, don't use it. It's not nice to fight Mother Nature.

Working With Normal Wood

The chart on page 42 indicates how much various normal woods move as the amount of moisture in the air (relative humidity) changes. When the wood arrives at a moisture content in balance with the air, we call it equilibrium moisture content, or EMC. When the humidity changes, wood moves to a new EMC in balance with the new average humidity.

It's important to take these changes into account when choosing wood and designing a piece. (See sidebar for more on designing around wood movement.)

It's critical to use wood dried to the correct level for its purpose. In my shop, we use a lot of pine for picture-frame liners and moldings. I can buy pine from a distant mill, kiln-dried to 6 percent moisture content (MC). But for

FIG:3 MORTISE & TENON JOINTS

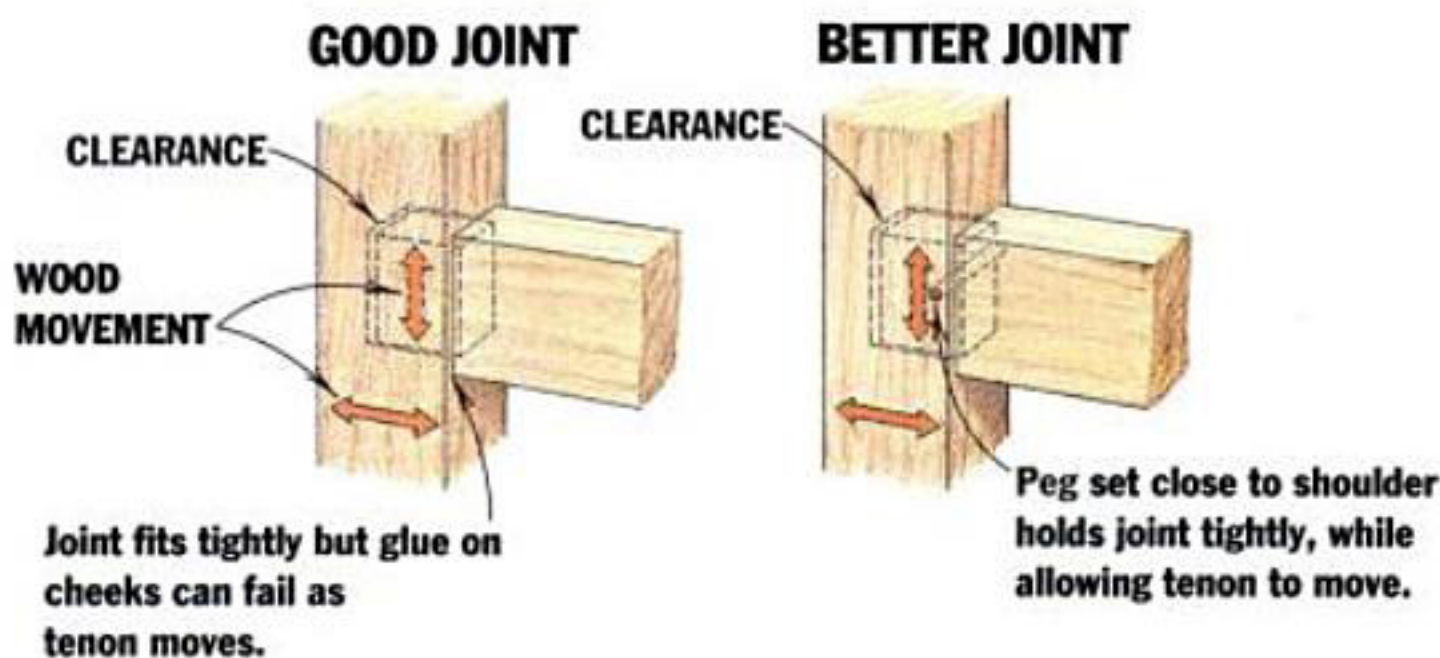
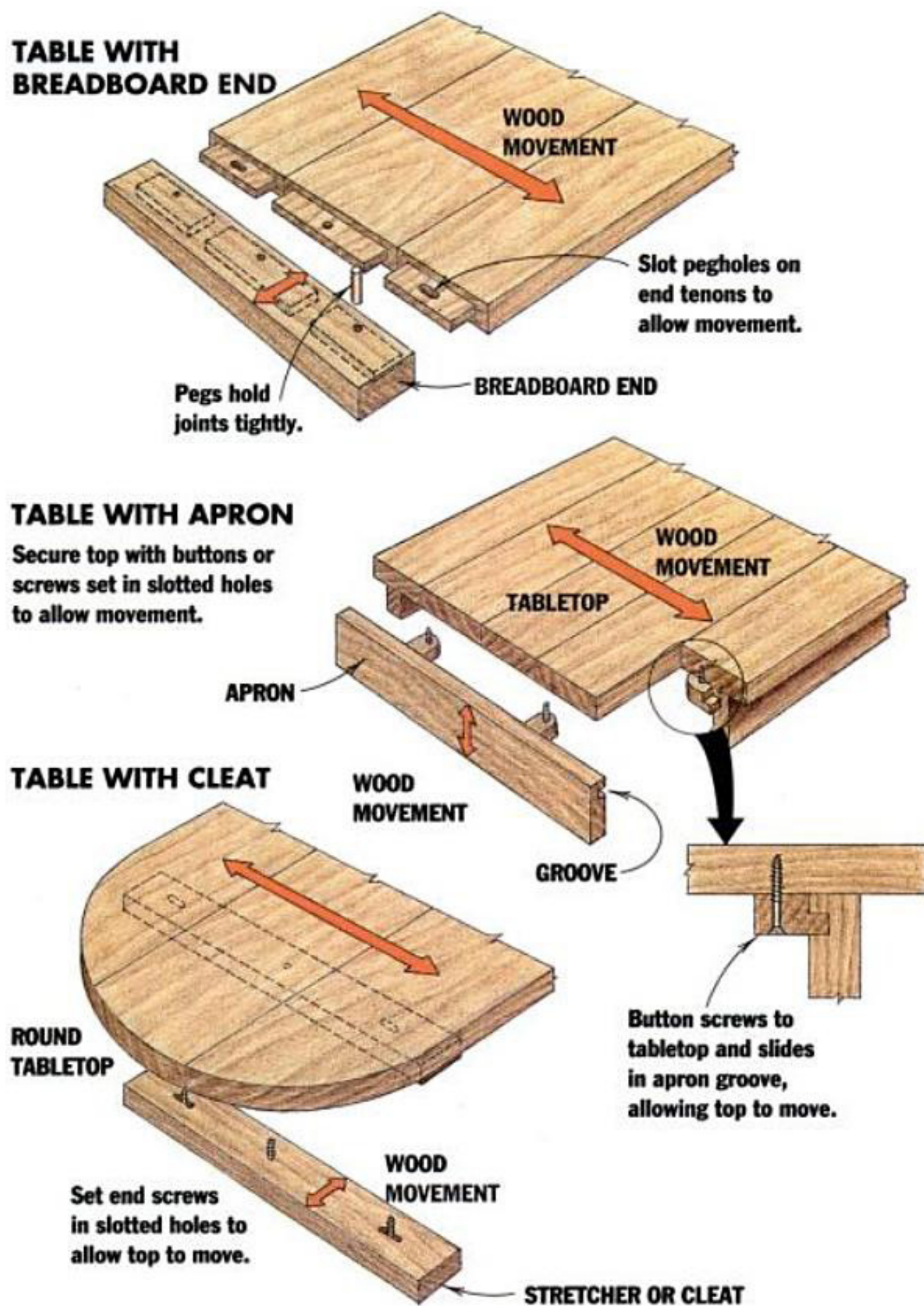


FIG. 4: FASTENING TABLETOPS



reasons of economy I most often buy #2 common pine from my lumberyard. This wood is meant for the construction industry and has measured as high as 19 percent MC when delivered. I've learned to monitor the wood with a moisture meter ([see sidebar, page 44](#)) until it has dried to around 10 percent, at which point it's safe to use indoors. It pays to check the moisture content of any wood not fresh from a kiln.

Thankfully, wood is a forgiving material and many modern furniture finishes further slow moisture exchange, although nothing can stop it entirely. Still, a project built of kiln-dried wood and finished on all sides will rarely succumb to extreme wood movement, because the finish allows the wood to absorb only a limited quantity of water before seasonal changes cause it to lose water again, thus limiting the overall range of movement.

Cross-grain Construction

The tips mentioned above will help head off many of the problems wood movement causes, but you will still have to deal with a basic frustration in woodworking: cross-grain construction, where the end of one board (the width or end grain) must be joined to the side of another (long grain). If there isn't any "give" in the joint, it will likely fail as one board restricts the wood movement of the other. In the rest of this article, I'll examine the ways we cope with this problem.

Frame-and-Panel Construction

Probably invented by some gifted woodworker in ancient Egypt, frame-and-panel construction is still one of the best ways to allow a wide piece of wood to move. (See Fig. 2.) The thin

DESIGNING AROUND WOOD MOVEMENT

Good joinery will keep you out of trouble 99 percent of the time when dealing with wood movement, but here are some other basic points to consider.

- Ideally, all the wood you use in a project should be at the same moisture content so the pieces will move at the same rates. (There are exceptions when you're deliberately working green wood.)

- Wood species used together in a project should have similar rates of movement. ([See chart, page 42.](#))

- Allow for future expansion if you're working wood that's just been kiln-dried to 6 percent moisture content, since the relative humidity in your area is unlikely to be low enough to maintain that moisture content.

- Allow for winter shrinkage if you

build a piece in summer, and vice versa.

- Use air-dried or construction grade wood for outdoor projects, and kiln-dried wood for indoor furniture.

- Choose wood species with a small range of movement (see chart) for projects that will be exposed to wide swings in relative humidity.—J.C.

frame around the panel provides a lightweight construction unit that remains stable in length as the panel inside shrinks and expands in its groove. (See AW #31, for more on frame-and-panel doors.) Familiar uses include doors, cabinets, lecterns, desk sides, drawer bottoms, headboards, and similar large pieces, but the concept extends further. A mullioned window is a frame with glass panels. A table is a frame with the panel laid on top.

There are various ways you can fix the panel in or on its frame. Pinning a door panel at the middle will keep it centered while allowing its width to expand and contract. To hold a tabletop in place, screw it tightly to the frame at the center, then set the screws at each side in slots. Or you can use the familiar metal or wood "buttons" set in a groove. (See Fig. 4.) To keep a round tabletop flat, use screw-on cleats, and slot the end screw holes so the top can move.

Mortise-and-Tenon Problems

A mortise-and-tenon joint is pure cross-grain construction. But if you construct these joints carefully, as shown in Fig. 3, they should resist wood movement. (See AW #18, for more on mortise-and-tenon joints.)

As I write this article, my computer sits on a cherry tavern table made with mortise-and-tenon joinery before 1750. It has no value as an antique because previous owners cut the aprons for knee room and replaced the original top at least once. But when I bought it at a roadside stand 20 years ago it was solid as a rock, because it had spent recent years in a shed, at a similar moisture content to the day it was made. After a winter of drying indoors, it began to creak a little, but it still stands firm. As far as I can tell, there's no glue in the joints now. The table's pinned tenons were made according to the principles shown in Fig. 3. Had it been merely glued, it would have fallen apart generations ago.

Case Construction

Dovetail carcass construction allows sides, top and bottom to move in tandem. But when you add cross-grain runners for drawers or apply moldings to the sides of a cabinet, the parts don't all move in the same direction. Resulting tensions have been known to crack case sides and pop off moldings.

Craftsmen have created numerous solutions to allow the back ends of case moldings to move. (See Fig. 5.) In the simplest, the mitered front end is glued and fixed firmly to the case, while the unglued back end is tacked on with wire brads. The brads in the molding flex as the case side moves. More sophisticated solutions fix the back end with a screw from inside the case (with the screw hole slotted) or allow the back part of the molding to ride on a short runner. The runner can be as simple as a screw head that fits a routed slot on the molding.

You can use similar approaches with crown moldings—secure the miter against cracking by gluing it, but

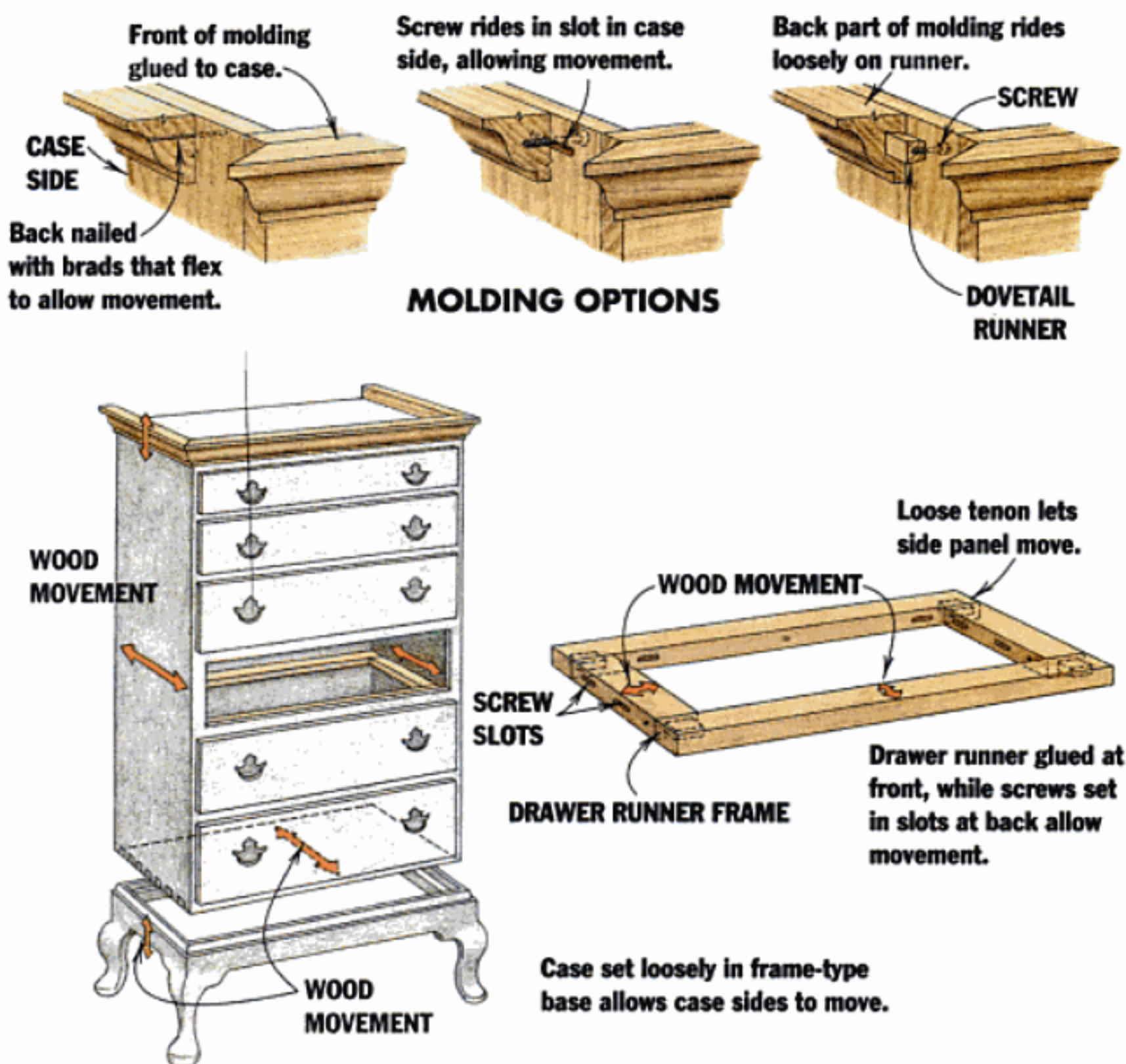
attach the rest of the molding with brads or slotted screws. Drawer runners are handled in the same way—tight fronts, loose backs.

The ancient way to fix the bottom to a chest so it can move is to nail it. We gasp at this perfidy, but nails are more sophisticated than they look. A nail will enlarge its hole at the point where the bottom and case sides meet, allowing movement, while the point of the nail remains relatively fixed and secure. Rustic old-timers often nailed tabletops for the same reason. City cabinetmakers scorned nails, however, and set their chests on frame-type bases, which is still the current practice. (See Fig. 5.)

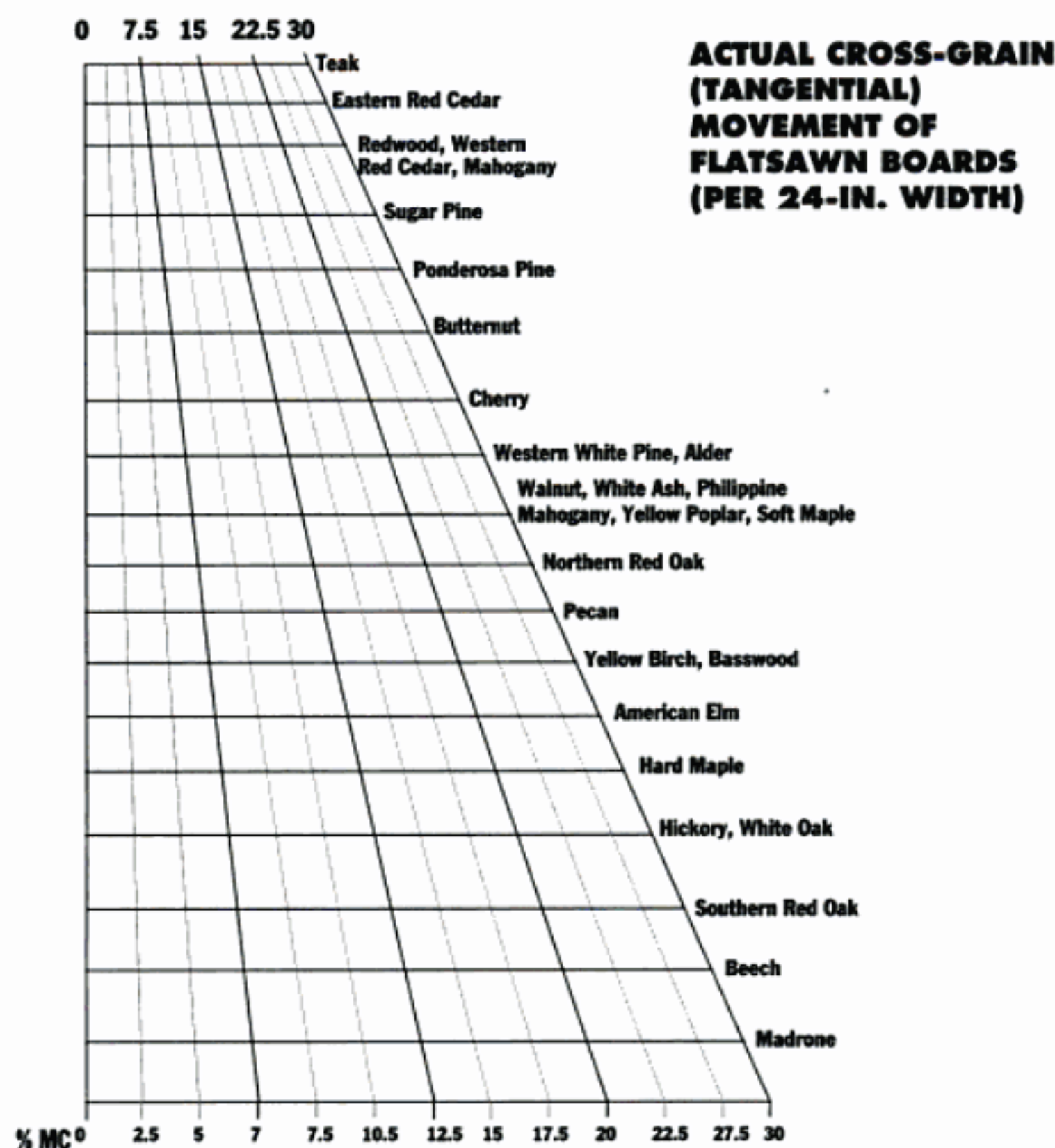
Miters, Dowels, and Screws

As shown in Fig. 6, moisture plagues miter joints. The miter is half end grain in the first place and presents a mediocre gluing surface. If that weren't bad enough, when the frame pieces expand or contract in width, the angle of the miter changes, and few frames can resist the tension. The wider the molding, the

FIG. 5: CASE CONSTRUCTION



HOW MUCH DOES WOOD REALLY MOVE?



These charts show how much common species of wood move over the course of the year in different parts of the country. The bottom chart provides the average annual swing in indoor humidity for cities and environments, while the top chart indicates the amount of shrinkage that occurs in a 24-in.-wide flatsawn board as it changes from green (30 percent MC) to oven-dry (0 percent MC). With this information, you can determine the amount of wood movement in your climate or the climate of the area of the country where the furniture will reside.

To use the charts, follow these steps.

Step 1: On the bottom chart, find a city (red) or environment (blue) whose climate compares to yours.

Step 2: Note the seasonal swing in wood's equilibrium moisture content (EMC) on this chart by reading from the colored bar up to the scale along the top edge of the chart.

Step 3: Move to the top chart and find the wood species you intend to use.

Step 4: Make two marks on the horizontal line beside the wood to indicate the equilibrium moisture content (EMC) range you found on the bottom chart.

Step 5: Measure the distance between your marks with a ruler. This gives you the actual amount of cross-grain (tangential) movement in inches on flatsawn boards 24 in. wide. (Radial movement will often be less.)

To more accurately identify the moisture swing in your area, measure the actual seasonal swing in indoor relative humidity (RH) in your area. Then match those readings to the RH scale on the bottom chart and read up to the EMC scale along that chart's top edge. Apply them to the top chart to see the actual amount a wood will move in your area. For even more precision, use a moisture meter (see sidebar, page 44) to test wood samples during the heating season and again during the summer. This will give you the actual extremes of EMC swing in your area. Applying them to the top chart will show you the actual amount a wood will move in your area.—J.C.

ANNUAL SWING IN AVERAGE INDOOR RELATIVE HUMIDITY*

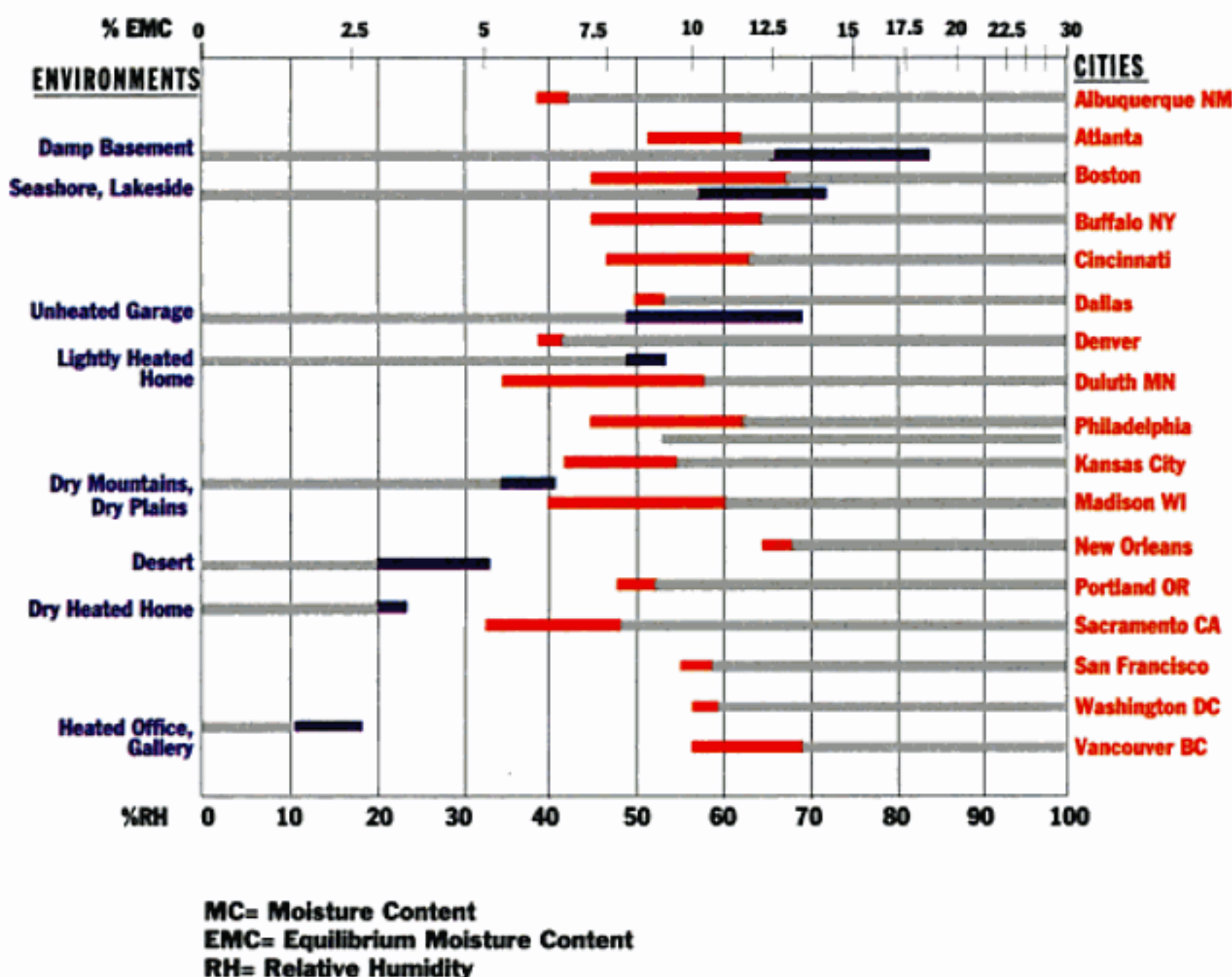
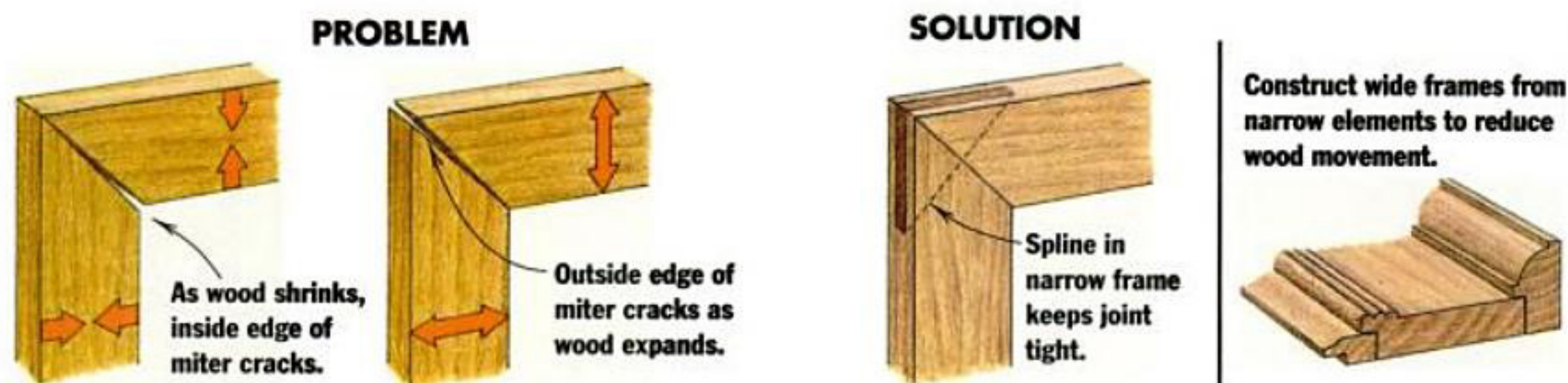


FIG. 6: MITER JOINTS



more likely something will give.

You can strengthen miter joints with splines (see Fig. 6) but you'll still be working against wood movement, and the joints are likely to fail if subjected to wide swings in moisture. As a picture framer, I've seen scores of old frames that self-destructed after being stored in arid attics or damp basements. Even in the living room, a picture frame is constantly stressing its joints with changes in the weather. Partial failure of the joint at the inside corner is commonplace because of winter heating. If a long, wet summer reverses the geometry and opens the outside as well, there will be nothing holding the frame together but a couple of nails.

Obviously, you shouldn't rely on miters as structural joints, but to help them last in decorative uses, you should always use properly dried stock, protect the work with a good finish, and avoid exposing it to excessive moisture swings. And when working with wide frames, it's best to make them from a series of narrow elements, as shown in Fig. 6. In this way, each thin piece will move a small amount.

Dowels are just round tenons, with all the familiar problems and then some. They may not only be cross-grain to one of the elements they join—and thus subject to glue-weakening movement—they are also inherently cross-grain within themselves. The "folk wisdom" I use to remember which way dowels and blocks will move is that the annual rings shrink shorter rather than closer together. Thus, dowels become oval in one direction with expansion, and in the

other direction with shrinkage.

This variable movement eventually cracks the weak side of the glue line, leading to joint failure. In chairs, particularly, but in other stressed frames as well, dowel joints will need periodic repair if subjected to extreme shifts in moisture.

Screws work well in furniture for climate-controlled office buildings, where wood movement is virtually forestalled. But in my opinion, screws generally promote wood failure. Wood expansion "pulls" a screw until its threads slightly tear the wood around them. The joint stays tight until the wood shrinks again, whereupon the screw becomes loose. The temporary cure, tightening the screw further, only postpones and exaggerates the problem—more wood will fail with the next expansion, until the threads tear out completely.

If you use an embedded nut or other fastener to avoid the thread problem, the machine-screw shank compresses the wood it passes through. More than a little wood movement will overstress the wood beyond its ability to recover to its original size. On shrinking, the joint is again loose. Still, here you can tighten the screw over and over again to effectively tighten the joint.

We often don't notice how loose screwed joints get. Mechanical features such as the long shoulders found in bed rail joints keep the wobble within practical limits. But no screwed joint subjected to wide moisture swings will stay tight for long.

Moving and Storage

Much has been written about the suffering of antique furniture exposed to modern central heating. For those of us without extensive antique collections, it's more important to consider the problem in reverse.

Modern furniture is designed and built to endure modern indoor conditions. But many pieces are placed in unheated storage these days—when people move to smaller quarters, for example, or inherit valuable sets they don't know what to do with. If these pieces are simply left in unheated parts of a house, garage or storage shed, they may self-destruct.

A change in lifestyle can have the same result. Some decades ago, my in-laws coped with skyrocketing electric rates by turning the thermostat lower and lower each winter until their home felt like their garage most of the time. When they finally capitulated and switched to wood heat, the frugal couple enjoyed high indoor temperatures for the first time in years—and all their dining room chairs fell apart!

To sum up, a healthy respect for wood movement can help you improve the quality and longevity of your projects. If you appreciate how and why wood moves, you'll be able to choose the right wood and the right design to fit your particular needs, and you'll know how to care for your piece when it's finished. ▲

JIM CUMMINS

is a contributing editor of American Woodworker. His shop is in Woodstock, NY, with EMC about 7 percent to 11 percent.

Veritas Tools
Timber Check
(\$79.95)



Lignomat
Mini-Ligno
(\$110)



Lignomat
Mini-Ligno
E/C
(\$139)



Delmhorst
J-88
(\$110)



Delmhorst
J-3
(\$165)



Protimeter
Mini C
(\$129.95)



Protimeter
Digital Mini
(\$169.95)



Electrophysics
MT270
(\$95)



LOW-COST

MOISTURE METERS

*How Dry Is
Your Wood?
These
Hand-held
Devices Will Tell
You With
Pinpoint
Accuracy*

BY JIM CUMMINS

Any woodworker who's progressed beyond hammer and nails should consider buying a basic moisture meter. It takes the doubt out of lumber selection and can save you from wood movement problems that might split your project apart or warp it like a potato chip.

I've had a moisture meter for about a dozen years now, and I'd give up my set of Forstner bits before I'd do without it. A moisture meter can tell you how tight to fit a drawer, how long you'll have to wait before using the oak drying in the back room, and whether a panel will buckle in its frame, pop out of its groove or behave the way it's supposed to.

There are less obvious applications as well. By testing a piece of thin wood from week to week in your shop, you can see how the shop's relative humidity varies and determine the average. By testing furniture already acclimated to your home, you can determine the moisture content (MC) needed for projects in your geographic area.

In short, if you start using a moisture meter, you'll soon wonder how you ever got along without one.

How They Work

Moisture meters work by measuring the resistance to an electric current which flows between a pair of prongs. When you push the prongs into a piece of wood, the moisture in the wood completes the electric circuit. The wetter the wood, the greater the current in the circuit. (Current flow is also affected by the temperature and species of the wood, and for greatest accuracy you should consult conversion charts.) On the less expensive meters I tested, the current triggers light-emitting diodes (LEDs) that indicate MC within a percent or two. This measurement is adequate for normal woodworking projects. More costly units will have analog meters or digital readouts that show moisture to a fraction of a percent.

For this comparison I tested eight meters that cost less than \$200. I used them on hardwoods, veneers, plywoods, finished furniture, construction lumber, firewood and timbers scavenged from my local landfill. I found little practical

difference in their performance, although meters with LEDs were harder to read outdoors in bright sunlight. My other observations follow.

How They Match Up

Delmhorst Instrument Co.—Along with Lignomat, Delmhorst pioneered the home-shop moisture meter. The J-88 (\$110), one of two Delmhorst meters tested, is a new-generation model of the LED meter I've used for more than 10 years. It's sturdy, without frills and measures MC in 10 intervals between 6 percent and 20 percent. To make the meter easier to read in low light, Delmhorst has marked the MC percentages on the face of the LEDs. The meter's "on" switch is a recessed button on the face of the unit.

Its companion, the J-3 (\$165), is a more accurate meter with an analog dial that can measure moisture from 6 percent to 30 percent. This meter also has a built-in calibration check.

Electrophysics—This company's MT270 (\$95) meter has an analog dial and push-button switch. It reads between 4 percent and 30 percent MC and is easy enough to use. However, it is calibrated for the "cedar" wood group—oak, beech and poplar, as well as many exotics. All the other meters tested are calibrated for the "fir" wood group, which includes cherry, walnut, pine, mahogany, basswood, ash, redwood, maple and birch. The Electrophysics readings were slightly lower than those observed on meters calibrated to the "cedar" group. The company supplies a conversion chart to correct for readings on woods in the "cedar" group.

Lignomat USA, Ltd.—The Mini-Ligno (\$110), the less expensive of the two meters tested from this company, reads MC in 2-percent intervals between 6 percent and 20 percent. To turn on the unit, you jam the probes deeply enough into a piece of wood, triggering a microswitch located between the probes. The standard probes are about 1/4 in. long. For deeper readings a 7/16-in. set is included inside the meter.

The Mini-Ligno E/C (\$139) operates on the same concept but can measure MC to 36 percent. This unit is also the only meter tested which comes with a set of remote probes (\$32.50 if bought

SOURCES

The moisture meters tested here came from the following mail order suppliers:

▶ **DELMHORST INSTRUMENT CO.**, 51 Indian Lane East, Towaco, NJ 07082, (800) 222-0638. CIRCLE #601

▶ **ELECTROPHYSICS**, Box 1143, Station B, London, Ontario, Canada N6A 5K2 (519) 668-2871

CIRCLE #602

▶ **FORESTRY SUPPLIERS, INC.** (Protimeter meters), Box 8397, Jackson, MS 39284, (800) 647-5368.

CIRCLE #603

▶ **LIGNOMAT USA, LTD.** Box 30145, 14345 N.E. Morris Ct., Portland, OR 97230, (800) 227-2105. CIRCLE #604

▶ **VERITAS TOOLS INC.** (Timber Check Meter), 12 East River Street, Ogdensburg, NY 13669, (800) 667-2986. CIRCLE #605

separately) that can be installed in the middle of a stack of wood in a small kiln, a boon to the many solar and dehumidification home-driers.

Protimeter—The Protimeter Mini C (\$129.95) features an extended range (from 6 percent to 60 percent MC), which makes it useful for monitoring next season's firewood as well as lumber. One doubtful "feature" is the switch, which turns on whenever the cap is removed; lose the cap and the unit will discharge the battery.

The higher-priced Protimeter Digital Mini (\$169.95) has a more practical push-button switch that lights the digital display for about 10 seconds. It will read moisture in tenths of a percent over an unlimited range.

Both Protimeter meters come with the extension probe that is shown with the digital meter, and both will accept the optional touch sensor (\$29.95) shown with the LED meter. (See photo.) The touch sensor, which lets you monitor wood without creating pinholes, proved surprisingly accurate for the general run of wood, plywood and veneers around my shop. It even warned me about the dangerous moisture level of the books (wood pulp, after all) stored in my basement.

Veritas Tools Inc.—The Timber Check Moisture Meter (\$79.95) is a

quirky cousin to the other sheep in this flock. Instead of indicating MC directly like the other meters, it works by a process of elimination. You turn the control knob from notch to notch in the 11 moisture levels (between 6 percent and 28 percent) it measures while carefully watching the indicator light. When the light comes on you've reached the correct reading. This might be a nuisance if you make a lot of readings. Still, this meter is the least expensive tested, and it comes with the best instruction sheet I've seen.

Recommendations

So which meter would I buy? Deep in my high-tech heart, I yearn for the digital Protimeter with the optional touch-sensor for versatility, but (sigh) at \$169.95 it cuts too deeply into my limited tool budget. However, many of the other meters also have features I like. The Timber Check Moisture Meter tells me all I really need to know for the least cost, while the Protimeter Mini-C with its extended range would be useful if I burned firewood or ran my own kiln.

If my shop specialized in projects with especially risky construction, I'd consider spending the extra money for the analog precision of a meter like the Delmhorst J-3. Still, my old Delmhorst has served me well and I won't argue with success. If I ever have to replace it, I'll probably opt for a J-88 on sale.

For meters more advanced, more versatile or more specialized, you should write to the manufacturers. Most manufacturers also offer accessories such as slide-hammer prongs for multiple tests in dense hardwoods, insulated probes for testing wood that's wet only on the surface, and sensors for concrete and building inspection work and other specialties. There are even models that will store multiple readings from several lumber stacks and print them out through a home computer for analysis. ▲



JIM CUMMINS
writes, edits and putters around his picture-frame shop in upstate New York.



*A Sneak Peek
At The Hottest
New Thing
In Saw Blades*

QUIET BLADES

BY ELLIS VALENTINE

Thunk! As my hammer tapped the prototype of Freud's new "quiet" circular saw blade, I thought I had tapped a wet rug by mistake. The sound, or lack of it, was amazing. We soon found out that this blade is noticeably quiet in use, too. It's a major technological breakthrough in the ongoing war against shop noise—and a blessing for sleeping families of late-night basement woodworkers everywhere. By coincidence, the Freud blade is also one of *two* quiet blades (Everlast makes the other) that are hitting the market almost simultaneously.

AMERICAN WOODWORKER shop-tested sample 10-in., 80-tooth blades from both companies, cutting $\frac{3}{4}$ -in. plywood, 1-in. pine, and 1-in. maple on a tablesaw, chop saw and radial saw. We've reported our tablesaw and radial saw results in the chart at right.

For comparison, we averaged sound-level readings from two conventional 80-tooth blades with the same tooth grind as our test blades. We suspended a sensitive decibel meter 24 in. from the blade, in roughly the same position as the operator's ears. (See photo, opposite.)

The results were very impressive, to say the least. The quiet blades performed similarly, averaging from 3 dB to 5 dB quieter than our comparison blades, depending on the material being cut. That's from *two to four times quieter!* (Decreasing loudness by 3 dB cuts sound intensity in half.) When freewheeling, the quiet blades ran 1 to 2 dB quieter than their standard counterparts.

Since sound levels typically fluctuate from one end of the cut to the other, we are reporting the decibel *ranges* we measured on our

The new blades from Freud and Everlast are the latest weapon in the war against shop noise, and they cut beautifully, too.

PHOTO BY JOHN HAMEL

HOW QUIET ARE THEY?

test saws. Note that even the quiet blades range over the threshold of hearing damage (85 dB), so we'd still recommend hearing protection.

How Did They Do It?

The key to the noise reduction lies in the strange-looking, laser-cut slots in the blade bodies. (See lead photo.) These narrow cuts reduce noise because they virtually eliminate vibrations caused by the cutting action and by the machine itself.

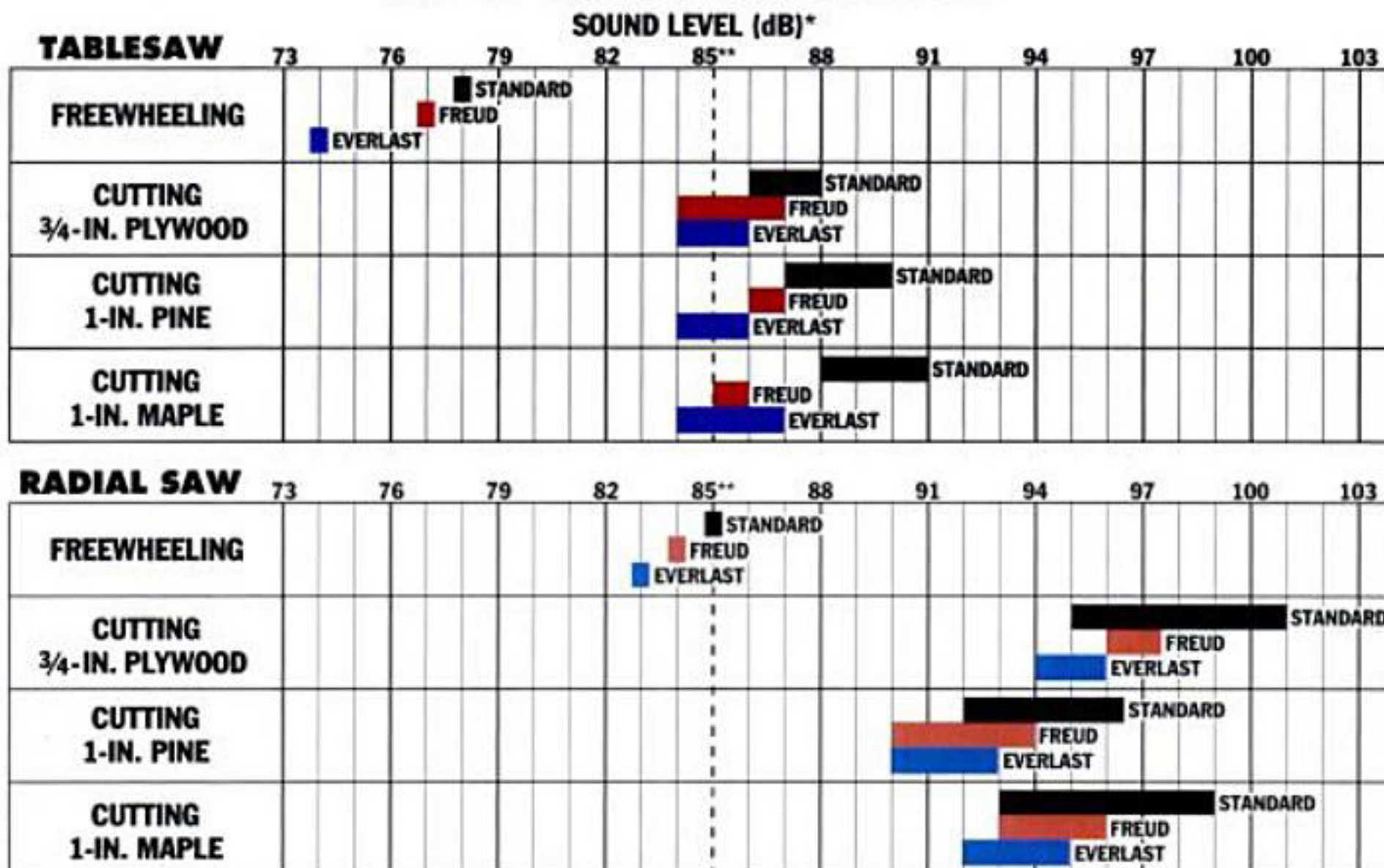
When you cut wood with a standard blade, vibrations form wave patterns that resonate through the tensioned-steel blade blank, producing that familiar ringing sound. In a quiet blade, the laser cuts dampen the sound—like cracks in a bell—by intercepting these vibrations and dissipating their energy. This energy travels along the cut to a shock-absorbing material at either end. Everlast blades use copper plugs to absorb the shock, and Freud blades use a proprietary material invented for this purpose.

Both manufacturers say they derived the patterns of their laser cuts from extensive computer analysis and experimentation. And though their patterns look very different (Freud calls theirs "reeds" and Everlast's are called "boomerangs"), both brands reduce cutting noise in much the same way.

In addition to the laser cuts which reduce vibration, both brands incorporate other features designed to minimize the annoying whistle of free-wheeling blades. Thin, laser-cut expansion slots and specially shaped gullets between the teeth reduce the turbulence created by air trapped in them as the blade spins.

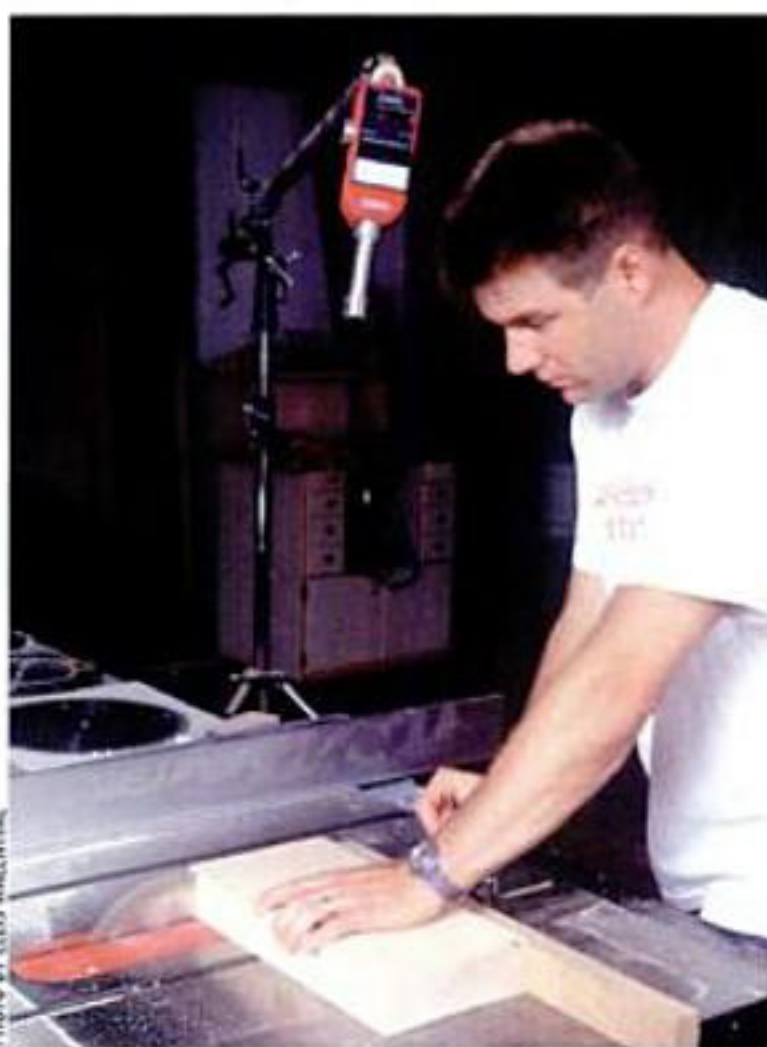
How Do They Cut?

Although we would recommend these blades on the basis of noise reduction alone, we found their cutting performance equally impressive. The effect of reduced vibration was most



■ STANDARD BLADE
 ■ FREUD QUIET BLADE
 ■ EVERLAST QUIET BLADE

*Measured @ 2ft. from blade.
 (Loudness doubles with each 3-dB increase.)
 **Threshold of hearing damage.



To measure sound intensity, we suspended a sensitive decibel meter two feet from the blade.

evident on tricky materials like lauan plywood and melamine-coated particleboard, which are likely to tear out when a vibrating blade exits a cut. Our test blades, which had just cleanly crosscut 2-in. rock maple, sliced through the fragile surfaces of these man-made materials with almost no tearout.

Cost and Availability

At the time of this writing, both manufacturers said they plan to make

FOR MORE INFORMATION

For more information on quiet saw blades:

FREUD USA, INC., Box 7187, High Point, NC 27264, (800) 334-4107

CIRCLE #629

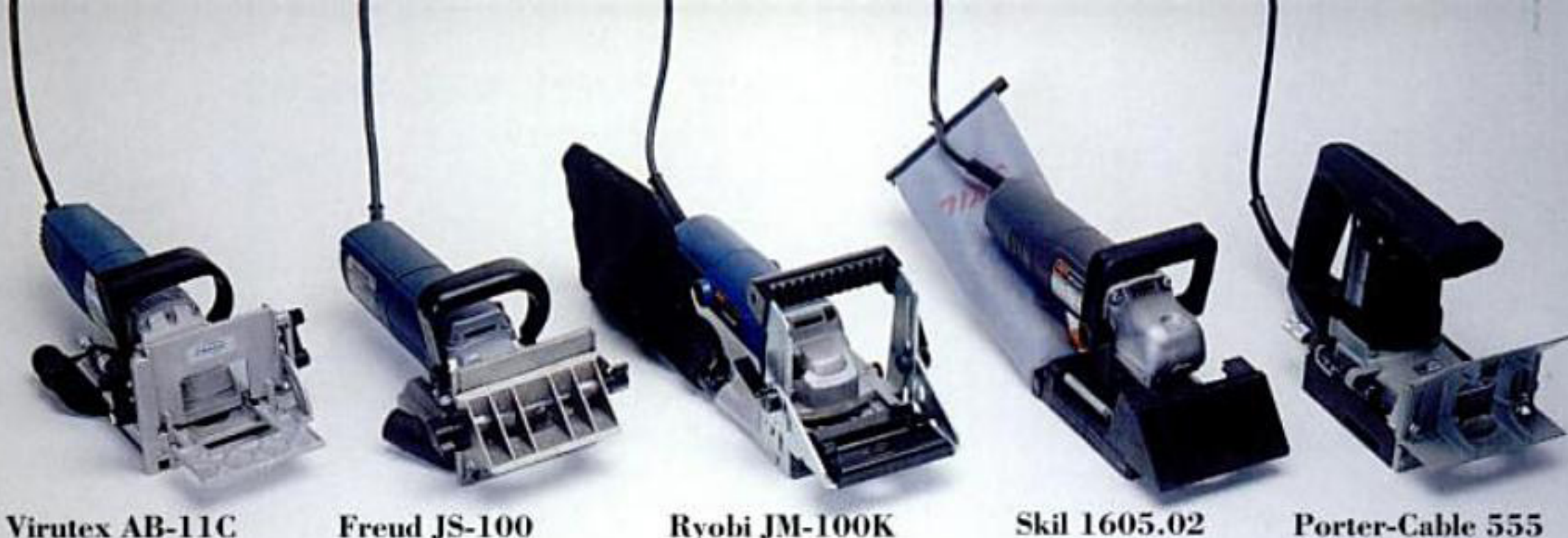
EVERLAST SAW AND CARBIDE, INC., 9 Otis St., West Babylon, NY 11704, (800) 828-7297 CIRCLE #630

their quiet blades available by September 1. Initially, Freud plans to offer three 10-in.-dia. blades: a 40-tooth ATB, a 60-tooth triple-chip (TC), and an 80-tooth high-ATB, at prices from \$90 to \$130. Everlast will offer four 10-in. blades: a 60-tooth ATB (\$104), a 60-tooth TC (\$104), an 80-tooth TC (\$160) and an 80-tooth TC with negative hook (\$187). Everlast will also offer several 12-in.-dia. blades. ▲



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Virutex AB-11C

Freud JS-100

Ryobi JM-100K

Skil 1605.02

Porter-Cable 555

BUYER'S GUIDE

PHOTOS BY MITCH MANDEL

Thirty years ago, while looking for a faster way to join wood, Swiss craftsman Herman Steiner came up with the concept of the biscuit joint. Today, there are more than a dozen portable and benchtop biscuit joiners on the market.

To help you decide which of these tools will work best for you, we tested 11 portable biscuit joiners and two benchtop units in the AW shop. (A new 6-amp Sears joiner should be on the market in November but was unavailable for our test.) We evaluated machines on operation of the fence, ease of adjustments, ergonomics and fit and finish, scoring each feature from one (unacceptable) to five (excellent). Then we added bonus points for extras like slip clutches and anti-skid pads.

A summary of our findings appears in the chart, and our favorites are featured on pages 50-51. Before we get into more detailed comments on the individual machines, let's examine how biscuit joiners work.

Biscuit Joiner Basics

The basic biscuit joiner has a 4-in.-dia., carbide-tipped circular saw blade set in a spring-loaded housing. When you plunge the machine into a workpiece, it exposes the blade, which then cuts a semicircular slot in the wood. A fence helps you place the biscuit slot where you want it, and there's a depth-of-cut adjustment that governs the depth and length of the slot. To join two pieces of wood, you cut slots in both, then glue in a football-shaped biscuit.

Sound simple? Simplicity is one of

A Shop Test of Eleven Portable and Two Stationary Machines

the things that makes biscuit joinery so popular. It's also forgiving. The biscuits are made of compressed wood and are slightly smaller than the slots. This gives them some lengthwise slop that lets you adjust the lateral alignment of the parts after assembly. Also, since the biscuits aren't as thick as the slot, the workpieces fit together easily, and then the glue swells the biscuit and locks the joint tight.

Biscuit joints aren't as strong as mortise-and-tenon or dovetail joints, but they're perfect for building carcasses with plywood, particleboard and MDF, as well as for edge, corner and miter joints on solid wood boards.

Features To Look For

There are just a few important features to consider when buying a biscuit joiner. Topping the list is whether the machine accurately locates the biscuit slots so that workpieces align automatically. A biscuit joiner's fence adjusts two ways for slot location: in height and in angle. In our opinion, height adjustment is the most significant of the two, because most biscuit

joining is done at right angles.

We found that machines whose fences had lock levers—like the AMT, the Lamello machines, the Ryobi and the Virutex—were the easiest to adjust accurately in height. The Freud had similar lock knobs, but they don't work independently, so it took two hands to tighten them.

The fences on all three Lamello machines moved up and down smoothly and were easy to keep parallel to the base, due to their precision machining. The action on the other machines was less precise, so it required more care to set the fence parallel. The DeWalt's height adjustment was the best of the bunch because its rack-and-pinion mechanism keeps the fence parallel while you adjust and lock it.

Height adjustment was most tedious on the Porter-Cable and Skil joiners. With these, you have to loosen two allen screws and then retighten them while trying to hold the height setting.

On the Elu, which operates differently than the other joiners, you make fine height adjustments by turning a screw that moves the blade up or down. The blade moves enough to position slots easily on thin stock, but for thick stock, Elu suggests making a spacer from scrap to bring the joiner close to the proper level. This is a minor annoyance if you're cutting slots at several heights—you may need a different spacer for each one.

Most machines provide a scale to help you set the fence height and keep it parallel. We found the scales on the DeWalt and Lamello machines clearest



Elu 3380

DeWalt DW682K

AMT 4960

Lamello Cobra

Lamello Standard

Lamello Top 10

TO BISCUIT JOINERS

and easiest to read.

Fence-angle adjustment is a nice feature to have if you make miter joints or join pieces at odd angles where you need to cut slots in a beveled edge. For setting angles, there are basically two types of fences: fixed and adjustable. (See photos below.)

Fixed fences, like those on the AMT, Freud, Elu and Skil, have a 90° side for straight cuts and a 45° side for miter cuts. To cut a miter, you install the fence with its 45° side facing down to register against the face of the work, and then make a plunge cut into the beveled edge. (See photo, below left.) This works all right, but since the reference surface becomes the inside of the miter joint, you may find that the outside corner won't align properly if the stocks' thicknesses aren't equal.

DeWalt, Ryobi, Lamello Top 10 and Porter-Cable provide a better way to cut miters. With these, you capture the beveled edge of the work between the

machine's fence and faceplate, which references and aligns the outside surfaces of the joint. (See photos, below middle and right.)

For more versatility in setting angles, the DeWalt, Ryobi, Virutex and Lamello Top 10 machines have adjustable fences with protractor scales, so you can set the fence precisely to any angle over a 90° range (135° on the Ryobi).

Most of these adjustable fences worked well, but locking the angle setting on the Virutex was awkward because the lock knobs for angle and height are interdependent: to change the angle, you have to unlock the height setting and vice versa.

Depth-of-cut adjustment is another feature to consider. For standard work, you'll want a machine with preset depth stops to accommodate the three standard biscuit sizes. All the machines but the Elu offer these stops. However, if you intend to use some of

the special accessory biscuits that are now on the market, it's nice to have a fourth preset for this depth. Only the DeWalt, Freud and Lamello machines offer additional depth stops.

The Elu is a different animal altogether. It uses a fine-adjustment knob to dial in depth over a wide range. This isn't as convenient as preset stops, but it allows you to set an exact depth easily when you're using this tool in its additional capacity as a groover.

Fit and finish—A biscuit joiner's fit and finish affects the precision of the plunge and whether the blade aligns square to the workpiece. As with most machines, on the biscuit joiners we tested the fit and finish varied according to price. It was clear that the high-priced Lamellos were designed and built to the most exacting standards. With their precisely machined, nickel-plated aluminum plunge ways, they plunged more smoothly than any of the other units. But even the machines



Biscuit-joiner fences work in different ways for cutting miter joints. Left: fixed 45° fences register against inside surface of work. Middle and right: Notched fences capture beveled edge.

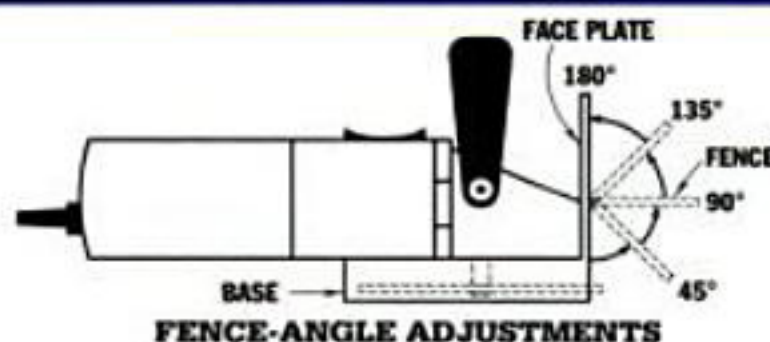
BISCUIT JOINERS

Name/Model	Street Price	EVALUATIONS					SPECIFICATIONS		
		Height Adj.	Angle Adj.	Fit & Finish	Hands-On Rating	Overall Rating★	Amps	RPM	Fence Angles (see illustration below)
PORTABLE JOINERS									
Dewalt DW682K (800) 433-9258 CIRCLE #606	\$250	●●●●●	●●●●●	●●●●●	●●●●●	94.5	6.5	10,000	Adjustable 90°-180° plus notch for 45°
Lamello Top 10 (617) 585-4364 CIRCLE #607	\$599	●●●●●	●●●●●	●●●●●	●●●●●	92.8	6.4	10,000	Fixed 90°, 135° adjustable 90°-180°
Lamello Standard 10	\$449	●●●●●	●●●●●	●●●●●	●●●●●	89.9	5.2	10,000	Fixed 90°, 135° plus notch for 45°
Ryobi JM-100K (800) 323-4615 CIRCLE #608	\$220	●●●●	●●●●	●●●●	●●●●	89.3	5.3	9,000	Adjustable 45°-180°
Lamello Cobra	\$299	●●●●●	●●●●●	●●●●●	●●●●●	86.3	2.3	18,000	Fixed 90°, 135° plus notch for 45°
KLU 3380 (800) 762-6672 CIRCLE #609	\$270	●●●●●	●●●	●●●●	●●●●	83.0	5.0	8,500	Fixed 90°, 135°
Vitutek AB-11C (513) 561-6560 CIRCLE #610	\$280	●●●●	●●●●	●●●●	●●●●	79.3	6.0	10,000	Adjustable 90°-180°
AMT 4980 (215) 948-0400 CIRCLE #611	\$165	●●●●	●●●●	●●●●	●●●●	76.3	6.0	10,000	Fixed 90°, 135°
Freud JS 100 (800) 334-4107 CIRCLE #612	\$175	●●●●	●●●●	●●●●	●●●●	75.4	5.0	10,000	Fixed 90°, 135°
Porter-Cable 555 (901) 668-8600 CIRCLE #613	\$185	●●	●●●●/●●●●★★	●●●●	●●●●	72.4/74.1★★	5.0	8,000	Fixed 45°, 90° plus optional adjustable 90°-180°
Skil 1805.02 (312) 286-7330 CIRCLE #614	\$140	●●	●●	●●●	●●●	65.0	6.0	12,000	Fixed 90°, 135°
STATIONARY JOINERS									
CFW 100 (619) 723-7586 CIRCLE #615	\$514.95	●●	●	●●●	●●●	N/A	3.8	29,000	Fixed 90°
Delta 32-100 (800) 223-7278 CIRCLE #616	\$299.95	●●●●●	●●●●●	●●●●	●●●●	N/A	10.0	10,000	Adjustable 90°-135°

FOOTNOTES

★ Scores above 85 are considered excellent, 75 to 85 good, under 75 fair. Different scores within these ranges do not indicate a significant difference in performance.

★★ with optional fence



with a little slop in their plunge action worked well when new. Our brief test couldn't tell us whether they'll hold up as well in the long run.

Fortunately, **blade parallelism** is one fit-and-finish feature you can analyze easily from the outset. For biscuit slots to line up properly on the work, the blade must be parallel to the base. (Any twist in the slots will be doubled when you put the joint together, making it much harder to assemble.) All the machines we tested cut parallel slots, but if your slots are out of parallel with the stock's face by more than .005 in. over the length of the slot, we'd say the machine is unacceptable.

Special Features—There were a few features on the biscuit joiners that enhanced their performance or made them safer to use, such as **anti-slip devices**. These prevent the fence from slipping sideways and off your mark when the blade bites into the wood.

All machines but the Skil had some anti-slip device. The Ryobi joiner worked the best. Its large rubber pad covers the full width of the faceplate



EDITOR'S CHOICE

Among the biscuit joiners we tested, two stood out for their superior design and construction. We liked the Lamello Top 10 (\$599) for its overall quality of construction and useful features. Clearly machined to tighter tolerances than the other joiners, the Top 10 features precise plunging action and fence adjustments, and a base and fence that are dead flat and square. It also has six preset depth-adjustment positions, plenty of power and a slip clutch, which will reduce wear on the motor if the blade jams and makes the machine safer to use.



The DeWalt DW682K (\$250) won our votes for its ergonomics, innovative design and reasonable price. It has protractor angle adjustment, the most comfortable handle and switch, four preset depth-adjustment positions and solid construction. And it was the only machine with rack-and-pinion fence-height adjustment.

Ht. Scale/ Angle Scale	No. of Depth Stops	Switch Type	Dust Collection	Anti-Slip Device	Weight (Lbs.)	Noise (dB)	Comments
Yes/Yes	4	Trigger	Bag, Vac. Port	2 Retractable Pins	6.45	93.2	Rack-and-pinion fence-height adjustment; comfortable bottom-mounted trigger switch
Yes/Yes	6	Slide	Vac. Port (option)	2 Rubber Pads	7.10	91.0	Exceptionally smooth plunge action; versatile fence system
Yes/No	6	Slide	Vac. Port (option)	2 Rubber Pads	7.15	91.4	Exceptionally smooth plunge action
Yes/Yes	3	Slide	Bag	Rubber Pad (full width)	7.20	90.3	Best anti-slip pad; most versatile fence adjusts between 45° and 180°
Yes/No	6	Trigger	Vac. Port (option)	2 Rubber Pads	6.30	89.2	Exceptionally smooth plunge action; motor runs faster, but quieter
Yes/No	3	Slide	Vac. Port	2 Adjustable Pins	7.90	93.0	Cuts grooves as well as biscuit slots; takes time to acclimate to unique design
Yes/Yes	3	Slide	Vac. Port	2 Rubber Pads	6.45	92.0	Switch has safety lock; fence height and angle cannot be set independently
Yes/No	3	Slide	Bag	2 Pins	6.75	92.6	Dust bag port tended to clog quickly when making deep cuts
Yes/No	6	Slide	Vac. Port	2 Rubber Pads	6.65	90.2	Fence adjustment awkward—must hold two lock knobs at the same time; good depth-of-cut adjustment
No/ Yes (on opt. fence)	3	Trigger	None	2 Pins	6.80	89.8	High handle grip awkward for some; sticky plunge action
Yes/No	3	Slide	Bag	None	6.25	95.6	Fence adjustment requires allen wrench; good value for price
No/No	1	Rocker	Vac. Port	4 Spring-loaded Stock Stops	35.0	91.2	Designed for face-frame work; preset work stops for 5 common stock widths
Yes/No	3	Toggle	Vac. Port	Adjustable Work Clamp	39.5	91.6	Foot pedal operates blade plunging mechanism; solidly built, versatile machine

and gripped even small pieces securely. Next best were the AMT, DeWalt, Elu and Porter-Cable joiners, which have small steel pins projecting from the faceplate. However, since they're spaced about 4½ in. apart, they're not much use on narrow end-grain cuts.

Less effective were the small, buttonlike rubber pads placed beside the blade opening on the Freud, the three Lamellos and the Virutex. These were also too wide for narrow stock.

In the way of **safety**, the Lamello Top 10 and Lamello Standard 10 have slip clutches that disengage the motor from the blade if you plunge too hard. They prevent the tool from jerking in reaction to the blade's bite, and they save wear on the gears and motor.

Ergonomics—Whether or not a tool feels comfortable in your hand is a matter of personal taste, but we noticed some differences among the biscuit joiners that deserve mention.

Several testers downrated the Porter-Cable's vertical handle, which gave it a top-heavy feeling and made it more likely to tilt, changing the



entrance angle of the cut as you pushed it forward. Also, the Elu's handles and pivoting operation are so different from the other machines that it takes some getting used to. (You hold the fence against the work with your left hand and rotate the pivoting motor into the work with your right hand.)

Placement of the **switches** also influenced the feel of the machines. Everyone liked the DeWalt's large, bottom-mounted trigger switch best, while the slide switches on the AMT,



For joining small pieces in production work, a stationary joiner works fast. Delta's (left) operates with a foot pedal; CFW's is designed for making face frames.

Elu, Freud, Ryobi and Skil were difficult for left-handers to reach because they're mounted on the left side.

Stationary Biscuit Joiners

If you're working with small pieces in a production situation, a stationary biscuit joiner may serve you better than a hand-held machine. We tested two stationary joiners that bolt to your benchtop: a Delta and a CFW. Both leave your hands free to hold the work, but they won't let you cut slots

BISCUITS ON A BUDGET

PHOTOS BY DAVID SELLERS



From top: CFW 50; Wolfcraft 2920; Sears Bis-Kit.

With one of these gadgets, you can convert your angle grinder or router to a biscuit joiner for less than the cost of most biscuit joiners.

CFW 50—(\$149.95, top) A conversion kit for your table-mounted router, this unit consists of a 1½-in.-dia. slotting cutter, an 18-in.-long spring-loaded fence and an adjustable work stop. It's designed for making face frames, and with the special biscuits supplied (⅝ in. by 1⅝ in. by 1⅝ in.), you can join pieces as narrow as 1½ in. (available from CFW, 619-723-7586).

Wolfcraft 2920—(\$70, middle) This assembly—a base, fence and 12-tooth carbide blade—lets you convert a 4, 4½ or 5-in. angle grinder into a biscuit joiner. Identical to the assembly on the Skil in the main article, it makes straight cuts in board edges or centers and 45° cuts into beveled edges (available from Woodcraft, 800-225-1153).

Sears Bis-Kit—(\$39.99, bottom) With this plastic base/fence assembly and three-wing slotting cutter, you can cut biscuit joints with a 6-in.-dia router. Bis-Kit is a cheap way to make basic edge-to-edge biscuit joints, but you can't cut slots in the face of a board or panel, and you can't make 45° cuts in a beveled edge (available from Sears stores).

Woodhaven's Biscuits & Bits—(\$51.99) This kit has a 1½-in.-dia. slotting cutter and special biscuits to turn your table-mounted router into a bis-



cuit joiner. At 1⅝ in. thick by 1⅝ in. long, the biscuits are thicker and shorter than conventional ones, so you can join stock as small as 1½ in. wide and ½ in. thick. There's also a straight router bit for making cuts in panel middles and 10 ft. of spline material for joining grooved stock (available from Woodhaven, 800-344-6657).

Woodhaven's Itty Bitty Biscuits and Bits—(\$24.99) A smaller version of the above kit, this includes a ⅝ by 1-in.-dia. slotting cutter for joining stock down to 1 in. wide and ¼ in. thick.

in the middle of large panels, as you'd need to if you were joining a shelf to the middle of a cabinet side.

These two machines aren't strictly comparable. Both may be used for edge-joining boards, but the ruggedly built Delta is more flexible for slotting beveled stock. Because of its small oval biscuits, the CFW is especially useful for joining face frames as narrow as 1½ in.

Delta's \$299.95 stationary joiner (see photo, page 51) is a sturdy, cast-iron machine with an adjustable-height table that tilts to any angle from 90° to 45°. A miter gauge is included for aligning stock for flat miter cuts, and there is a beefy clamp for holding the work in place. To make a cut, you register the work against the table and fence. Then you step on a foot pedal that pulls the blade into the workpiece.

The \$514.95 CFW 100 stationary biscuit joiner looks like a small router table. It's made mainly of particleboard and aluminum extrusions and is powered by a ¾-HP router. To cut a slot, you push the workpiece against the spring-loaded fence, triggering a microswitch and exposing the cutter. The fence has five preset work stops to quickly register common face frame widths from 1½ in. to 2½ in.

The CFW unit needed some tuning before it would work smoothly for us: we had to adjust and lubricate the fence's guide blocks and plane the bottom edge of the fence to make it parallel to the table. Then the CFW cut accurate slots in both end grain and edge grain. The router bit was easy to adjust but awkward to change. Also on the minus side, vacuum dust collection was necessary to prevent the unit from filling up with dust, which clogged the grooves in the fence guides.

Our Recommendations

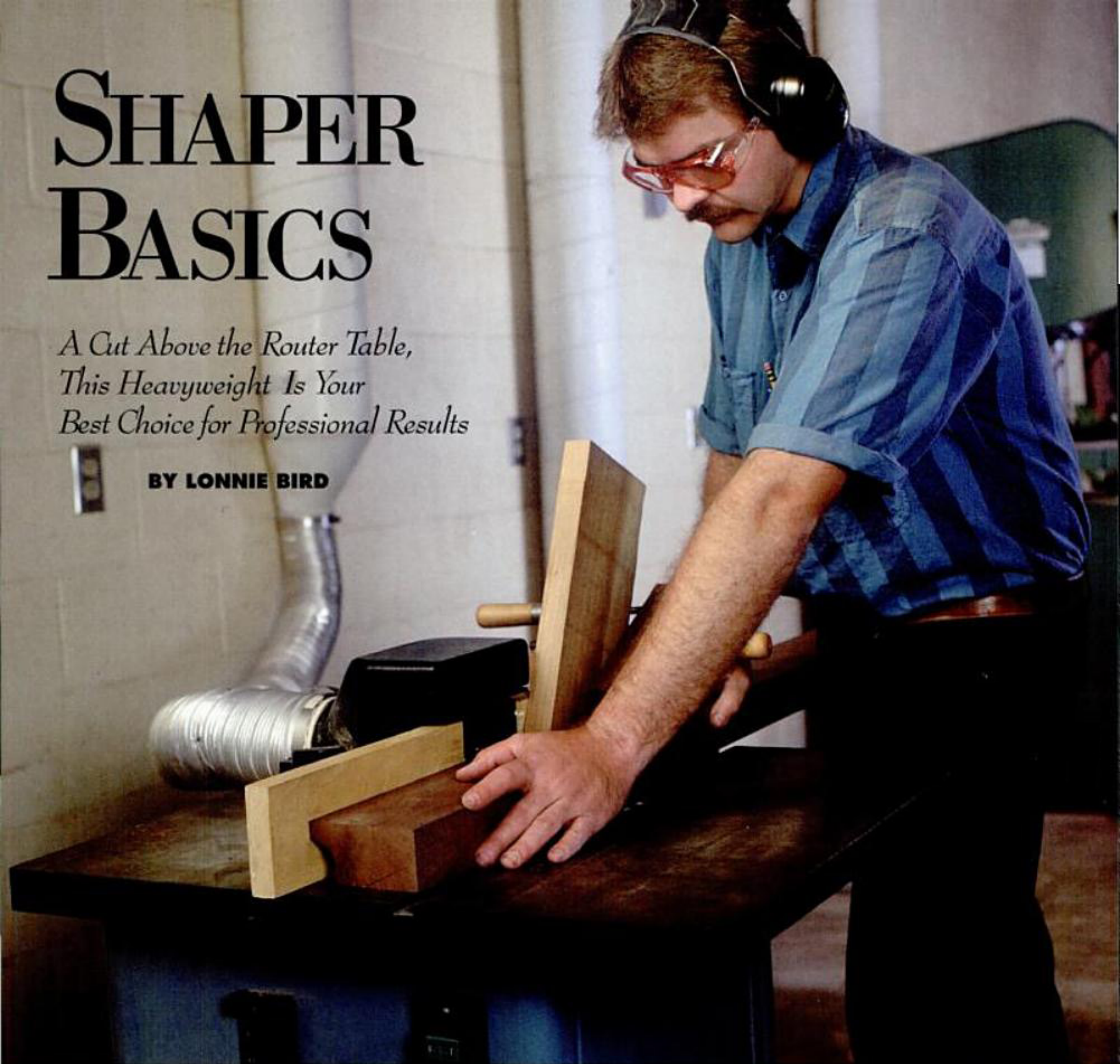
So which biscuit joiner do we recommend? Well, we've got several choices to fit different needs. Our top choices among the portable units are the Lamello Top 10 and the DeWalt. (See sidebar, page 51.)

If your work involves joining small pieces in a production environment, a stationary biscuit joiner like the Delta will let you work faster than a hand-held machine. And if you like the versatility of cutting grooves with your biscuit joiner, get the Elu. ▲

SHAPER BASICS

*A Cut Above the Router Table,
This Heavyweight Is Your
Best Choice for Professional Results*

BY LONNIE BIRD



Spindle shapers outweigh and outperform routers for many woodworking tasks.

PHOTOS BY LAURA ELLIOTT

Like many woodworkers, I used to shape everything with a router and the usual assortment of bits. I soon realized, however, that I couldn't create large or unusual profiles with a router. In a sense, the router limited the scope and creativity of my woodworking. I finally found the answer for these more complicated cuts when I became an apprentice in an architectural woodworking shop and was introduced to the versatile, high-performance shaper.

The shaper has a more powerful motor and larger spindles and bearings which allow it to make wider and deeper cuts than a router. It can also handle a wide variety of tasks, from curved moldings and raised panels to cope-and-stick joinery. The shaper can quickly cut the tapered bevels on a pencil-post bed, shape the edges of tabletops and create an exact copy of a molding for your reproduction piece—all with power and efficiency the router can't match.

However, the shaper is more complicated than a router because of the vast array of cutters, jigs, fences and spindles you can use with it. It also has a reputation for being dangerous. Its large, high speed cutters and powerful motor demand respect and careful attention to safety precautions.

In this article I will offer a basic explanation of the shaper, along with instructions on how to use it for basic cuts and for more complex tasks like stop cuts, panel raising, and end-grain

shaping. Part 2 of this series (in the next issue) will discuss shaping curved parts, arched raised panels and complex moldings, as well as freehand shaping, cope-and-stick joinery, and grinding custom knives.

About Shapers

Like a table router, the shaper has a top to support the workpiece and a fence to guide it past the cutter. (See drawing, right.) But the shaper is definitely designed for heavier-duty work. The spindle, driven by a motor via a pulley system, may be raised or lowered with a handwheel to vary the height of the cut.

Shapers are designated by the diameter of their spindles, which ranges from ½ in. to 1½ in. Generally, the larger the spindle, the larger the table and the more powerful the motor. For small-shop woodworking, a ¾-in. to 1-in. shaper is sufficient. Avoid the ½-in. models—they don't have the power or cutter capacity you need for many applications.

To accommodate cutters of different diameters, a shaper should have at least two speeds. Small-diameter cutterheads require high speeds to achieve smooth cuts, but it can be dangerous to run large cutterheads at high rpms because their rim speeds are higher, and slight imbalances can lead to excessive vibration.

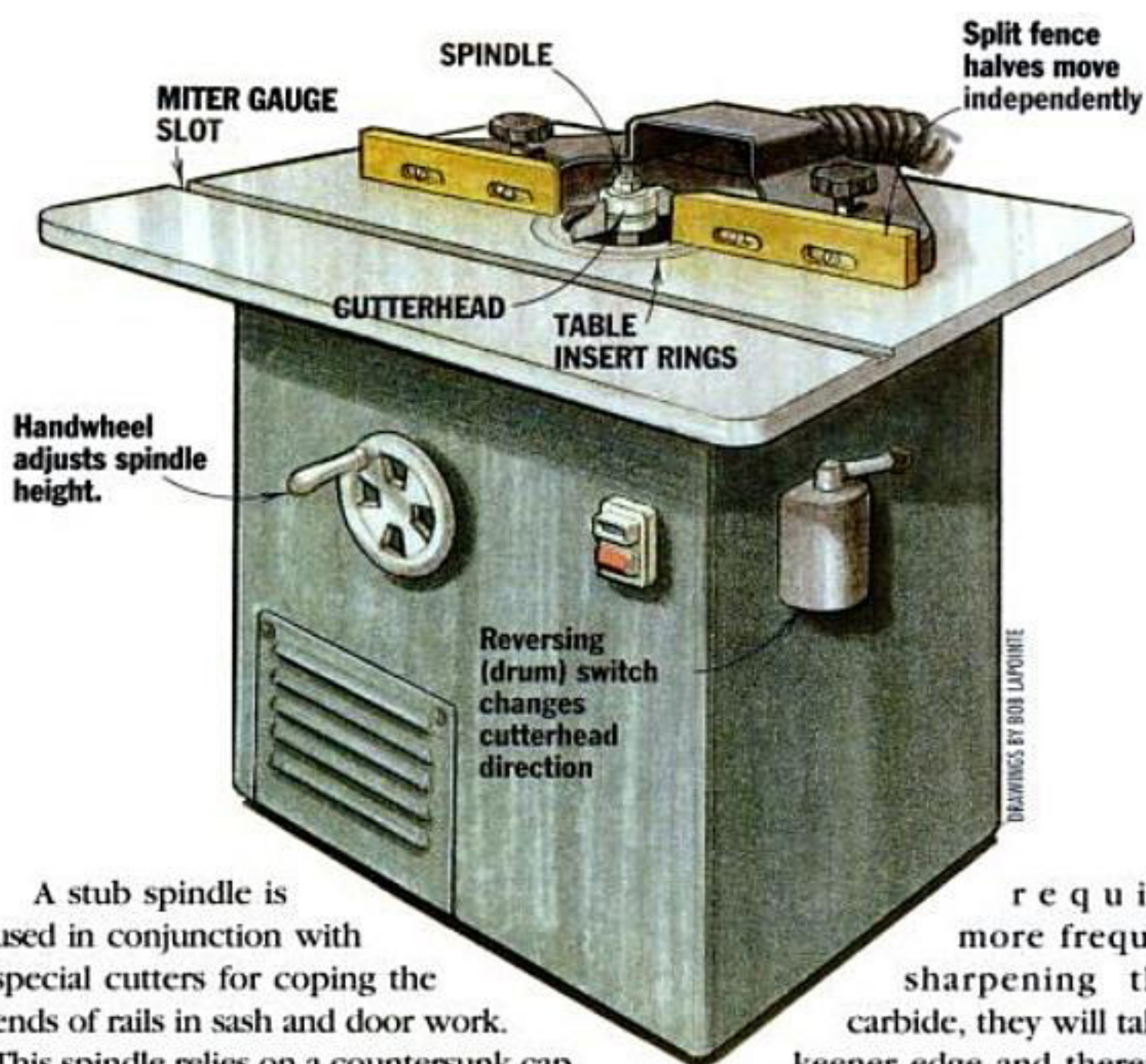
A reversing switch for changing the direction of spindle rotation is also desirable. It allows you to cut from underneath the work for greater safety, and it lets you reference the same face of both stiles and rails on the table when coping and sticking. (More on coping and sticking to come in Part 2.) Also, when shaping curved parts, you can choose the spindle direction that produces the least tear-out.

Shapers generate large amounts of chips and sawdust, so a fence with a dust collection hookup is a must.

Spindles

Some shapers come with just one permanent spindle, but for greater flexibility you should choose a shaper with interchangeable spindles. These machines are usually equipped with ½-in., ¾-in. and 1-in.-dia. spindles, with optional extra-long and stub spindles.

FIG. 1: SPINDLE SHAPER



A stub spindle is used in conjunction with special cutters for coping the ends of rails in sash and door work. This spindle relies on a countersunk cap screw rather than a spindle nut to secure the cutter. This allows you to cope rails of any tenon length. Since the cutter and screw are flush with the top of the spindle, tenons simply pass unobstructed over the top of the spindle and cutter.

Cutterheads

The cutterhead is the vital link between the shaper and the wood. As with any machining operation, the sharpness and balance of the cutters are key to producing a quality surface. Fortunately, there are several types of excellent-quality tooling available for the shaper. (See top photo, opposite.)

Three-wing cutterheads are most common, mainly because they're convenient to use. Available in standard sizes to fit all spindles from ½ in. up, three-wing cutters are the easiest to set up because the knives and cutterhead are all one piece, with no gib screws or loose cutters. The knives are usually carbide tipped, although some economy cutters for ½-in. spindles are made from high speed steel (HSS). (Unless you cut a lot of abrasive wood or man-made materials, HSS is not a serious drawback. Although the HSS knives

require more frequent sharpening than carbide, they will take a keener edge and therefore produce a better surface on the wood. You can also custom-grind the profiles on HSS knives.)

Often, three-wing cutterheads come in sets designed to be stacked on the spindle for making combined profiles with one pass, such as shaping frame parts that have beaded edges with a groove in the middle.

Carbide three-wing cutterheads can be expensive compared to other types of shaper cutters, from around \$25 for a simple three-wing slotting cutter to over \$300 for a matched set of stacking cutters. Price is usually an indication of quality: higher-priced heads usually have thicker, fine-grained carbide which requires less frequent sharpening than cheaper kinds.

Apart from cost, the biggest drawback of three-wing cutters is the limited variety of profiles available. As with router bits, I can seldom find one that exactly fits the profile I'm reproducing.

Gib-screw cutterheads are good lower-priced alternatives to one-piece, three-wing cutterheads. The knives come in matched pairs and lock into the head in much the same way jointer knives do, with gibs and screws. This arrangement costs less because you

only need to purchase one head. The knives are usually made of HSS, which further lowers the cost.

To prevent the knives from flying out during use, each knife is either corrugated on the back to mesh with corrugations in the head or has holes that fit onto pins in the head. Either system is safe if you follow the manufacturer's instructions carefully.

Gib-screw cutterheads are primarily intended for cutting straight stock with a fence, unless you're willing to stock up on several sizes of ball-bearing rub collars that will let you register the workpiece directly off the cutterhead. This can be a limitation for those who shape curved parts. These cutters also require more care and skill to set up than three-wing heads.

Bevel-edge steel cutters with lock collars are the most flexible of the three common cutterhead types, but they require the most skill to use. First, you grind profiles on blank knives to match an existing molding or drawing. Then you clamp the matched pair of knives between two heavy steel discs, or lock collars, for mounting on the spindle.

Although bevel-edge steel cutterheads aren't as convenient to use as other systems, they're popular with professionals because of the ease of matching knife profiles to job requirements. They're also excellent for shaping curved work because the wood rides against the lock collars, eliminating the need for ball-bearing rub collars. And the cost of the HSS knife blanks is the lowest of the three main cutterhead systems.

Of course, there are some drawbacks to bevel-edge systems. It requires a fair amount of skill to grind and mount the knives and to operate them safely. But for woodworkers making reproduction furniture, building woodwork to architect's specifications or replacing moldings in old houses, this is the best system.

Fences

The fence is an integral part of most shaper operations. The fence assembly is typically bolted to the shaper table with studs or knobs that allow it to move forward or backward to guide the work and control the depth of cut. Most fences have shrouds that cover



The three main cutterhead types are (counterclockwise from left) three-wing, gib-screw and bevel-edge cutters. Each has advantages for certain types of cuts.

the cutterhead for safety and direct the shavings into a dust collector port.

Manufacturers usually supply a "split" fence with their machines because this type of fence is the most versatile. Split fences have independently adjustable infeed and outfeed sections. These may be offset for cuts that remove material from the entire edge of a workpiece, or they may be aligned with a straightedge for jobs where part of the edge remains intact. If the fences aren't aligned (or offset) correctly for a particular operation, sniping will result as the workpiece leaves the infeed fence.

The fence halves can also be adjusted laterally to control the size of the

opening around the cutterhead. For safety and accuracy, the opening should be as small as possible while allowing the cutterhead to rotate freely. This reduces the chance of the work dropping into the cutter and kicking back.

You may want to consider building one or two solid fences for your shaper (see photos, below), with cutouts for cutterheads of different sizes. Solid fences eliminate the need to constantly realign a split fence, but they're useful only for cuts that don't remove material from the entire edge of a board. Otherwise, without the offset capability of a split fence, you'd get a snipe at the end of your workpiece.



Above, a shop-made solid fence can simplify setup for cuts that remove only part of an edge. Note cutterhead set to cut from underneath the stock for greater safety.

Left, the split fence allows you to adjust the outfeed fence forward to compensate for material removed by the cutter.

When you make a solid fence, use hard-wood plywood or particleboard for stability, and cover the face with plastic laminate to reduce friction and wear.

You can devise other shop-made fences as you need them. Higher and longer fences give additional support to oversize work, angled fences are good for producing beveled cuts, and curved fences can help you shape arched rails or moldings. (See Part 2.)

Setting Up For Basic Cuts

The simplest cuts on the shaper are small beads, coves, ogees, etc. on the edges of boards. If you're inexperienced with the shaper, these cuts are a good place to begin. I'd also recommend starting with a small set of three-wing cutters because these are the safest of the cutter types.

Begin by positioning the cutter as low as possible on the spindle to reduce stress on the spindle bearings while still allowing room for height adjustment. If possible, position the cutter to cut from underneath the work so that the workpiece acts as a guard. To do this, it may be necessary to run the spindle in a clockwise direction; just be sure to use the keyed lock washer supplied with the spindle to prevent the spindle nut from working loose.

After tightening the spindle nut,



A miter gauge is a must for shaping the ends of narrow pieces. Hold or clamp stock firmly to avoid having it pulled into the rotating cutter.

use the handwheel to raise or lower the spindle to the correct height, then lock the handwheel. Now, position the fence for the desired depth of cut and secure the fence assembly to the table with the bolts or knobs provided. Adjust the fence halves as close as possible to the cutterhead. Rotate the spindle by hand to be sure that it clears the fences.

To make a test cut, set the spindle for a slow speed, start the machine and feed the workpiece against the spindle rotation. Examine the cut and compare

it to your drawing or the profile you're trying to match. If necessary, readjust the fence and/or spindle height. With everything set, now you're ready to run. Remember to use things like push sticks and feather boards to guide your workpiece safely. These also improve the quality of your cuts by holding the work tightly to the fence and table.

Shaping End Grain

End-grain shaping requires your attention to two special considerations. First, there is the danger of narrow pieces being pulled into the opening between the fences if they aren't held securely. When possible, shape the end grain of a wide piece of stock, then rip it to width. If this is impractical, hold or clamp your stock tightly to a miter gauge for increased control. (See photo, left.) Second, to avoid chip-out on the trailing edge of your workpiece, fasten a backup board to the miter gauge. Also, always shape the end grain first. If any chip-out remains, it will be removed when you shape the edge.

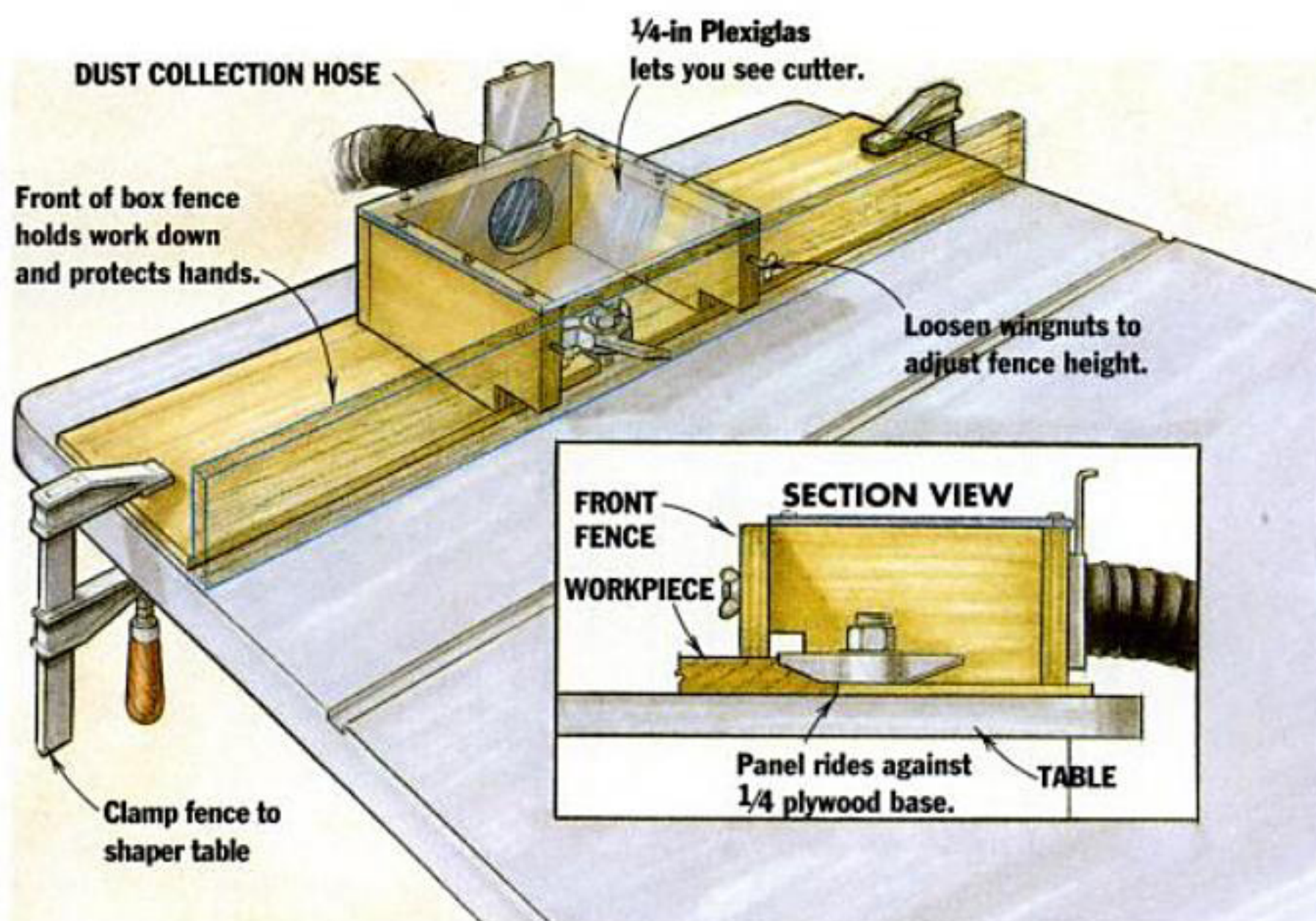
Shaping an Entire Edge

Whenever your cutter removes material from the entire edge of a board, the stock is reduced in width by the depth of the cut. In such cases, you need to adjust the out-feed fence forward to support the stock as it leaves the cutterhead. Otherwise you'll end up with a snipe at the end of your cut.

To adjust the fence, shape enough stock to reach the outfeed fence, then turn off the shaper and bring the outfeed fence forward so that it just makes contact with the workpiece. Often the fence will have a micro-adjustment knob for this purpose.

Now, turn the power on and shape the remainder of the workpiece. If the cutter snipes the trailing end of the workpiece, you should move the out-feed fence a bit more.

FIG. 2: BOX FENCE FOR PANEL RAISING



13 POINTS ON SHAPER SAFETY

As with all machinery, you should read and follow the directions in your owner's manual and exercise common sense whenever using your shaper. Here is a short recap of the major shaper safety rules.

1. Always feed your workpiece against the rotation of the cutterhead. If your machine has a reversing switch make sure of the spindle rotation before feeding your work. This will prevent your hands from being pulled into the cutterhead.

2. Keep the fence opening adjusted as small as possible. This prevents the work from dropping into the cutterhead and kicking back.

3. Avoid heavy cuts. Besides being hard on spindle bearings and motor, heavy stock removal is an

invitation for kickback. It's better to take several passes or remove excess material with the tablesaw.

4. Select a spindle speed appropriate for the diameter of the cutterhead. Large cutterheads have faster rim speeds and should be run at lower rpms than smaller cutterheads.

5. Don't run large cutterheads on small spindles, even if you have the bushings to do it. Small spindles are not designed to handle the forces exerted by large cutterheads.

6. Position the cutter so it cuts from underneath the workpiece when possible. This way, the workpiece acts as a guard and the portion of the cutter not being used is below the surface of the table.

7. Always use guards. If the guard that came with your machine can't be used for a given operation, devise a guard of your own.

8. Use feather boards and spring hold-downs. They prevent chatter and help minimize kickback.

9. Use table insert rings when possible to give greater support to the workpiece.

10. Avoid shaping thin, narrow or short stock. Shape a larger piece of stock first, then rip it to size.

11. Keep hands a minimum of 6 in. from the cutterhead when the shaper is running. Use push blocks to keep hands away.

12. Use a starting pin when shaping freehand.

13. Unplug the shaper before making setups or adjustments.—*L.B.*

Stop Cuts

Most of the time you will be shaping the full length of your stock, but sometimes it's necessary to begin or end a cut somewhere in the middle of a workpiece. The best and safest way to do this is by attaching stop blocks to the infeed and/or outfeed fences.

When you start a cut in the middle of the stock, clamp a stop block to the infeed fence to prevent the work from being kicked back. With the shaper running, rest the back end of the workpiece against the stop and slowly pivot the other end into the cutterhead until it contacts the fence. Now advance the work as usual.

Ending the cut is simple—just mark the location on the workpiece and feed the stock until the cutter reaches that point. If you are shaping several pieces, clamp a stop block to the outfeed fence so all your cuts end at the same place.

When you're shaping long stock, it may be necessary to attach long fences to the machine in order to attach the stop blocks.

Shaping Raised Panels

Shaper cutters designed for panel raising are large in diameter in order to create the wide bevels found on case pieces and architectural woodwork.

Although some manufacturers provide 1/2-in. bushings with their panel cutters, I recommend using a shaper with at least a 3/4-in. spindle to get a smooth bevel with cutters this large. Otherwise you're likely to get chatter and a rough cut. To further reduce chatter, it is a good idea to take several light passes instead of one heavy one. Or you can remove excess wood with the tablesaw prior to shaping.

When panel raising, I shape with the cutterhead above the work to insure a consistent fit in the frame groove. This way, any slight variation in stock thickness ends up in the field of the panel. (See Fig. 2.)

Because of the size of the cutter, panel raising requires a large opening in the split fence. Exposing this much of the cutterhead is dangerous, and there is the additional risk of smaller panels dropping into the large opening and kicking back. A split fence, like the one shown in the photo on page 55, eliminates these problems. The fence is actually a box which completely surrounds the cutterhead except for a slot in the bottom for the spindle.

The front of the box is attached with wing nuts that let you adjust it vertically for different stock thickness-

es. This way it serves as a hold-down for the stock while preventing your hands from getting too close to the cutter. The edge of your workpiece rides against the 1/4-in. plywood which forms the base of the box. At the rear of the box is an opening for dust collection. The entire assembly is secured to the top of the shaper with clamps or fence hardware.

Shape the end grain first so that subsequent passes on the edge will remove tear-out. Long, narrow panels may require you to use the miter gauge for shaping the end grain. You should also use sharp cutters and light passes to help minimize sanding on the beveled surfaces.

In the next issue, I'll discuss some more advanced shaper techniques that will help you to take full advantage of this versatile tool. ▲



L O N N I E B I R D

makes reproduction furniture and teaches woodworking at the University of Rio Grande in Ohio.

COLONIAL BENCH



Phil Andrews is a cabinetmaker with a great affection for early American furniture. Visit his showroom and workshop in the town of Kintnersville, Pennsylvania, and you'll find an impressive collection of tables, beds, sideboards, jelly cupboards, and other pieces that might have graced a household 200 years ago.

It really takes a second or third glance to realize that nearly all of Andrews' furniture is new. "I've done a lot of restoration work on old pieces," Andrews explains. "It's second nature for me to use these proportions and construction details whenever I build something."

Such is the case with this storage bench, which would be a fine addition to just about any hallway or entry foyer. Even though the finished bench

With Its Hand-planed Surfaces and Antiqued Paint, This Bench Looks Like a 200-year-old Original.

BY TIM SNYDER

looks like a well-preserved antique, Andrews actually made it recently with standard 4/4, 5/4, and 8/4 pine.

The bench construction is an exercise in frame-and-panel joinery. As shown in Fig. 2, there are five separate frame-and-panel assemblies: two sides (which include the bench legs), a

back, a front, and a seat back. Andrews screws the lower assemblies together at the corners to form a box, then adds the seat and the seat back to create a comfortable bench. Cleats attached to the inside of the box hold the bench bottom in place.

Making the Arms, Rear Legs and Panels

Begin by cutting out a pair of arms and a pair of rear legs. (See Fig. 3.) These are the only parts made from 8/4 stock, and they're also the only curved parts in the project.

Don't cut the tenon in each arm at this stage; just shape the top edges of the arms using a drawshave or spokeshave. Work for an easy, even curve that feels good to the touch.

Next, glue up all the blanks you'll need to make the 5/4 bench seat and the bottom and raised panels, which are made from 4/4 stock. For now, it's best to size each panel at least 1/2 in. wider and longer than the finished dimensions given in the Bill of Materials in Fig. 2. This way, you can custom-fit each part to its opening later.

Making the Stiles, Rails and Seat Frame

Now you'll want to cut the stiles, rails and the U-shaped seat frame to size. Note: Don't cut the notches in the seat frame yet.

At this point you're ready to groove the stiles, rails and rear legs to accept the raised panels. (See Fig. 1.) Andrews does this on the tablesaw with a dado cutter, but another alternative is to rout the grooves with a slotting bit in a router table. Whichever method you choose, make sure you center the cutter on the 5/4 stock, testing your setup on some scrap pieces first.

Once you've grooved the stiles and rails, use the same setup to mill the stopped panel grooves in the rear legs shown in Fig. 2. To make sure the grooves align with the rails, register the outside face of each leg against the fence on your saw or router table. This way, the side panels will fit in the correct plane during assembly. (See photo, above.)

Mortising work comes next, and there are plenty of mortises to cut in this project. Andrews cuts his 1 1/8 in. deep, making most of them with a 3/8 in. mortising bit in the drill press. To cut the angled mortises in the rear legs, shown in the side view in Fig. 3, he uses a bevel gauge to lay out the angles on the side of the legs. Then he uses a hand drill to remove most of the waste, cleaning up the walls of the mortises with a chisel.

Now it's time for the tenons. For this project, Andrews cuts all except the arm tenons (they come later) on the tablesaw, making multiple passes over the dado cutter. You'll want to cut all the tenons to a uniform 3/8 in. thickness, then make the notch cuts in the tenons that have to be haunched. You'll find these tenons wherever panel grooves are exposed at corner joints. (See Fig. 2.)



PHOTO BY ANDY KAE

Note that groove in leg is offset to align with grooves in rails.

Finish up this part of the project by bandsawing the curved cutouts for the feet. (See Fig. 3.)

Making the Raised Panels

Since the raised panels must float in their frames to allow for wood movement, it's important to size each panel individually. It's a good idea to take your measurements off the frames after dry-fitting them. Dry-fitting not only gives you accurate dimensions, it also lets you check the fit of the mortise-and-tenon joints.

To size a panel, simply measure the frame opening, then add 1 in. to the opening length and 1 in. to the

opening width. Since the panels will fit into a 5/16 in.-deep groove, this formula leaves about 1/16 in. at the bottom of the groove to allow for any expansion across the width of the panel.

Andrews' tablesaw panel-raising technique creates a 1/8 in.-high shoulder, 1 5/8 in. from the panel edge, and a bevel that tapers down to 5/16 in. thick. (See Fig. 1.) You'll need a jig for doing this safely on the tablesaw (see AW #8, June 1989, page 33), or you can combine router and hand plane techniques (see AW #31) to create the same effect.

After raising his panels, Andrews removes any saw marks on the bevels with a sanding block and fine-grit sandpaper. For the "lands" of the panels—the flat area inside the bevels—he uses a hand plane with the iron ground very slightly to a curve. Working with this modified plane, which now acts like a scrub plane, really makes a difference in the finished piece. Instead of looking machine-made, the panels gain a rustic appearance.

Assembling and Finishing the Bench

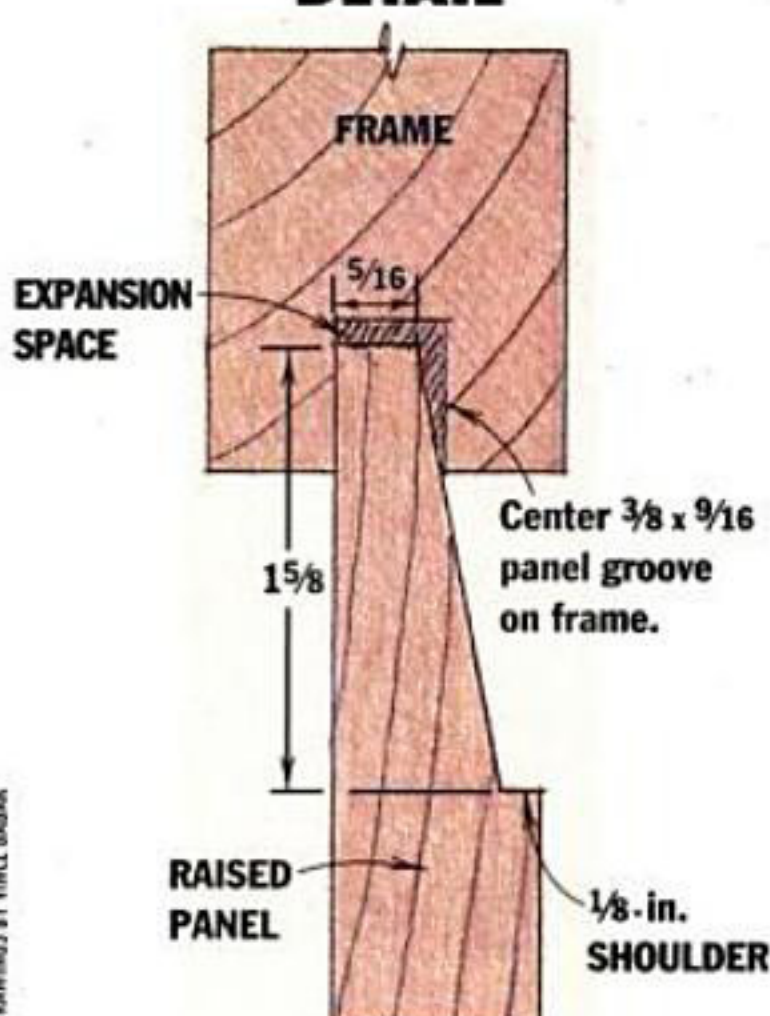
After you test-fit the frame-and-panel assemblies, you can glue them up. Remember to keep glue off the panel edges and check the frame for square as you clamp up each assembly.

Pegging the mortise-and-tenon joints is optional, since the glue will provide more-than-adequate holding power. If you want to add this traditional touch, you might try what Andrews does. Instead of making pegs from dowel rod, he whittles his from a scrap of pine. The slightly irregular form of each peg adds to the handmade quality of the finished bench.

Once the glue has dried, scrape off any excess, plane any high spots where stiles and rails meet, and give the frames a once-over with your modified plane to remove any mill marks.

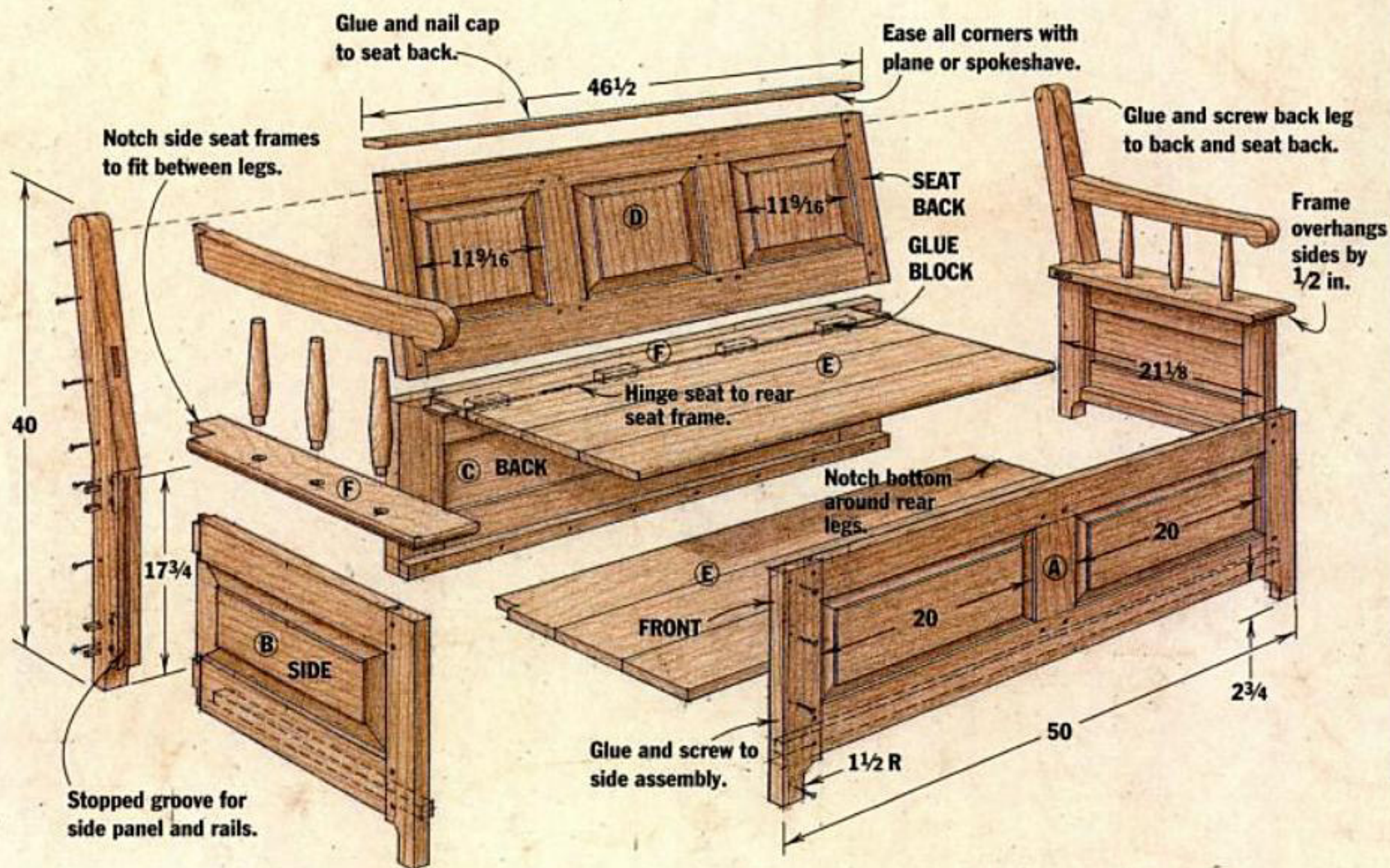
Now you can screw together the lower assemblies to make a box. Because the front overlaps the two sides and the back is let in between them, you'll need to start at the front. Make sure the top edges of the front and sides are flush with each other. Glue these joints, and pull them fast with 2 1/4 in. trim-head (finish) screws (available from McFeely's, Box 3, Lynchburg, VA 24505, 800-443-7937).

FIG. 1: RAISED PANEL DETAIL



DRAWINGS BY VINCE BABAK

FIG. 2: STORAGE BENCH



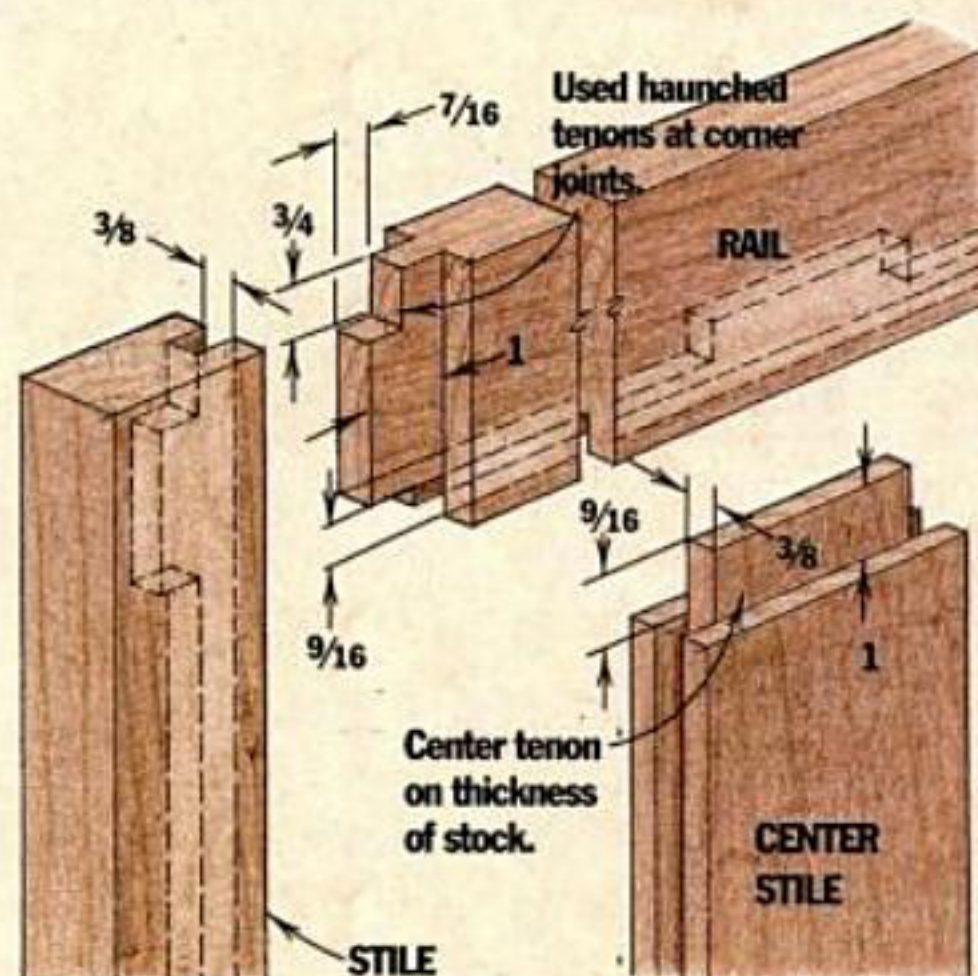
Note: Use haunched tenons where panel grooves are exposed at corner joints.

BILL OF MATERIALS

Parts	Qty.	Dimensions	Parts	Qty.	Dimensions
Rear legs	2	1 3/4 x 6 x 40	① SEAT BACK		
Arms	2	1 3/4 x 3 x 20	Side stiles	2	1 3/16 x 1 7/8 x 19 9/16
① FRONT			Center stiles	2	1 3/16 x 4 x 13 7/8
Side stiles	2	1 3/16 x 3 x 17 3/4	Top rail	1	1 3/16 x 3 3/8 x 44 3/4
Center stile	1	1 3/16 x 4 x 10	Bottom rail	1	1 3/16 x 4 5/16 x 44 3/4
Top rail	1	1 3/16 x 3 x 46	Panels	3	3/4 x 12 9/16 x 12 7/8
Bottom rail	1	1 3/16 x 4 x 46	Cap	1	3/4 x 1 3/4 x 46 1/2
Panels	2	3/4 x 9 x 21	② SEAT AND BOTTOM		
② SIDES (2 req'd)			Seat	1	1 3/16 x 17 x 40 7/8
Front stile	1	1 3/16 x 1 7/8 x 17 3/4	Bottom	1	3/4 x 18 1/2 x 47 5/8
Top rail	1	1 3/16 x 3 x 17 1/16	③ SEAT FRAME		
Bottom rail	1	1 3/16 x 4 x 17 1/16	Side frames	2	1 3/16 x 5 x 21
Panel	1	3/4 x 9 x 16 1/16	Rear frame	1	1 3/16 x 4 x 43
③ BACK			Spindles	6	1 1/4 sq. x 9
Stiles	2	1 3/16 x 4 x 16 3/16	Cleat material	1	1 x 1 3/16 x 14'
Rails	2	1 3/16 x 5 x 40 1/2			
Panel	1	3/4 x 7 7/16 x 39 1/2			

Note: Lengths include 1-in. tenons.

MORTISE & TENON DETAIL



In pine, these screws don't require pilot holes to be driven and recessed below the surface.

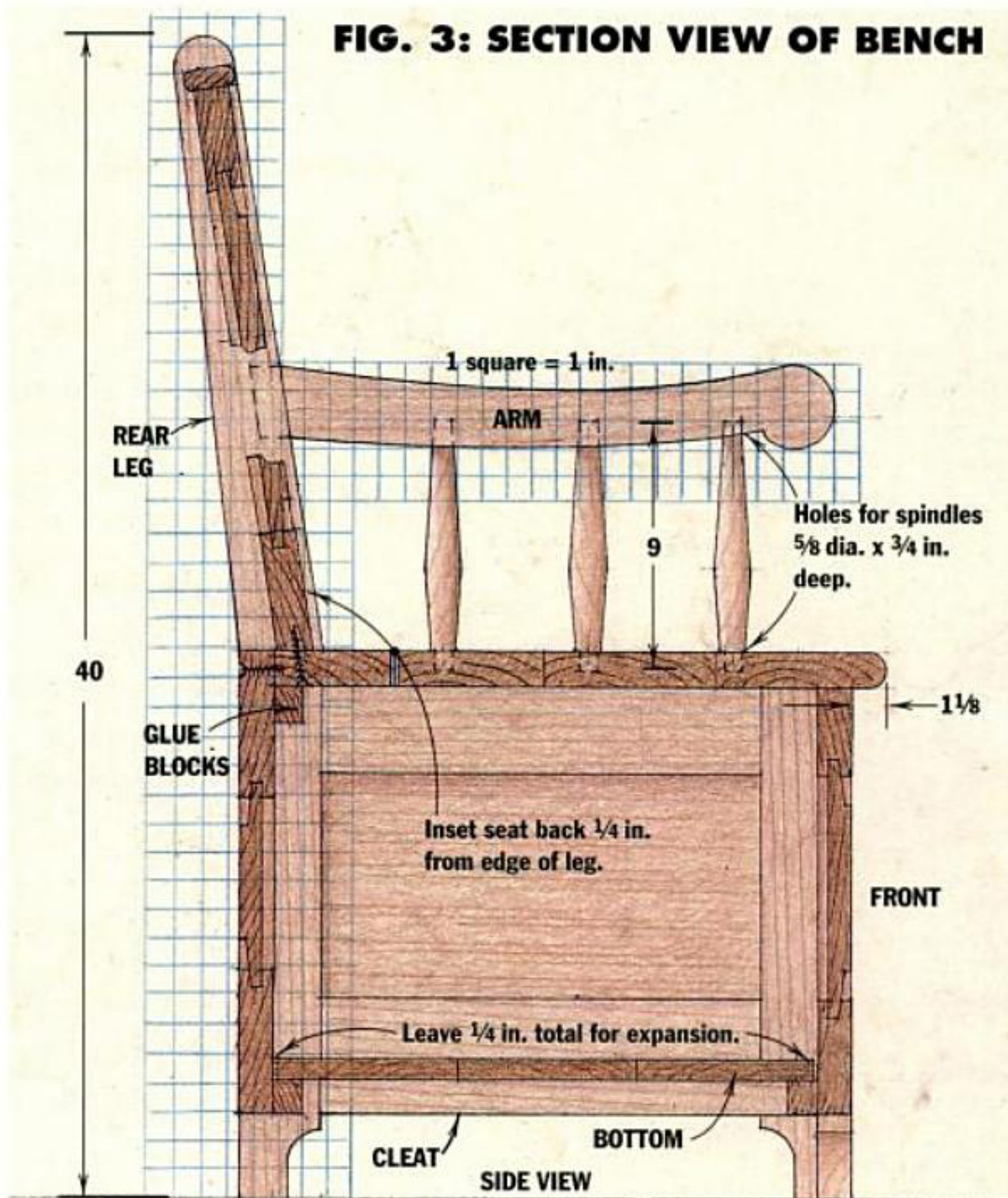
Using glue and trim-head screws, attach the back to the sides. Square up the sides with the front and back of the bench, and cut and install the four cleats that will support the bottom. Also, cut and install the glue blocks that help support the rear seat frame. (See Fig. 2.) Saw the bottom panel to fit, allowing about $\frac{1}{8}$ in. of expansion space at the front and back. You'll have to notch the back corners of the panel to fit around the rear legs. (See Fig. 2.) Screw the panel to the cleats.

Next, dry-fit the seat frame assembly on the bench and lay out the notch cut in each side frame piece. As shown in Fig. 2, these notches allow the side pieces to fit between the rear legs. After cutting the notches, glue the frame together and attach it to the bench with glue and screws.

Test the fit of the seat back between the rear legs, and trim to fit if necessary. At this point, bevel the bottom edge of the back on the tablesaw or with a hand plane so that it will fit flush against the seat frame. Then glue and screw the back to the rear legs and to the seat frame, locating the seat back so it's inset $\frac{1}{4}$ in. from the edge of the legs. (See Fig. 3.) To complete the back, cut the cap molding shown in Fig. 2 to fit between the legs, and then secure it on the seat back with glue and finish nails.

Next, lay out and cut the arm tenons. To do this, first make sure the bench is on a level surface. Hold an arm against the outside face of a rear leg, at mortise height, and use a small level to keep the underside edge of the arm approximately level. In this position, you can lay out the shoulder line for the arm tenon by marking on the arm where it rests against the leg. Transfer this shoulder line to the opposite side of the arm with a square, and mark a $\frac{3}{8}$ -in.-thick tenon that's centered on the arm. Cut the tenons with a backsaw, then use a chisel or shoulder plane to pare them for a sliding fit.

Now it's time to take a break from assembly to turn the arm spindles. (See Fig. 3.) Turn shouldered tenons at the bottom of the spindles, but leave the tops tapered with no shoulder. This



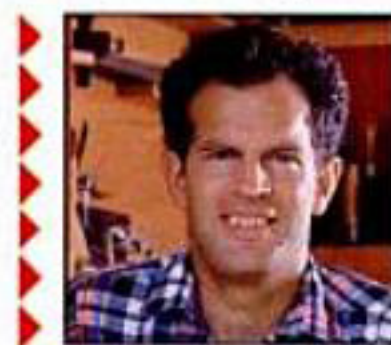
way, when the spindles are installed, they can seat themselves tightly into the holes under the curving arms.

When the spindles are turned, lay out and drill the $\frac{5}{8}$ -in.-dia. by $\frac{3}{4}$ -in.-deep holes in the arms. (See Fig. 3.) Then fit the arm tenon in its mortise and use a square to mark holes so you can drill the bottom spindle tenons in the side seat frame pieces. When gluing up these assemblies, you may need to use a mallet to coax each arm tenon into its mortise while tapping the spindles home at the same time.

The seat goes in last. Cut it to fit its opening, allowing a $\frac{1}{16}$ -in. clearance between seat ends and side frame edges. Complete the assembly process by covering screw and nail holes with wood filler.

This bench would look good with a number of different finishes. Andrews likes to give many of his pieces, including this one, an antique painted

finish. First, he applies a base coat of semi-gloss enamel to bare wood (instead of over a primer coat). This allows some wood grain to show through and even tends to highlight hand planing marks and peg locations. On top of this coat, Andrews brushes on, then wipes off, a darker accent color. This technique produces a finish which looks a lot older than it actually is. ▲



TIM SNYDER is a woodworker in Pennsylvania. He wrote *Shelving and Storage* (1992, Rodale Press Inc., 33 E. Minor St., Emmaus, PA 18098), in which this bench first appeared.

*Careful
Preparation
Is The Key
To Peak
Performance*

Japanese planes are sensitive and must be tuned up to work properly. Here the author checks a plane sole for flatness.

PHOTOS BY ELLIS VALENTINE



— TUNING — JAPANESE PLANES

BY TOSHIO ODATE

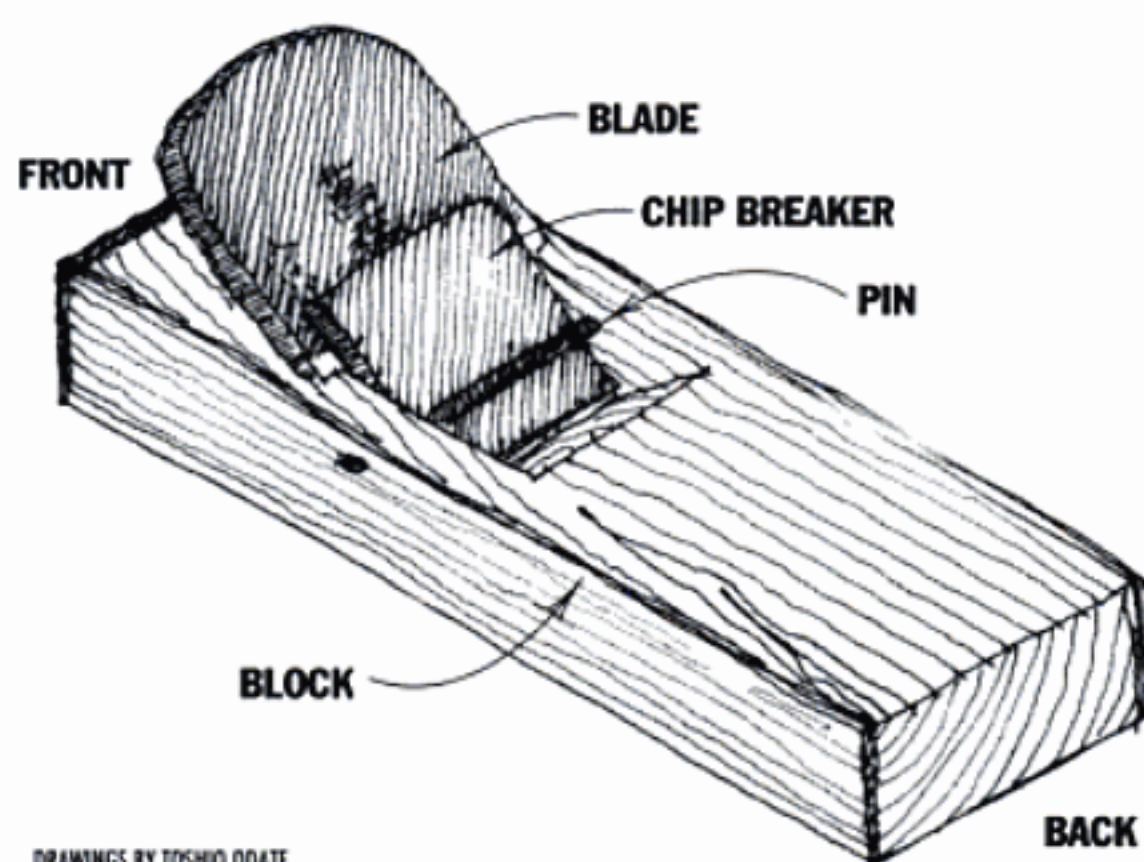
Most Westerners know that Japanese planes cut on the pull stroke, but few realize they were not always this way. When Korean carpenters brought the first wooden planes to southern Japan in the early 16th century, the planes had handles on both sides and cut on the push stroke. But soon the planes were modified to cut on the pull stroke for the convenience of Japanese craftsmen, who were accustomed to working in a kneeling or seated position. From there, they slowly evolved into today's uniquely styled Japanese planes.

Modern Japanese planes usually have only four parts: the laminated steel blade, the chip breaker, the pin and the block. (See Fig. 1.) These planes look very simple, but they are actually very delicate and sensitive. New planes need some preparation before they will work, and even well-used planes need periodic maintenance to keep them in tune. In this article I'll explain how to set up and tune Japanese planes.

Fitting the Blade and Chip Breaker

The first step in setting up a new plane is to fit the blade into the block. When you buy a new Japanese plane, the blade is just temporarily inserted into the block. It is not ready to be used until it is seated properly. (Some planes are sold as "ready-to-use," but even these are never perfect.)

FIG. 1: JAPANESE PLANE



Begin by taking the pin out. To do this, hold the pin with a pair of pliers and strike the block gently alongside the pinhole with a hammer.

Next, check the width of the blade opening from groove to groove. Put the blade in, but do not force it. There should be a little space, about $\frac{1}{64}$ in., on either side of the blade. If you do not have this much space, cut the grooves deeper with a small saw or hacksaw. (See photo, page 64.) Then pare off the wood between the saw cuts with a narrow chisel.

Once you have established side clearance for the blade, the next step is to fit the bevel side of the blade to the bed of the plane. Usually you must remove some material from the bed of a new plane to allow the blade to protrude from the sole.

To figure out where to remove material, use a charcoal or soft pencil to smear the front half of the blade sur-

face on the bevel side. Now, insert the blade into the block and tap it *gently* with a hammer until it becomes tight, then take it out again. You will see a black mark on the inside of the block wherever the blade touched.

Use a chisel to take off the black marks. Just pare or scrape the marks off—do not dig them out. Again, put charcoal on the blade and repeat the process. Ideally, the entire blade surface should be touching the block, because the more it touches, the more friction is

created and the tighter the block holds the blade. (Don't worry if you don't get it perfect—complete contact is nearly impossible to achieve.) When you can tap the blade in without too much force (the blade tip should be $\frac{1}{8}$ in. to $\frac{1}{16}$ in. above the mouth opening), the job is done. It seems like very tedious work, but it makes the blade very stable inside the block.

The cutting edge of a Japanese plane blade is narrower than the overall width of the blade. (See Fig. 4.) This is because the sides of the blade have to go about $\frac{1}{8}$ in. into grooves in the block, but the edge has to clear these grooves to keep shavings from being wedged in them. The blade has angled corners (*mimi*) to line up the cutting edge with the mouth opening. Make sure that these *mimi* are big enough to do this, and regrind them if necessary.

After fitting the blade, install the chip breaker between the blade and



To increase side clearance for the blade, deepen the sides of the grooves with a small saw or hacksaw, then chisel out the waste between the cuts.

the pin. Often the opening for the chip breaker is not wide enough, so you have to open it by paring the sides of the throat with a chisel. Then put the pin back through the hole and tap the chip breaker into place.

If the chip breaker does not sit evenly on the back of the blade, a gap may open between them so that the chip breaker will not function properly. On most new planes, the *ura* (the flat areas around the hollows on the backs of the blade and chip breaker) are very flat and mirror-finished. When the two *ura* are put together, there should not be any space between them.

To check this, put the blade on a table, hollow side up, and set the chip breaker on top of it, with its bevel edge about $\frac{1}{64}$ in. back from the blade's cutting edge. (See photo, above right.) Tap each corner of the chip breaker very gently with your fingertip. All four corners should be touching the blade at the same time without any rocking.

If you can feel a space or hear a sound, you can adjust it by bending one of the upper corners of the chip breaker. Bend the high corner down slightly by striking it with a hammer over the corner of an anvil or over the end grain of a hardwood block. Be careful not to bend the chip breaker too much. Check the fit and repeat this process until all four corners touch the blade at the same time. Then



Check for gaps between the blade and chip breaker by tapping lightly on the corners of the chip breaker.

reinstall the chip breaker between the blade and the pin.

In a Japanese plane, the edge of the chip breaker should be positioned $\frac{1}{64}$ in. to $\frac{1}{16}$ in. from the edge of the blade, depending on how fine a shaving you plan to cut. But unlike Western planes, the chip breaker of a Japanese plane is not inserted until after the blade is installed. Because of this, it can be difficult to see how far the chip breaker's edge is from the edge of the blade.

One way to position the chip breaker accurately is to hold the plane above a piece of white paper so that light is reflected from the bevel of the chip breaker. The exposed part of the blade in front of this bright bevel looks like a dark shadow. For final smoothing, this shadow should be very fine (about $\frac{1}{64}$ in.), but for rougher shavings, the shadow should be wider (about $\frac{1}{16}$ in.). It's good to experiment with different chip breaker settings to see how they affect the plane's performance.

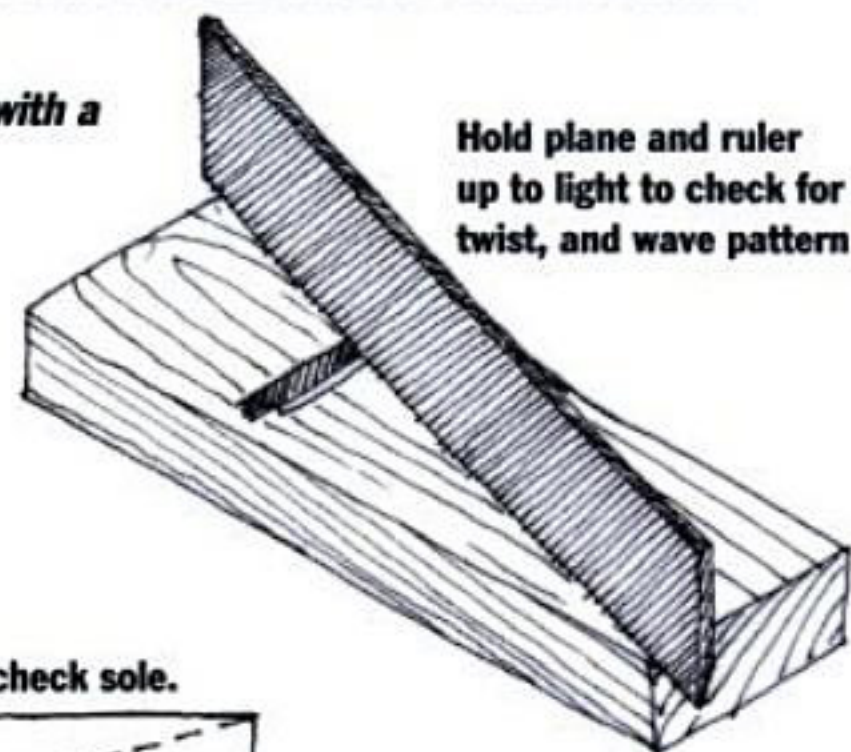
Conditioning the Block

After you have fit the blade and chip breaker to the block, you need to condition the block to make the plane cut cleanly and evenly without clogging. You also need to condition the plane if the blade is badly chipped and you have to remove a lot of metal to sharpen it again. I will explain this process below.

Once the block is conditioned, most of the parts do not need to be done again for a long time, except for the sole. Because the plane block is made

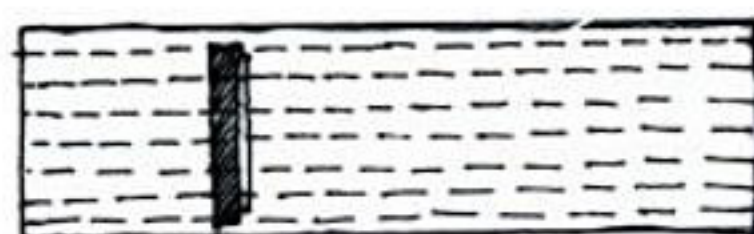
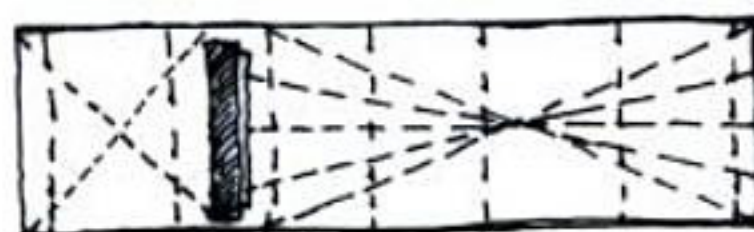
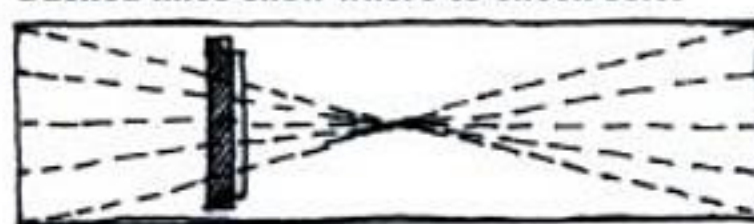
FIG. 2: CONDITIONING THE SOLE

STEP 1: Check sole with a straightedge.



Hold plane and ruler up to light to check for warp, twist, and wave pattern relief.

Dashed lines show where to check sole.

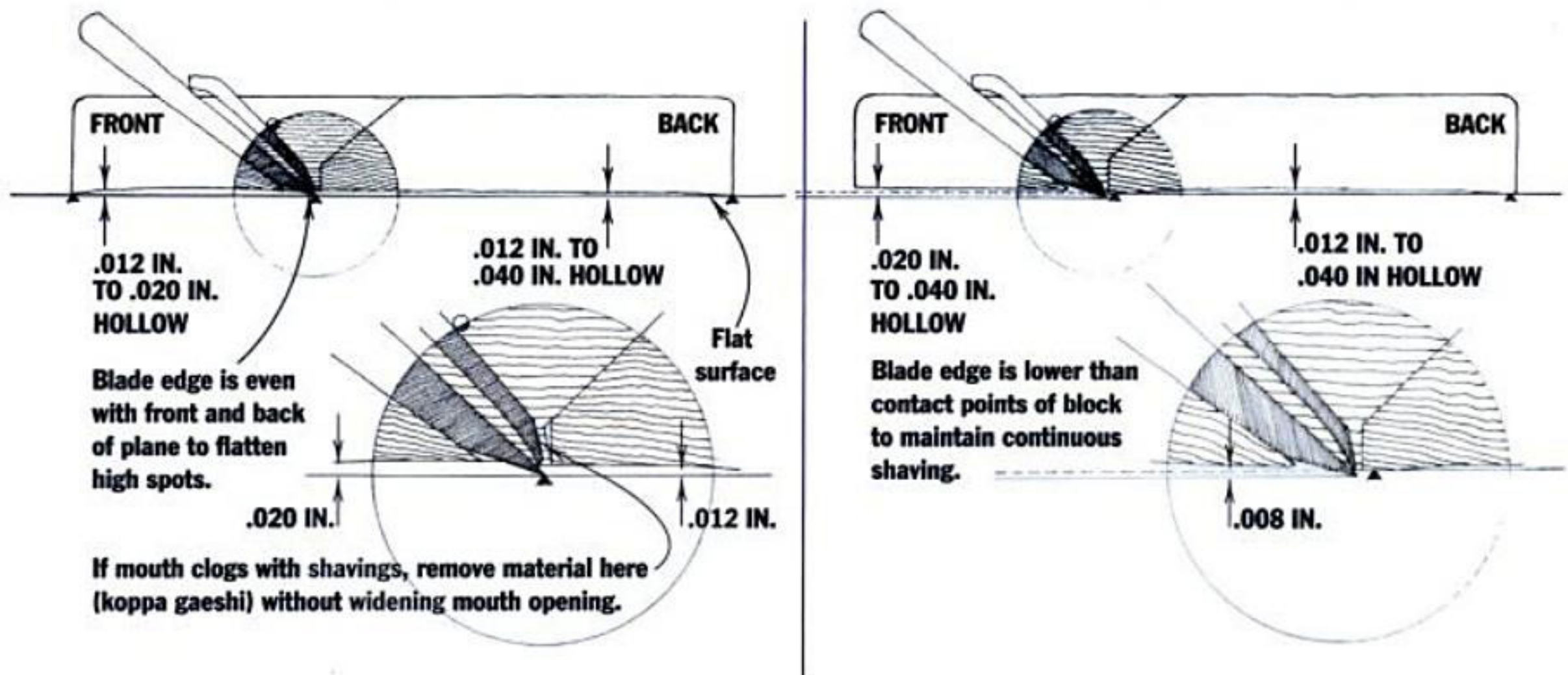


STEP 2: Remove material with scraper plane where necessary.

FIG.3: HOLLOWING THE SOLE

FOR TRUEING

FOR ROUGHING AND SMOOTHING



of solid wood—usually white or red oak—it will change with the weather conditions. So even if you prepared the block well in the beginning, you must check the sole from time to time and adjust it as necessary.

Many people think the plane sole is straight and flat, but this is not so. Japanese craftsmen create wavelike patterns on the soles of their blocks by scraping away some of the wood in places with a scraper plane.

There are two basic wave patterns—one for “trueing” and one for “roughing” and “smoothing.” (See Fig. 3.) These patterns can be used on any plane, but the trueing pattern is more common on longer planes used for edge work. With either pattern, the waves should be shallower when the work is finer.

Planes set up for trueing are for making surfaces straight and flat, usually before marking out joints. When you prepare a plane sole for trueing, the object is to relieve the sole so the plane block contacts the work at two places—the front and back. (See Fig. 3.) The cutting edge is set at this same height. Since these three points are even, the plane can create a perfectly flat surface, because it removes only the high spots of the wood. Of course, nothing is automatic—you need skill and practice to plane a flat surface.

Planes set up for smoothing and roughing are used to produce a continuous surface, and they vary only in how thick a shaving you make. Planes for roughing have wider mouths and deeper wave patterns than smoothing planes, and planes for top-quality smoothing have very shallow waves. In both cases, the whole sole in front of the blade is relieved, and the plane block contacts the work at only two points—at the back end and just behind the cutting edge. (See Fig. 2.) The cutting edge is at the lowest point, so it will contact even a slightly waved surface.

With both wave patterns, the front and back parts of the plane sole are at different levels (see Fig. 3); the front portion should be higher off the work than the back portion. To make it easier to scrape the sole cleanly where the levels change, make a little cut (*mimi*) at each end of the plane’s mouth. (See Fig. 3 and photos below.) Even then, it’s better to use a scraper or chisel to scrape the relief just in front of the mouth opening, because this is difficult to do with a scraper plane.

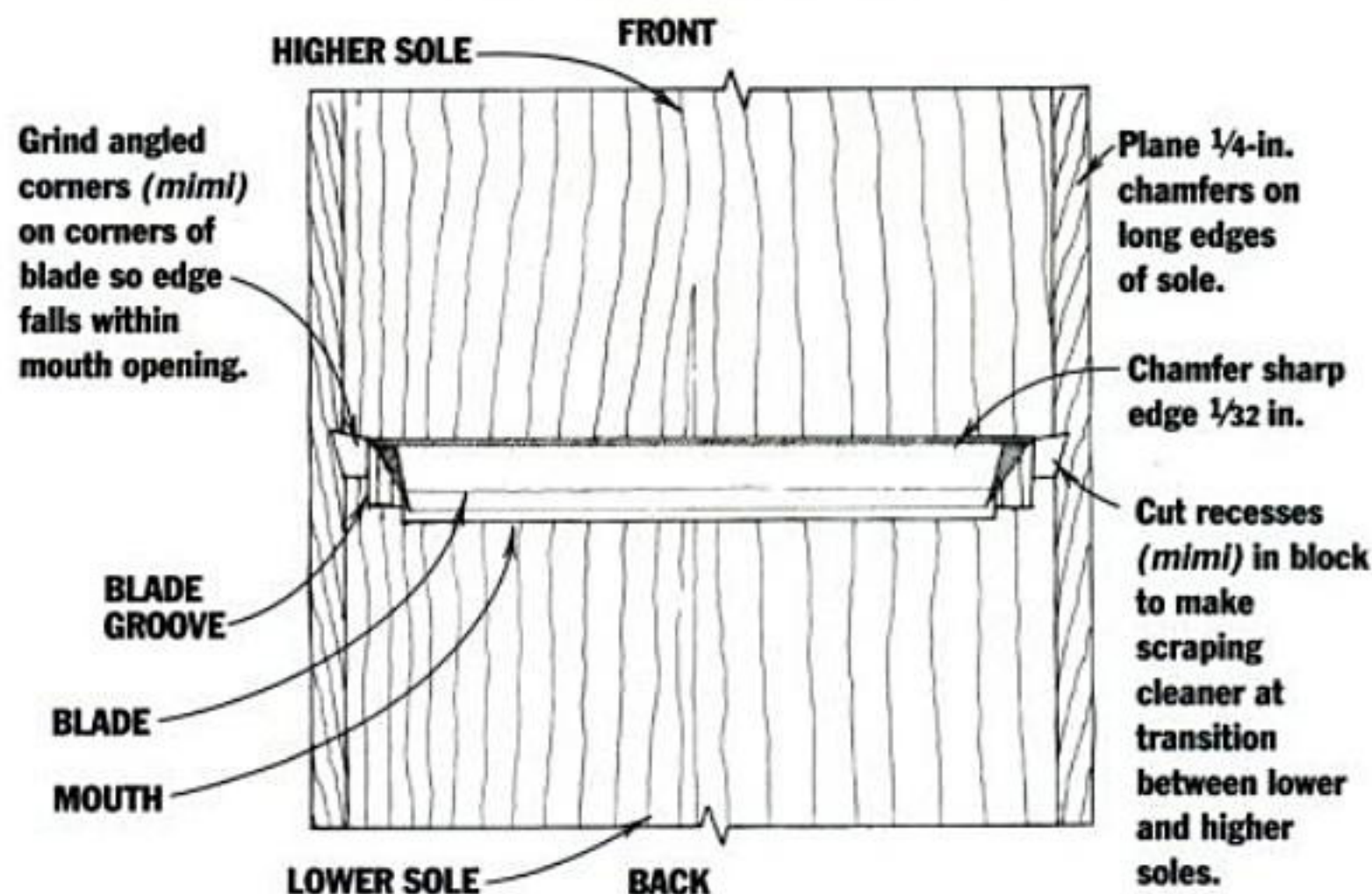
To check the sole, you would traditionally use a wooden sole ruler, but a



To make it easier to scrape the sole in front of and behind the mouth, cut recesses (*mimi*) at ends of the mouth, by first chopping lightly into the sole (left), then paring to your chop marks (right).



FIG. 4: PLANE MOUTH



To prevent the sharp edge of the mouth from chipping or picking up splinters, the author chisels a $\frac{1}{32}$ -in. chamfer.



With the side of the plane body square to the sole, you can plane square edges easily by sliding the plane on the bench.

metal straightedge will do the job. Before you check the sole, position the blade and chip breaker just shy of the mouth opening, so that they will exert the same pressure on the sole as when you use the plane. Then examine the sole lengthwise, crosswise and on the diagonals for twist or other distortions as shown in Fig. 2, holding the plane up to the light to see the gaps and high spots. (See lead photo.)

Use a scraper plane (*dai naosbi*

kanna) to adjust the sole and create the wave pattern you want. (See Fig. 3.) Once again, be sure the blade and chip breaker are installed just shy of the sole. The chip breaker should be about $\frac{1}{16}$ in. from the cutting edge. (If you removed the blade and chip breaker to adjust the sole, the section of the sole immediately in front of the blade will bulge out when you attempt to reseat them because of the blade pressure.) Scrape across the grain and check your progress frequently with the sole ruler as you work. This method should also be used when parts of the plane sole wear out from use or distort because of weather conditions.

After conditioning the sole, chamfer the long edges about $\frac{1}{4}$ in. with another plane. (See Fig. 4.) Chamfering reduces friction by reducing the surface area of the sole, and it makes the plane easier to pull. You

also avoid picking up shavings and dust with the edges.

Also chamfer the sharp edge of the mouth about $\frac{1}{32}$ in. (See photo, far left.) This will prevent the edge of the mouth from chipping and picking up splinters. Do not chamfer the front or back ends of the sole, because you want these sharp corners to push the shavings and dust out of the way. This way, the sole and cutting edge will contact a clean surface.

Next, check the back wall of the throat, above the mouth (*koppa gaesbi*). (See Fig. 3.) It should be parallel to the bevel of the chip breaker. If shavings clog between the *koppa gaesbi* and the chip breaker, chisel off a little material, but do not widen the mouth. The mouth opening is very important. It should be just wide enough for shavings to go through—the narrower the opening the better.

Now, if you are right-handed, square the right side of the plane to the sole. If you are left-handed, square the left side. This way you can plane the edge of a board squarely by raising the board off the bench and running the side of the plane on the bench to trim the edge. (See photo, left.)

The final step in conditioning the block is to chamfer the upper part of the block about $\frac{1}{8}$ in. on the sides and back. Round over the top front edge of the block, and especially the corners, to prevent damage from hammer tapping when you adjust the height of the blade.

When you are completely finished working the wood, put a little vegetable oil all over the block, especially on the sole and the inside of the mouth. Wipe off any excess oil, and polish the block with a soft cloth. ▲



TOSHIO ODATE is a noted sculptor and *shoji* maker in Connecticut. He is the author of the book, *Japanese Woodworking Tools: Their Tradition, Spirit and Use* (1984, Taunton Press, Newtown, CT 06470).

SOURCES

Japanese planes are available from:

HIDA TOOL AND HARDWARE CO., 1333 San Pablo Ave., Berkeley, CA 94702, (510) 524-3700. CIRCLE #617

THE JAPAN WOODWORKER, 1731 Clement Ave., Alameda, CA 94501, (800) 537-7820. CIRCLE #618

INLAID EARRINGS

BY FRED METZGER

Over my 39 years as a cabinetmaker, I've accumulated lots of inlay strips left over from furniture projects. But it wasn't until a customer asked whether I made jewelry that I thought of turning my scrap into these exotic-looking earrings.

Now I make several pairs of earrings at a time. The process is simple. I glue inlay into grooves in both sides of a 36-in.-long piece of hardwood, cut the stock to a pleasing shape, then resaw the pieces to create two mirror-image earrings. The drawings show the basic steps, but here are a few other tips:

- I make the earring blanks from attractive hardwood scraps, cut with the grain to create strips $\frac{5}{8}$ in. thick by 1 in. wide by 36 in. long. The inlay itself is available from Dover Inlay Mfg., Inc. (Box 151, Williamsport, MD 21795, 301-223-8620). The company sells many designs and the strips come 36 in. long and $\frac{1}{28}$ in. thick. Widths vary from $\frac{1}{16}$ in. to $1\frac{3}{16}$ in.
- To rout the grooves for the inlay, I clamp each hardwood strip to the

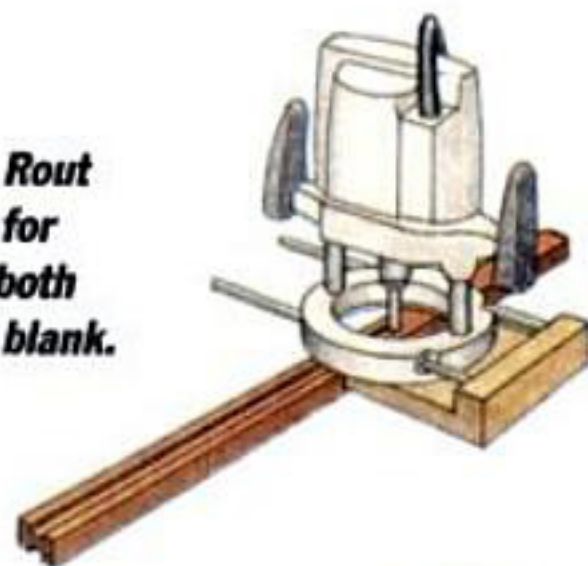
bench and use my router fence to guide the bit. For greater control, you could use a router.

- To shape the earrings, I cut them on the bandsaw, using a $\frac{1}{8}$ -in. or $\frac{1}{4}$ -in. blade, and then I sand the edges on a drum sander. (You can make sanding drums by wrapping sandpaper around a dowel and chucking it in the drill press.)
- To make the hole in the end of the earring for the fine wire, I use a Dremel drill and a #64 drill bit (.036 dia., available from MSC Industrial Supply Co., 151 Sunnyside Blvd., Plainview, NY 11803, 800-645-7270). You can buy earring wire and hooks from River Gems and Findings, 6901 Washington Ave. NE, Albuquerque, NM 87109, 800-443-6766.
- I glue the wire in place with medium-thick cyanoacrylate glue and cut the wire to leave $\frac{1}{2}$ in. exposed. This is just enough to make the small loop you will use to attach the earrings to the earring hooks after finishing.

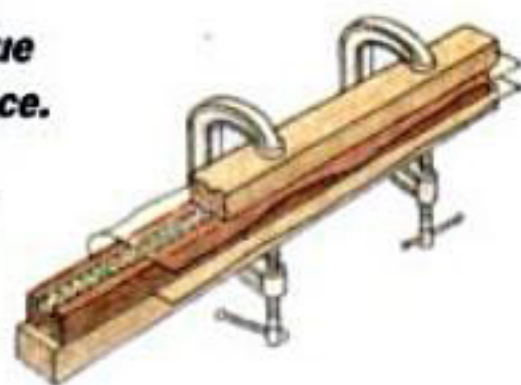
We often describe wood as strong, durable and heavy, but these earrings are lighter in weight than metal or ceramic earrings. They make great gifts, and anyone who receives a pair is sure to love them.

CONSTRUCTION STEPS

STEP 1: Rout grooves for inlay in both sides of blank.



STEP 2: Glue inlay in place. When dry, sand inlay flush with hardwood.



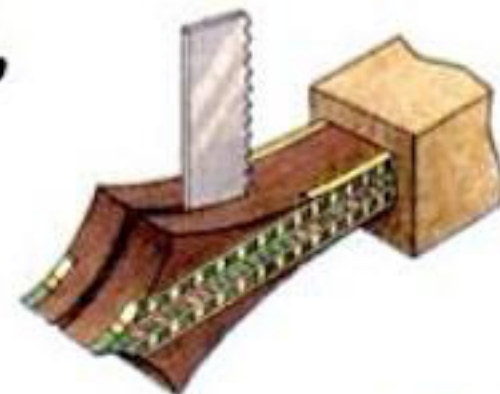
STEP 3: Trace earring shape on stock, then bandsaw.



STEP 4: Sand earring to final profile.



STEP 5: Hot glue to scrap push stick and resaw pieces to make two earrings.



STEP 6: Drill hole for earring wire and attach wire and hook.



FRANK ROHRBACH



FRED METZGER
works wood in Swannanoa, N.C.

BY STEPHEN H. BLENK

From the bow lathes of the Egyptians to the spring poles and treadles of the bodgers, from windmills and inertial flywheels to electric motors, power sources for lathes have taken many forms throughout history. Now the electronic age has spawned yet another improvement: variable-speed, direct-current (DC) drives. These DC drives offer a range of

features—infinately variable speed, electronic braking, and relentless torque even at low speeds—that make them the first choice for serious turners, especially those who often turn large-diameter objects.

DC drives are a major improvement over the alternating-current (AC) drive systems commonly available today. AC drives use reciprocal step pulleys or Reeves variable-speed drives to trans-

mit power to the headstock, but neither pulley arrangement can slow the headstock to speeds less than 300 to 400 rpm. This makes AC drives dangerous for large turnings.

There are other disadvantages as well. The systems' AC motors go almost instantly from a dead stop to their rated rpm when you switch them on. On a lathe, this rapid acceleration shocks turnings and causes faceplate mounting screws to loosen. Also, if you want to reverse the rotation of the drive shaft (a desirable feature for many lathe operations), you need to install a drum switch or a three-position switch. By contrast, DC drives run as slowly as 1 rpm, and you can easily reverse direction.

AC drives also aren't as responsive as DC systems. Reciprocal pulley systems give good power but limit you to four or five fixed speeds, and you have to stop the lathe to change speeds. This repeated starting and stopping is hard on motors.

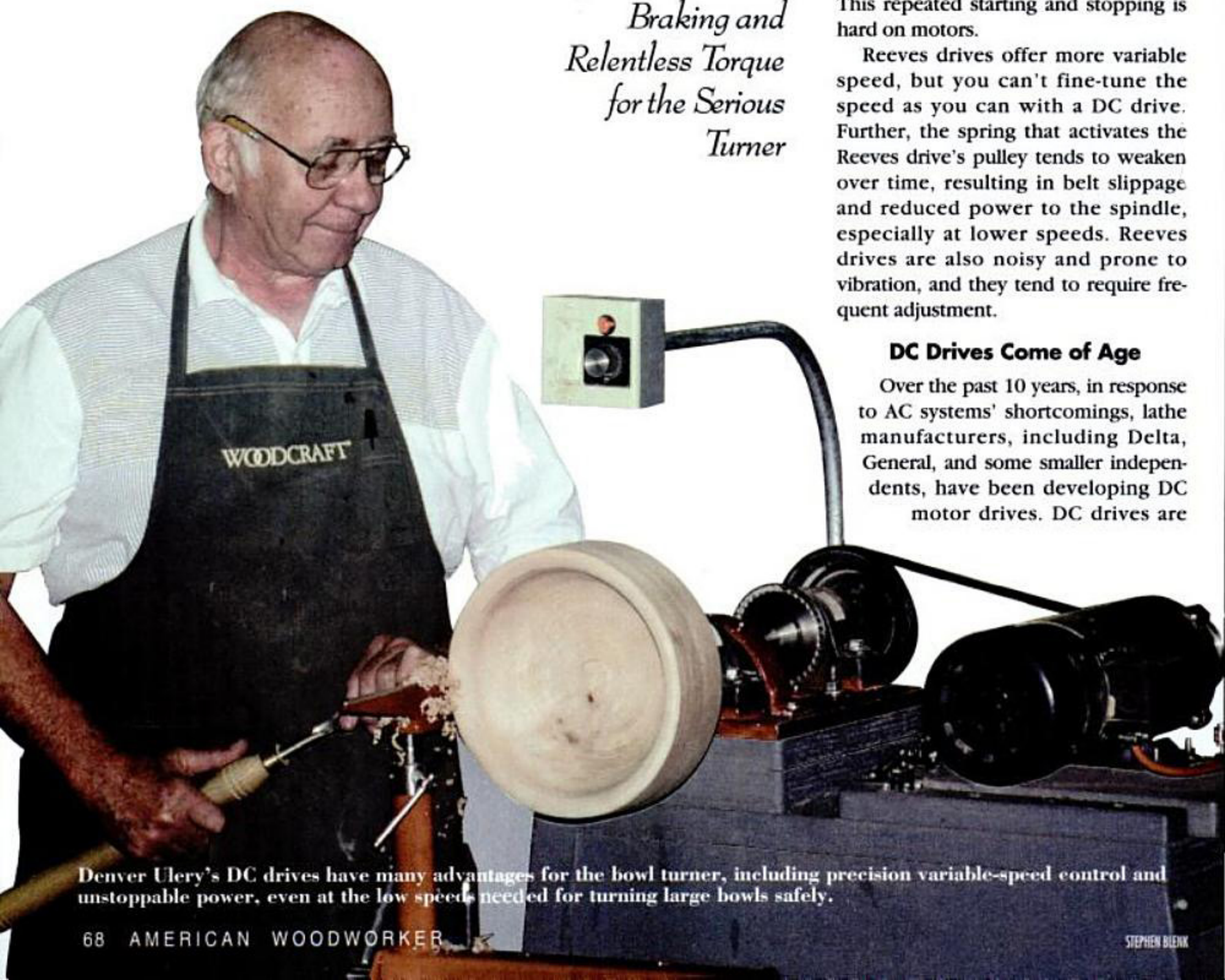
Reeves drives offer more variable speed, but you can't fine-tune the speed as you can with a DC drive. Further, the spring that activates the Reeves drive's pulley tends to weaken over time, resulting in belt slippage and reduced power to the spindle, especially at lower speeds. Reeves drives are also noisy and prone to vibration, and they tend to require frequent adjustment.

DC Drives Come of Age

Over the past 10 years, in response to AC systems' shortcomings, lathe manufacturers, including Delta, General, and some smaller independents, have been developing DC motor drives. DC drives are

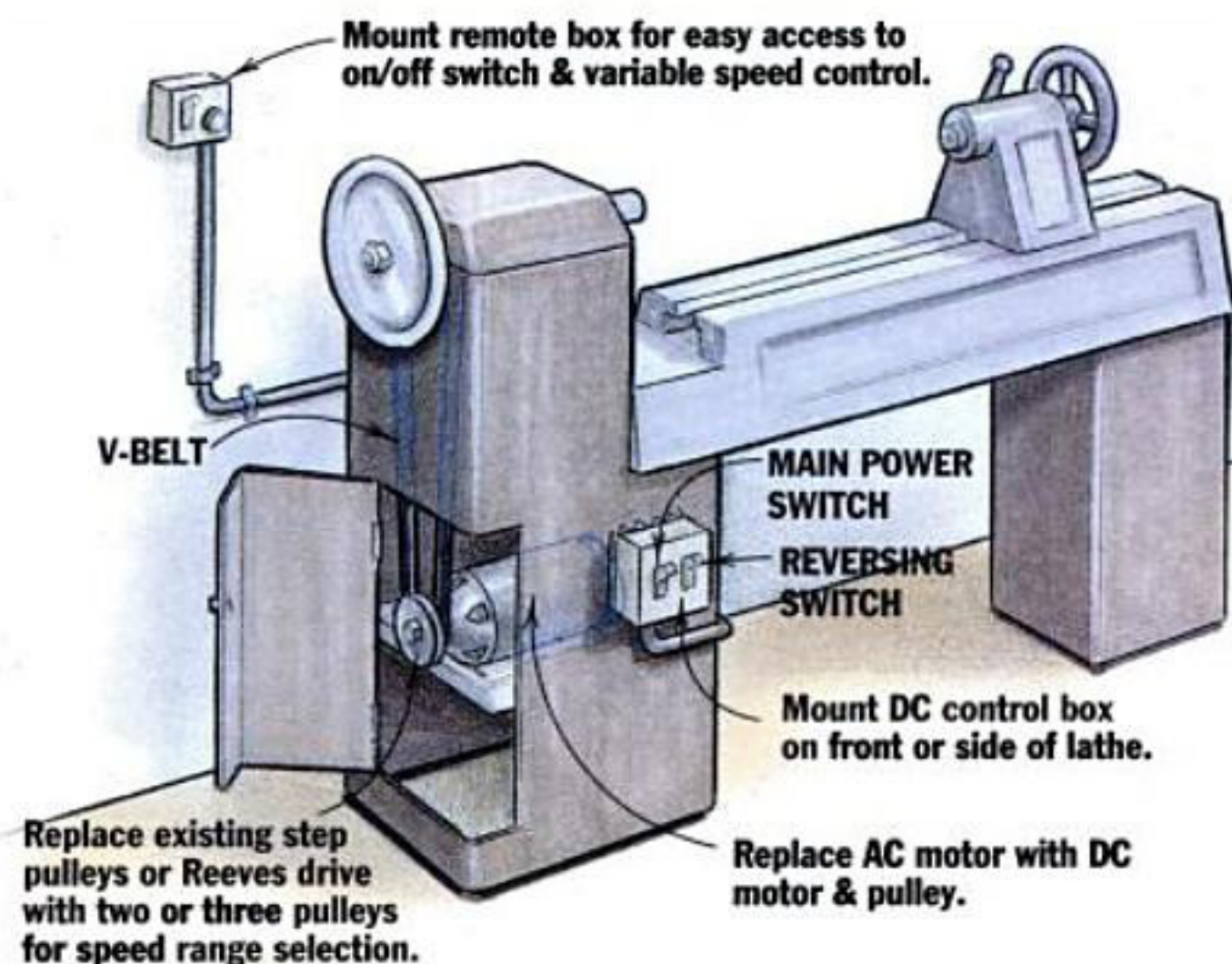
DC DRIVES

*Infinately Variable
Speed, Electronic
Braking and
Relentless Torque
for the Serious
Turner*



Denver Ulery's DC drives have many advantages for the bowl turner, including precision variable-speed control and unstoppable power, even at the low speeds needed for turning large bowls safely.

RETROFITTING A DC DRIVE SYSTEM TO YOUR LATHE



BOB LAPOINTE

ideal because they eliminate the need for a variable-speed drive system—the motors themselves can run at infinitely variable speeds. However, early production models of DC drives were disappointing, and horror stories abounded: torque problems at low speeds, blown fuses, poor heat dissipation, speed surging, and controllers that didn't perform as advertised. But as more turners got involved in the engineering process, DC drives began to achieve their potential.

One of the pioneers in DC drive systems and a turner himself is Denver Ulery of D/J Wood Sales in Bothell, Washington. Many consider his DC drives to be the best available. Ulery's drives are now used by Craft Supply USA of Provo, Utah, on their variable-speed Woodfast lathes, and Delta is also considering them.

At the heart of his system is a sophisticated controller, an electronic "black box" that may be attached in a variety of locations on the lathe. The controller performs several crucial functions: it converts standard AC current to DC; it has a switch for reversing spindle rotation; it provides the same torque in both forward and reverse; it controls acceleration and maximum current draw; and it prevents speed surges.

The system also supplies "dynamic braking." When you shut off a DC-driven lathe, the momentum of the spinning workpiece causes the motor to actually generate electricity. The con-

trol box channels this electricity into a bank of resistors, exerting an adjustable braking effect on the workpiece and saving time when you want to stop a turning to check your progress.

A smaller, remote box houses the system's on/off and speed functions. The box has a rheostat to set the spindle speed (with the system either running or stopped) and an on/off switch that you can easily adapt for foot switching.

Speed Controls

Ulery sets up his bowl lathes with two speed ranges—one from 0 to 700 rpm for large work, and the other from 0 to 1300 rpm for smaller work. For spindle turning, he also adds a higher range which gives speeds up to 2500 rpm. He can vary these ranges by using different pulleys to connect the motor to the headstock.

Although you have to move the belt to another pulley to change speed ranges, this isn't usually an inconvenience because you seldom need to change speed ranges in the middle of a job. Furthermore, having to move the belt can be viewed as a safety feature because it allows you to set a top speed and vary up to that. There's no danger of inadvertently raising the lathe to a higher speed. (Note: The lathe will run at low rpm in the higher speed ranges, but the motor will not supply good

torque, like a manual-transmission car being driven too slowly in fourth gear.)

The biggest advantage of DC drives is the sensitivity and range of their speed control, right down to 0 rpm. By varying the speed a small amount, you can often eliminate a lot of vibration.

DC systems do have some drawbacks. One is cost: retrofitting one of Ulery's systems to your AC-motor lathe costs \$616 for a 1-HP/110-volt system, \$691 for a 1½-HP/220-volt system, and \$1075 for a 2-HP/220-volt system, not including the speed-range pulleys or a magnetic starter. On a new lathe, the cost isn't as great. A Woodfast lathe with the 1 HP/110-volt variable-speed DC option is just \$300 more than the equivalent AC lathe with step pulleys. But a DC system will also take you a minimum of several hours to install, depending on your lathe.

Another drawback is the audible hum the system produces, although I don't find it a major annoyance. To eliminate the hum, Denver has developed an electronic noise filter. This is now available on the Woodfast lathes as a \$105 option, making them by far the quietest lathes on the market.

DC motors also present some mounting challenges: they're longer than comparable AC motors. But Ulery has successfully converted lathes by General, Woodfast and Delta among others, as well as bowl lathes of his own design.

If you decide to buy a DC lathe, I'd recommend a 220-volt system for economy and performance. For larger-diameter work, the 2-HP/220-volt system is worth the expense. It's virtually unstoppable in normal operations. ▲

For more information on DC drive systems, contact Denver Ulery of D/J Wood Sales, 23708 Locust Way, #59, Bothell, WA 98021, (206) 868-5442.



STEPHEN BLENK is a turner in Washington state and founder of the Olympic Peninsula chapter of the American Association of Woodturners.

WOOD FACTS



American black walnut



Claro walnut



European walnut

PHOTOS BY MITCH MANDEL

WALNUT

BY DICK BOAK

SPECIES NAMES

Primary species:

Juglans nigra (American black walnut)

Juglans regia (European walnut)

Juglans sieboldiana (Claro walnut)

TRADE NAMES

American black walnut is usually marketed simply as walnut, though it is occasionally called gumwood or canaletto. European walnut is typically named after the country of origin (e.g., English, Persian, French, etc.). Claro walnut, grown mostly in California, is sometimes referred to as Japanese walnut.

APPEARANCE

American black walnut ranges in color from deep chocolate brown to purplish gray or black, with creamy white sapwood. Commercial lumber is often steamed during kiln drying to merge the darker pigment into the sapwood, making it resemble heartwood and increasing its value. European walnuts are typically lighter in color: light brown to gray-brown with irregular streaks of smoky black or brown. Claro walnut varies from light to dark brown. It is often figured and may have colorful swirling grain. All the walnuts may contain curly grain or burls and tend to develop dramatic crotch figure at larger branch junctions.

WORKABILITY

Walnut works smoothly and easily with both power and hand tools. It is

often finished with oil to produce a dark, leathery surface.

TECHNICAL PROPERTIES

The walnuts are medium-density hardwoods, all with a specific gravity around .64 (40 lbs. per cu. ft.). Walnut is strong and stable, and it possesses excellent bending properties. Because it has a coarse texture and large pores, walnut requires filler for a smooth finish. The wood tends to bleach to a yellowish brown color with prolonged exposure to light.

USES

Applications include high-quality furniture, cabinetry, gunstocks, turnings and carvings. Veneers are used for high-grade interior plywood paneling and decorative furnishings.

SIZES

Walnut trees can attain substantial age, height and girth. Planks are usually available in widths of 6 in. to 10 in., though "log run" planks, cut through-and-through, can reach a width of 48 in. Typical lengths are 6 ft. to 12 ft. and primary thicknesses are 4/4, 5/4, 6/4, and 8/4. Thicker 12/4 and 16/4 boards are rare and valuable. The National Hardwood Lumber Association's FAS lumber-grading rules (see AW #28) are less stringent for walnut, allowing more knots and smaller cut sizes than for some other woods.

TOXICITY

Aside from the pungent odor during machining, walnut is not toxic, although some woodworkers report an allergic reaction to contact with the wood. As with any species, a dust mask should be worn during sanding and machining.

SUSTAINABILITY

Walnut trees grow relatively quickly over a wide geographic area. Currently, there is no apparent need to regulate the cutting of walnut, except to recommend cutting only trees larger than 18 in. dia. at chest height.

AVAILABILITY

Walnut is not generally available at local lumber and building-supply centers, but it is extremely popular and widely available through local sawmills and specialty wood dealers.

COST

Wholesale costs for 100 bd. ft. or more range from \$3 to \$5 per bd. ft. depending on grade and quality. "Log run" prices can be much cheaper. Retail prices for FAS lumber range from \$3.50 to \$7 per bd. ft. Unusually thick, wide, or figured stock can cost upwards of \$10 per bd. ft. American black walnut is generally less expensive than Claro or European walnut. ▲

JUST FINISHING



BY MICHAEL DRESDNER

Of all the wood finishes on the market, I can't think of one that is as under-appreciated as shellac. Made from a resin secreted by the tiny *lac* bugs of India and Thailand as a protective coating for their nests, shellac is all-natural, environmentally friendly, fast-drying, clear, glossy, easy to apply and repair, and so completely non-toxic that it's used as a coating on candy and time-release medicines. If someone marketed shellac as a new discovery, it would probably be hailed as a miracle coating.

Pros and Cons of Shellac

Shellac has some very appealing qualities. It dries in under an hour and imparts a beautiful clarity and depth to wood, making it a favorite of turners and musical-instrument makers. Its only smell is that of the solvent, either ethyl or methyl alcohol. And since alcohol will redissolve it, even after many years, shellac is always easy to repair or renew. Because shellac is non-toxic when dry, it is the perfect finish for children's toys and furniture.

Shellac's sealing properties are legendary. It will seal in stains, grease, soot and smoke odors, wood sap streaks, bleeding knots and even silicone oil, while it provides a good barrier against water vapor and oil. Many refinishers use it as a first-coat "safety net" on all stripped pieces, just in case they run into wax or silicone.

Shellac is compatible over and under almost all finishes except urethanes, and it's also ideal under the new water-based coatings, where it improves the appearance of wood by saturating and



Dissolve shellac flakes in alcohol to make a fast-drying, easy-to-apply finish.

SHELLAC

This Miracle Finish is Often Overlooked

toning the wood's natural color. It provides a compatible (and uncontaminated) base to which water-based coatings can adhere, and it even prevents the white spots that often show up when these coatings are put over oil-based stain or filler. Shellac is easy to apply by brush, gun or rag, adheres to almost any surface, and has a long shelf life (up to 10 years) in flake form.

But shellac does have a few weaknesses. Because it redissolves in alcohol, it is not an appropriate finish for bar or tabletops, where drinks may be spilled. It also has a somewhat undeserved reputation for showing water rings easily. This is only a problem if a mixture has been kept on the shelf too long before application. If shellac is applied while it's still fresh, the dry film remains very resistant to moisture. But once you add alcohol to shellac flakes, the mixture begins a deterioration process known as esterification. As this process progresses, the liquid shellac takes longer to dry, forms a more rubbery film, and permits water rings to form more easily. If the shellac is really old, it won't dry at all. Most liquid shellacs should be used within two months of mixing for optimum perfor-

mance. If in doubt about the age of your shellac, test it on scrapwood.

Another minor problem is that in its natural form, shellac contains a wax. Most processed shellac has been dewaxed, but unrefined shellacs still contain this wax, which may appear as a cloudy liquid at the bottom of the jar or can. The wax robs the shellac of some of its clarity and makes it more susceptible to water damage.

Handling Shellac

Shellac is one of the easiest finishing products to deal with, but a few tips will make this user-friendly material even more agreeable:

Storage—Since light, moisture and metal containers may have adverse effects on shellac flakes, you should store the flakes in an opaque plastic or glass container in a cool, dry place. **Mixing**—To mix a three-pound cut or "30-percent-solids"—the standard premixed concentration—add three pounds of shellac flakes to one gallon of ethanol or denatured alcohol. For a smaller amount, use six ounces of flakes (about two cups, loosely packed) to a pint of alcohol. Let the mixture sit in a lidded jar overnight,

JUST FINISHING

and give it a few quick shakes whenever you think of it. By the next day, all the flakes should be dissolved. If there is any residue at the bottom, strain the mixture through cheesecloth to remove it.

Applying Shellac

Shellac is usually brushed on, but it may also be wiped on with a rag or sprayed. In almost every case, I like to dilute the three-pound cut mixture about 50 percent with alcohol before applying it. This allows you to build it slowly and evenly, with good color continuity. Always be sure to stir the shellac before using it.

Brushing—Use a soft natural-bristle brush and work quickly. Ox or hog-hair bristles will do, but I like fitch best. (See AW #26.) Load the brush and flow the shellac slowly and evenly onto the wood. Don't try to rebrush; shellac dries too fast for that. You can use the three-pound-cut mixture for the first coat if you like, since you'll be

sanding it anyway. Use the 50-50 mix for subsequent coats.

Shellac flows better in cold weather because the alcohol evaporates more slowly, so it's best to brush shellac in the cool evening hours, although it isn't mandatory. Wait at least two hours between coats, and scuff-sand only if you need to smooth the surface. Three coats will give you a nice finish. Clean your brushes in alcohol or a mixture of water and ammonia.

Wiping—This is a great way to apply a very thin sealer coat prior to a brushed or sprayed coat, and it also makes a good base coat for a French-polish finish, if you are so inclined. (For more on French polishing with shellac, see AW #7, Mar/Apr 1989.) You'll need two clean cotton rags to wipe on the shellac. Make a pad from one of the rags, dip it in the 50-50 shellac mixture, and flood it onto a small area of the raw wood. Then immediately wipe off any excess with the other rag. You should wear a pair of rubber gloves to protect your hands

from the alcohol in the mixture.

Spraying—This is my least favorite way to apply shellac because you have to apply more coats to get the same build you'd get with a brush. Here again you should use a 50-50 mixture of three-pound cut and alcohol, and spray four coats at least one hour apart. ▲

SOURCES

Shellac flakes, alcohol and brushes are available from:

GARRETT WADE CO., 161 Ave. of the Americas, New York, NY 10013, (800) 221-2942. CIRCLE #619
WOODFINISHING ENTERPRISES, 1729 N. 68th St., Wauwatosa, WI 53213, (414) 774-1724. CIRCLE #620
WOODWORKER'S SUPPLY, INC., 1125 Jay Lane, Graham, NC 27253, (800) 645-9292. CIRCLE #621

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 Cambridge, Ont. N1R 5V5
 1-800-265-8612 Fax 519-621-3442

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CIRCLE NO. 89 ON PRODUCT INFORMATION FORM

TOOL BOX



Deep Throat ▲

Add Mastadon Jaw Extenders to your ordinary pipe clamps and you'll have a tool with an 8-in. clamp reach, more than four times the reach of normal clamps. The aluminum extenders slip over regular 3/4-in. pipe clamps, and they weigh only 2 lbs. The ends of the

jaws have swiveling pads to clamp angular or tilted surfaces. They'll also accept the

plastic protectors made to fit regular pipe clamp jaws. (Price: \$29.95 per pair)

Wade Manufacturing Co., Dept. AWT, Box 23666, Portland, OR 97281-3666, (503) 692-9027.

CIRCLE #622 ON PRODUCT INFORMATION FORM

Substantial Square

Here's an industrial-strength aluminum combination square with the heft and length for big jobs. You can square and mark large panels and cabinets with it, or use its I-beam blade as a rigid cutting guide for saws and routers. It is available in 24, 36 or 60-in. lengths and the head comes in a quick-release trigger-lock version or with a standard thumb-screw lock. An optional protractor head fits on the blade with a cam lock for marking and measuring angles from 0° to 90°. (Price: trigger-lock head and 36-in. rule \$120; optional protractor head alone, \$140)

Hudson Valley Metal Works, Inc., Dept. AWT, Box 2755, Newburgh, NY 12550, (914) 565-3525.

CIRCLE #624



Cool Sandpaper ▲

This new Dust Ejecting Sandpaper runs cooler and lasts longer without clogging than ordinary sandpaper. The secret is the wave-shaped channels in the aluminum-oxide abrasive surface. They carry dust out to the edge, where it's dispelled.

Made by Elefant Abrasives, a 100-year-old German company, the heavy "E"-weight sandpaper is available in rolls, belts, disks (plain, pressure-sensi-



Iron Grip in a Soft Glove ▲

If you're worried that the sharp jaws of your pliers will damage wood, soft metals or plastic, slip on a pair of Pli-Boots. These plastic pads cushion the pliers' jaws so you can grip finished surfaces without marring, and they resist puncturing and most solvents. They're available at most home centers and hardware stores. (Price: package of six \$3.95)

Pli-Boots, Inc., Dept. AWT, Box 365, Bulverde, TX 78163, (210) 979-6621.

CIRCLE #623 ON PRODUCT INFORMATION FORM

tive or Velcro), and cut sheets from 24 grit to 220 grit. The company will cut hole patterns in the paper to match the dust collection ports of your sander at no extra charge. (Price: 5-in. pressure-sensitive disc 30 cents ea.; 3-in.-by-21-in. belt \$1.14 ea.; 4 1/2-in.-by-11-in. half-sheet 25 cents ea.)

Elefant Abrasives, Inc., Dept. AWT, 4460 38th St. So., St. Petersburg, FL 33711, (800) 753-5582.

CIRCLE #625 ON PRODUCT INFORMATION FORM

Truck-Bed Stretcher ▶

Carrying extra-long boards in your pickup truck is a breeze with the Extend-It rack. The rack's tubular steel arms nearly double the effective length of the truck bed, so you can easily support boards up to 14 ft. long, with as much as 250 lbs. beyond the truck's bed. The rack assembles in a minute and attaches to the rear of your truck's bed. When not in use, the three-piece rack folds into a convenient 2-in. by 3-in. by 60-in.

package for storage in the truck bed. (Price: \$129)

Construction Accessories Co., Dept. AWT, Box 123, Cambridge, MA 02140, (617) 354-0923. CIRCLE #626





Panel Saw Kit ▲

It's a pain to crosscut 4-ft. by 8-ft. sheet stock on a tablesaw. Outfeed tables help, but they take up lots of floor space. If shop space is tight, a panel saw's the solution.

Commercial panel saws start at \$850. The Saw Trax Panel Saw Kit converts your circular saw to a panel saw for a lot less. (You can also mount a router.) The saw carriage rides on chromed-steel guiderails for crosscutting only. An optional rip carriage costs an extra \$110.

The Saw Trax 68 (\$299.95) cross-cuts 4-ft. by 8-ft. sheets (53 in. maximum width) and the Saw Trax 80 (\$329.95) cuts 5-ft. by 10-ft. sheets (65 in. maximum width).

The kit includes carriage assembly, guide rails, hardware and instructions. Saw, backboard and fence along bottom edge not included.

Tinkerdell, Inc., Dept. AWT, Box 1170, Kinnesaw, GA 30144, (404) 424-3046.

CIRCLE #627 ON PRODUCT INFORMATION FORM

One-Hand Clamping ▼

Jorgensen's new E-Z Hold bar clamps let you adjust and tighten a clamp with just one hand, leaving your other hand free to align the work. The trick is a small lever attached to the movable jaw. Squeezing the lever advances the jaw in increments of about 1/2 in. When the jaws have moved enough to grip the work, you tighten the screw to



exert full clamping pressure.

The clamps are available in six sizes with clamping capacities from 6 in. to 36 in. You can also buy an E-Z Hold adaptor kit to convert your old bar clamps for one-handed tightening. (Price: 18-in. clamp \$21.96; adaptor kit \$6.55)

Adjustable Clamp Co., Dept. AWT, 417 N. Ashland Ave., Chicago, IL 60622-6397, (312) 666-0640.

CIRCLE #628 ON PRODUCT INFORMATION FORM



IMPORTS, INC.

QUICK-CHANGE ARTIST!

These Grizzly sanders have a convenient quick-release lever that makes belt changes and proper tension a snap. If you do plenty of sanding and need to change belts frequently, this is one feature you can't do without. *Remember, this is another Grizzly exclusive - you check!*



BELTS & DISCS AVAILABLE!

MODEL G1014 ONLY \$195⁰⁰

F.O.B. BELLINGHAM, WA or WILLIAMSPORT, PA

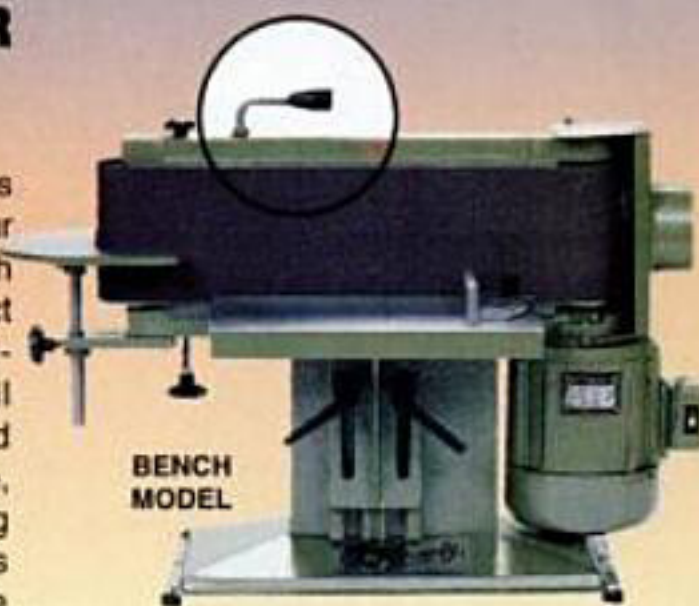
COMBINATION BELT/DISC SANDER



This sander's size, quality and price make it an excellent value for the medium-to-heavy duty workshop. Features a powerful 3/4 HP, single phase motor and shielded bearings on both belt rollers. It is heavily constructed with a cast iron body and an all-steel stand. The surface ground cast iron table tilts 45° and has a handy miter gauge. Weighs 125 lbs.

EDGE SANDER 6" X 17"

This edge sander offers many of the features of our larger version, in a much smaller space. It's perfect for the serious woodworker or the small cabinet shop. It's powered by a 3/4 HP, single phase, 110/220V motor. Turning at 1750 RPM, it develops of 2300 FPM. The 7" x 13-3/4" cast iron table adjusts 4-1/2" vertically and has a fixed-point miter gauge. The bed size is 17". Shipping weight is 132 lbs. Belts in stock.



BENCH MODEL

MODEL G1072 ONLY \$225⁰⁰

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1-800-523-4777

CIRCLE NO. 23 ON PRODUCT INFORMATION FORM

GALLERY

◀ Linen cabinet by Gregg Zall, Sebastopol, California. Douglas fir, doussié, basswood, cedar. Dimensions: H: 53 in., W: 25 in., D: 12 in.



SHAWN SPRAGUE



JON ALLEY



▲ "Looking Back" writing desk by Jon Alley, Churchville, Pennsylvania. Maple, mahogany, applewood, vermillion (purpleheart), gold leaf. Dimensions: H: 49 in., L: 38 in., D: 19 in.

▼ Mirror by Roger Howard Smith, New South Wales, Australia. Australian cedar. Dimensions: H: 32 in., W: 24 in., D: 2½ in.



ROGER SMITH

▲ End table by Carter Sio, Newtown, Pennsylvania. Rosewood veneer, marble, MDF. Dimensions: H: 18 in., L: 18 in., W: 18 in.

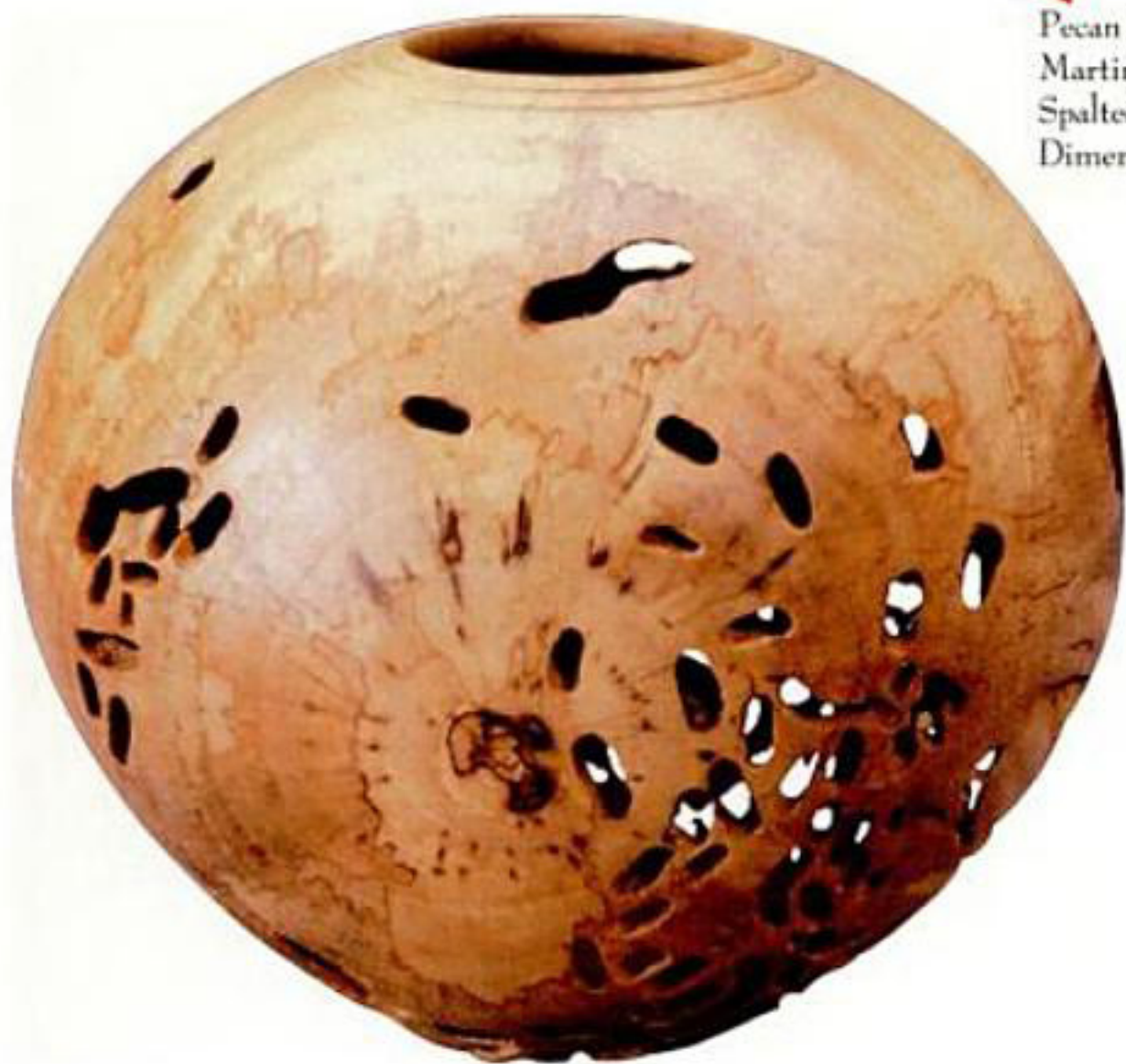


DAVID DIMICKO

▼ "Indian Bowl" by John I. Timby, Deming, New Mexico. Bloodwood, purple heart, maple, wenge. Dimensions: H: 7½ in., Dia: 8 in.



JOHN TIMBY



▲ Pecan hollow form by Terry Martin, Queensland, Australia. Spalted and grub-eaten pecan. Dimensions: Dia: 10 in.



▲ Model truck by John Smith, British Columbia, Canada. Walnut, maple, cherry, mahogany, brass. Dimensions: H: 11 1/2 in., W: 12 1/2 in., L: 33 in.



Want to see your work in "Gallery?" Send color slides or color transparencies to "Gallery," AMERICAN WOODWORKER, 33 E. Minor St., Emmaus, PA 18098. Please include: materials, dimensions, name of photographer, your name, address, and phone number. We'll pay you \$25 if we publish your work. If you want your photos returned, enclose a self-addressed stamped envelope.

▲ "Bird Cabinet" by Gregg Zall, Sebastopol, California. European cherry, nutmeg, maple, chantiqueero (a Peruvian hardwood). Dimensions: H: 40 in., W: 12 in., D: 10 in.



JESS SHIRLEY

FINAL PASS

Beware the Patent Pirates

Like most woodworkers, at one time or another you've probably dreamed of hitting it rich by patenting and marketing some clever woodworking gadget. But beware: it's an endeavor fraught with problems, not the least of which is protecting your idea from patent pirates.

John Cantlin learned this lesson the hard way last year when he found himself in court battling Taiwanese knockoffs of his MULTI-STOP, an adjustable stop for woodworking machines. Cantlin had to hire a patent attorney and fight for



A patent doesn't guarantee protection from knock-offs, as John Cantlin, inventor of the MULTI-STOP, above, has learned.

more than a year before the U.S. International Trade Commission ordered the imitators to stop. While the suit was going on, the knock-offs depressed sales of the original MULTI-STOP by as much as 50 percent, said Cantlin.

Unauthorized knockoffs have long been a problem for inventors and entrepreneurs. The International Trade Commission handles about a dozen cases each year, and Cantlin says he's heard from several woodworking inventors who've been in situations similar to his. His advice to would-be inventors? "You just better have a good patent, and you better be willing to fight" to defend it.

Furniture from the Pen

Dennis McMillan has gone to jail. No, the Santa Fe-based furniture designer and manufacturer isn't doing time. He's set up a woodworking shop at the New Mexico State penitentiary, south of Santa Fe, and is training inmates to produce his line of Southwestern and country furniture.

McMillan pays the inmates minimally for their work—state law sets wages at 30 cents to 90 cents per hour—and then buys the finished furniture from the prison. But the prisoners aren't being shortchanged. They're learning to build quality furniture to exacting standards, training that should help them get jobs when they're released.

McMillan's access to cheap labor initially alarmed other Southwestern furniture makers, who feared they would not be able to compete. So far, however, that has not become a problem. After one year he is busy filling orders, but production has been affected by the high turnover of prisoners, who are moved to other facilities or else released. Whether the business will prove profitable enough for McMillan is unclear. If it does, he'll gladly do more time in jail.

Sally Eauclore

Got Any Good Jokes?

Heard the one about the woodworker and the virgin redwood? Well, we won't get into that one, but if you've got any (printable) jokes or humorous true stories about woodworking, send them in. We'll pick the best and run a tribute to the lighter side of woodworking in a future issue. You can FAX jokes or cartoons to AMERICAN WOODWORKER at 215-967-8956, or write us at 33 E. Minor St., Emmaus, PA 18098.



Made of hand-carved mahogany, this bed really is as hard as a board.

Talk About Making Your Bed!

Remember how as a kid you parked your gum on the bedpost overnight? Well, here's a bed you'd never dare mar with your Double Bubble.

This imposing four-poster's soft, draping fabric is actually made of solid mahogany. And so are the canopy, headboard, and rope tassels.

Hand-carved by New York City furniture maker and restorer Joseph Biunno, the bed is finished with antique-white paint and 23-karat gold leaf details. One minor point—which you'll appreciate when it's time to turn in—the mattress is real, not wood.

Nancy Wallace Humes

If you have a news item, anecdote or opinion you think belongs in "Final Pass," send it to American Woodworker, 33 E. Minor St., Emmaus, PA 18098.

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- Six Projects for the Holidays
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