

SPECIAL ROUTER ISSUE

RODALE'S

AMERICAN WOODWORKER

AUGUST 1993 #33

30 PLUNGE ROUTERS RATED

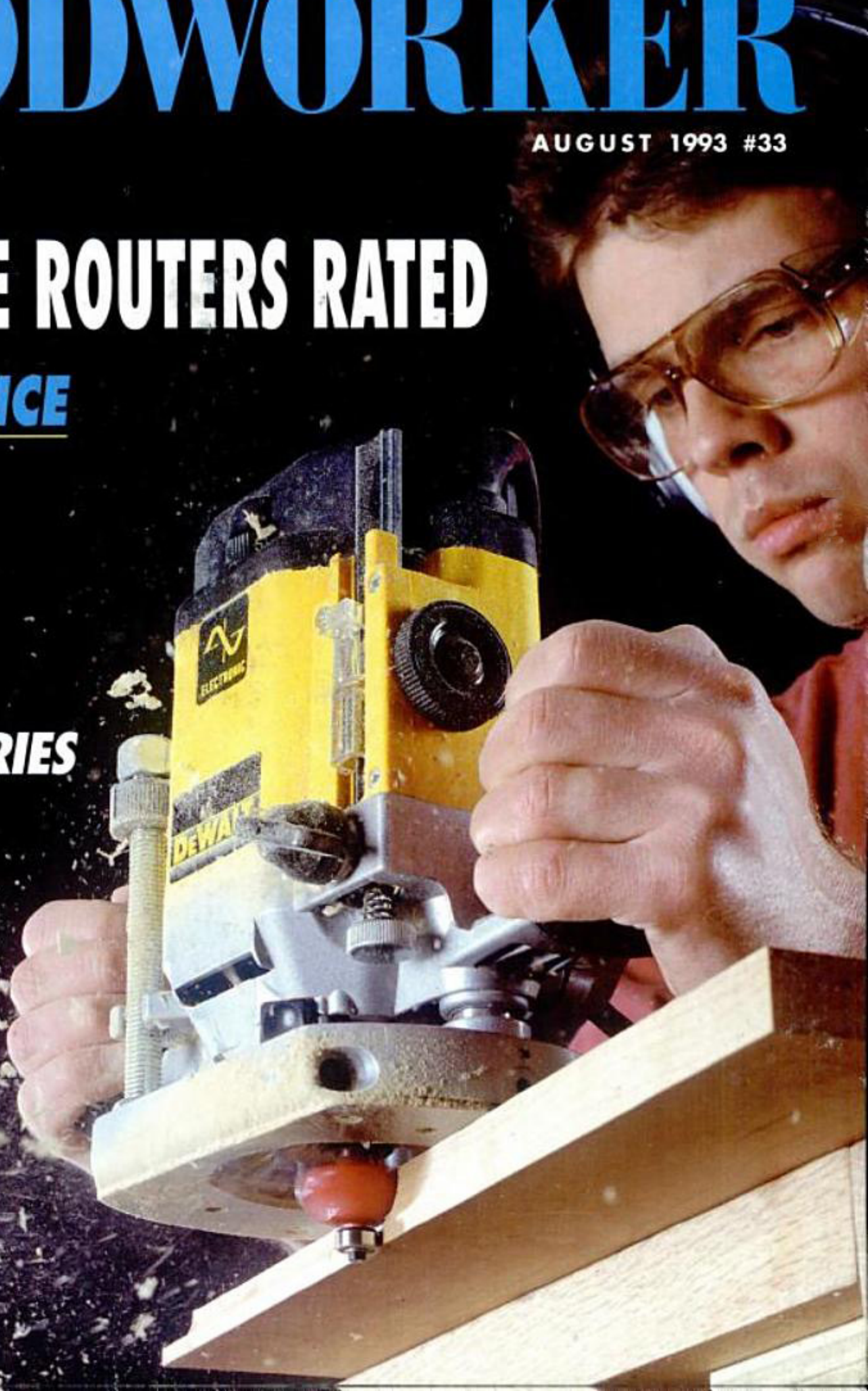
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A WORD FROM THE EDITOR



ROUTER REVOLUTION

Routers. Not since the Shakers invented the circular saw blade back in the early 1800s has a tool caused such a sweeping change in the way woodworkers work. Overnight, the router replaced an entire toolbox full of specialty planes: molding planes, router planes, sash planes, panel raisers and dozens of others. The router's impact is so significant that we devoted a large chunk of space in this issue to routers and their accessories.

On page 36, you'll find our review of 30 plunge routers—every model we could round up for the test. It's the most comprehensive product test ever at *AMERICAN WOODWORKER*—or any other woodworking magazine for that matter.

For three days, editors Ellis Valentine, Kevin Ireland, Dave Sellers and I joined forces with Fred Matlack and Phil Gehret in the *AW* shop. We represent a good cross-section of woodworkers: short guys, tall guys, big hands, small hands, production woodworkers and hobbyists. We put each of the 30 routers through its paces and discussed what we liked and disliked about each machine, making side-by-side comparisons of the features. We rated the routers based on our observations and voted to come

up with our picks for "Editors' Choice." (See page 40.)

After that, we spent more than a month testing the routers on a *dynamometer*, measuring torque, rpm and current draw at different loads in order to chart a power curve for each router. Our equipment and our results were evaluated by engineers Robert Flower and Tom Gavigan to make sure that our methodology was on target. We found that horsepower ratings aren't a reliable guide to the amount of work a router can do.

So check out the results in this issue. You'll also find info on the new anti-kickback router bits—the latest router-bit technology to come out of Europe. (See page 53.)

If you're not into routers, don't despair, we haven't forgotten you. You'll also find a couple of articles on hand tools (including some from the 1500s!) plus the usual good mix of woodworking info and ideas you've come to expect from *AW*.

And if you haven't already done so, be sure to enter your best work in our **1993 Excellence in Craftsmanship Awards**. The deadline for entries is September 1, 1993. See page 19 for details.

David Sloan
Editor and Publisher

AMERICAN WOODWORKER

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LETTERS

Handling Hazardous Waste

I agree with your article on hazardous waste (Just Finishing, AW #32) with the exception of allowing the vapors of hydrocarbon [solvent-based] stains, varnishes, etc. to "just evaporate away." If you tasted the air out here in the Los Angeles Basin you would appreciate the reasons. In general, the release of these materials adds a tremendous amount of smog to an already polluted area. If it was one or two people that's one thing. But when you think of the 40,000 to 60,000 refinishers and painters, not to mention a couple of million "weekend warriors" such as myself, this is a significant amount of vapor.

A quick suggestion: Be it water-based or oil-based, pour off all your excess varnishes, thinners, paints, etc. into a 5-gallon sealable container. When full, take it to a hazardous waste center or county hazardous materials center.

Bruce White
Huntington Beach, CA

A hazardous waste collection center is your best choice for solvent disposal but many communities don't have one. The next best solution is to allow the solvents to evaporate outdoors and dispose of the solids in the trash. We don't recommend mixing odd solvents together.

Go for the Gustav!

It was a nice surprise to see an Arts & Crafts cabinet in issue #32. Personally, I'd like to see more furniture from this turn-of-the-century style—maybe a regular feature.

Paul Lasicki
Warwick, NY

We've got a few more Arts & Crafts gems in the works. Stay tuned.

Figure in Design

Monroe Robinson's article, "Wood Figure in Design" (AW #32) really drove

Disabled Woodworkers

If you're a disabled woodworker who has altered your shop or tools to make them easier to use, we'd like to hear from you. Please write to: Kevin Ireland, AMERICAN WOODWORKER, 33 E. Minor St., Emmaus, PA 18098.

home the point that wood figure can make or break a design. As a juror for regional craft shows I've seen lots of otherwise well-designed furniture that just didn't cut it because the maker paid no attention to the effect of the wood on the overall piece. Red oak, in particular, is so often abused in furniture. The bold, coarse-grained figure of oak works well on large-scale pieces but can easily overwhelm a smaller piece. To use oak effectively, the maker needs to consider the visual effect of the grain and make sure it harmonizes with the lines of the piece. I find it helpful to sketch in the wood figure when I'm sketching furniture design ideas.

Lyle Warzinski
Athens, OH

Frame and Panel Tips

As a professional, I have made several thousand raised [panel] doors using mortise and tenon joinery, and I have to disagree with [some] advice offered in the article, "Frame and Panel Basics" (AW #31).

1. The old one-third rule for determining tenon thickness produces undersize

Correction

Last issue's Final Pass story about Timbrex contained an incorrect telephone number. For information about this composite timber made from plastic and wood, call (800) 972-5355.

tenons. I recommend using $\frac{3}{8}$ -in.-thick tenons for $\frac{3}{4}$ -in. stock.

2. Cut the outside curve of the top rail *after* the door is glued up. This saves time and will result in a smoother curve.

3. I always run the grooves in the stiles and rails before doing any joinery. This helps guide the chisel while mortising and ensures the rails and stiles end up in the same plane when assembled.

4. The best way I have found to raise a panel is with a raised panel plane. These are still available and give the glass smoothness and crispness that only planing can give to wood.

David Kenney
Middlesex, VT

Saw's Faster Than Fingers

Re: "Saw Guards Aren't the Key to Safety" (Letters, AW #32). I once read a saw blade formula something like this:

If you use a 10-in. blade
with 60 teeth
running at 3450 rpm

2043 teeth will pass
through your hand before
you can move it.

This goes through my mind each time I start to turn on a saw.

Max Olson
Abilene, TX

Hand Tool Projects

When will woodworking magazines [publish] projects to be done with only hand tools? Is there no one out there still interested in doing projects by hand and enjoying what the hand can do?

Paul Myszak
Bellaire, MI

We cover hand tool techniques in every issue, Paul, and you can tackle most any project completely by hand if you choose. Most woodworkers we know of rely on power tools for grunt work like sawing and thicknessing and reserve

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LETTERS

band tools for finish work where the touch of a human hand really shows.

Don't Clean Those Bearings

Re: "Cleaning Gummy Bits and Blades" (Tech Tips, AW #31). Woodworkers should be cautioned to remove any ball bearing pilots before cleaning router bits. Oven cleaner or ammonia will likely penetrate the bearing seals and cause bearing failure.

Dick Dietrich
Portland, OR

How About Tool Ratings?

Would you please include a simple rating scale when evaluating tools? With the "Buyer's Guide to Sliding Compound Miter Saws" (AW #31) you could have included projected durability, accuracy, sliding action, electronic brake, etc. To be fair to the manufacturers, I know this

is difficult, but it may assist the consumer when making a choice.

Douglas J. Walkner
Milwaukee, WI

We're working on it. See "Buyer's Guide to Plunge Routers" in this issue for the results.

No "E" in Silicon

Re: "Rust on Machines" (Q&A, AW #32). You state that silicone carbide paper is a "friendly" type of silicone. Surely you mean silicon carbide paper. Or, just maybe, there is a new kind of sandpaper that hasn't made its way to Texas yet. That is a possibility since some people go west from California to get to Texas. (It does take longer that way.)

John McDaniel
Leander, TX

More Workshop Solutions

How about an article on other woodworkers? How they laid out their shops, work space, heating, lighting, storage, etc. Having no permanent work space available now (I rent), I'd like to see other shops as an "idea getter" for mine.

Bob Eaton
DeLavan, WI

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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Q & A

Making Period Profiles

Q *I've been commissioned to re-create some 18th century interior paneling but can't find router or shaper cutters that match some of the original profiles. Is there some way to reshape stock cutters to match?*

Robert J. Hall
Mill Valley, AZ

A The paneling you are re-creating was originally cut by hand using wooden molding planes and the panels were raised with a specialty plane known as a panel raiser. I suggest you do the same: It is very fast and remains a viable alternative to having custom-ground cutters made to your specifications. The trick is to find the planes, but you have several options.

First, you can buy old planes. There are numerous antique tool dealers around the country who sell by mail. Here are two: Tom Witts, Box 399, Matawan, MI 49071, (616) 668-4161; Roger K. Smith, Box 177, Athol, MS 01331, (508) 249-5990.

Another option is to have a new plane made for you. Several people, including Stuart Worthing (32 Payne Rd., York, ME 03909, 207-439-5486) will make custom reproduction planes as long as you provide them with a tracing of the profiles you want (an actual sample of the molding is better). Finally, you can make your own planes. If you do so I recommend examining some old planes to get an idea how the old-timers did it.

If you'd rather stick with your power tools, Eric Hollenbeck (Blue Ox Millworks, Eureka, CA 95501, 800-248-4259) will free-hand grind shaper knives to any profile you want.

Michael Dunbar
Windsor-chair maker
Portsmouth, NH

Junking Cordless Drills

Q *The built-in battery on my cordless Ryobi screwdriver finally gave up the ghost. The motor*

and switch are still fine so I hate to throw the tool out just because the battery is shot. Is it possible to replace the battery on tools like this?

Kevin Matthews
Portsmouth, OR

A Ryobi's customer service department says cordless tools with internal batteries are not designed to be consumer serviced. And if you return them to the factory for battery replacement, labor and shipping charges are likely to add up to more than the cost of a new tool. Sounds like it's best to just throw the screwdriver away.

Simon Watts
West Coast editor

Valuing Antique Tools

Q *I recently inherited a chestful of hand tools, most of them Stanley. Are there any books on old tools that would help me establish their market value?*

Arthur E. Boyers
Topeka, KS

A Since most of the tools in your chest are made by Stanley I recommend you check John Walter's *Antique and Collectible Stanley Tools, a Guide to Identity and Value*. As for the remaining tools and the tool chest itself (which may also have value), I have co-authored two books that will help answer your questions. The first, *Collecting Antique Tools* by Kean & Pollak, describes more than 700 tools, and discusses how to buy and sell them. A companion volume, *A Price Guide to Antique Tools*, gives the current market value for the tools in the first book, plus several hundred additional tools.

All three of the books are available from Astragal Press, Box 239, Mendham, NJ 07945.

Emil Pollak
Author and tool collector
Mendham, NJ

To Wipe or Not To Wipe

Q *Please settle an argument. I've always removed glue squeeze-out by wiping off the excess with a damp rag. My shopmate says this smears glue into the pores of the wood and spoils the finish. His method is to let the glue dry and scrape it off with a chisel. Who's right?*

Dale Young
Woburn, MA

A In most situations, a damp rag works fine to remove squeeze-out, but you have to use care when wiping or you can ruin the project. I use a succession of *clean* rags and dip them in *clean* water contained in a clean bucket. To wipe off excess glue, I start with a fairly wet rag to dilute the glue. After scrubbing the joint I put the rag aside (not back in the container) and take another clean one. After dipping it in the bucket I wring it out until it's damp—not wet—and continue scrubbing the area. I keep this up until the glue is gone.

Squeeze-out often occurs at joints where long grain meets cross grain—like the joints in a frame and panel door. You're forced to wipe across the grain at these spots, making it harder to remove the glue. To eliminate tell-tale glue shadows at these points, use your final clean rag to "feather out" any dampness into the surrounding area.

When you can't get to the glue because clamps are in the way, wait until the glue has set, remove the clamps, and immediately scrape off the glue while it's still pliable. Waiting until it hardens before scraping can result in tearing out some of the wood.

Wally Kunkel
Furniture maker
Hackettstown, NJ

Burning the Steel

Q *Every time I grind a plane iron or a chisel on my high-speed grinder I burn the edge. I'm*

Q & A

using a white, 100-grit aluminum-oxide wheel and a very light touch. I cool the tool in water after each quick pass. I've dressed the wheel with a diamond dresser. What am I doing wrong?

George Vadorski
Sequim, WA

A You are doing most things right. But your problem may be caused by the grit and grade of your aluminum oxide grinding wheel. "Grade" refers to the strength of the bonding agent that cements the grains together. Grades A-H are considered soft; I-P are medium, and Q-Z are rated hard. For this type of grinding a wheel that is both coarser and softer than the one you're using will generate less heat. Try 60 grit, and for a 3,500 rpm grinder use an "H" grade wheel. For a 1,750 rpm grinder an "L" or "M" grade is standard. The slower speed grinders are a better choice for woodworkers.

Norton Abrasive (800-543-4335) or

another grinding wheel manufacturer will provide advice and also a local supplier that carries their products—or check the Yellow Pages under "Abrasives." Catalog sales companies also carry a variety of grinding wheels.

John Grew-Sheridan
Grew-Sheridan Studios
San Francisco, CA

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WHERE TO FIND IT

Variable-speed motor controls (for AC/DC universal motors up to 3 HP) are available from Trend-lines, 375 Beachem St., Chelsea, MA 01250, (800) 767-9999.

Non-ferrous nails, carriage bolts, machine screws, wood screws, hangar bolts, lag screws and rivets (made from stainless steel, bronze, brass and copper) are available from Jamestown Distributors, 28 Narragansett Ave., Jamestown, RI 02835, (800) 423-0030.

Pintles, turnbuckles, gudgeons and shackles are available from Doc Freeman's, 999 N. Northlake Way, Seattle, WA 98103, (800) 247-2149.

Bandsaw tires in 10 in. to 42 in. diameters are available from Carter Products Co. Inc., 437 Spring St. NE, Grand Rapids, MI 49503, (616) 451-2928.

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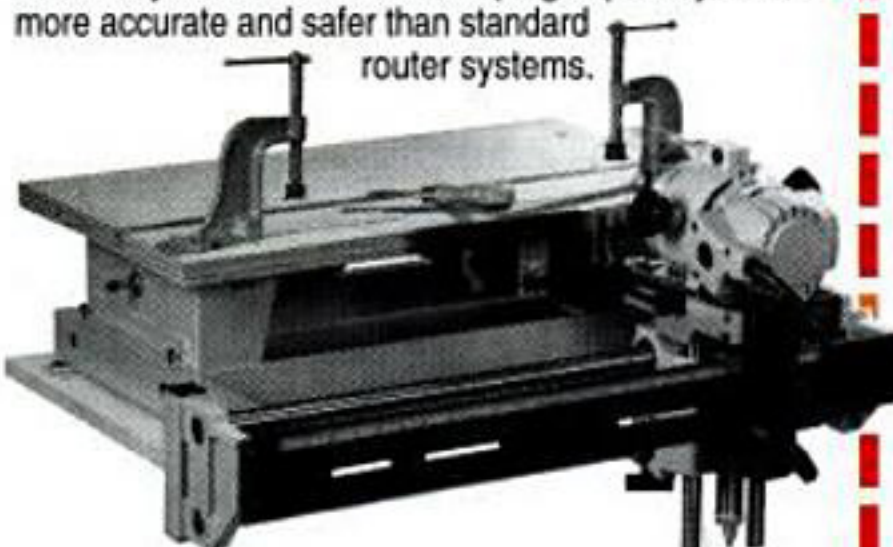
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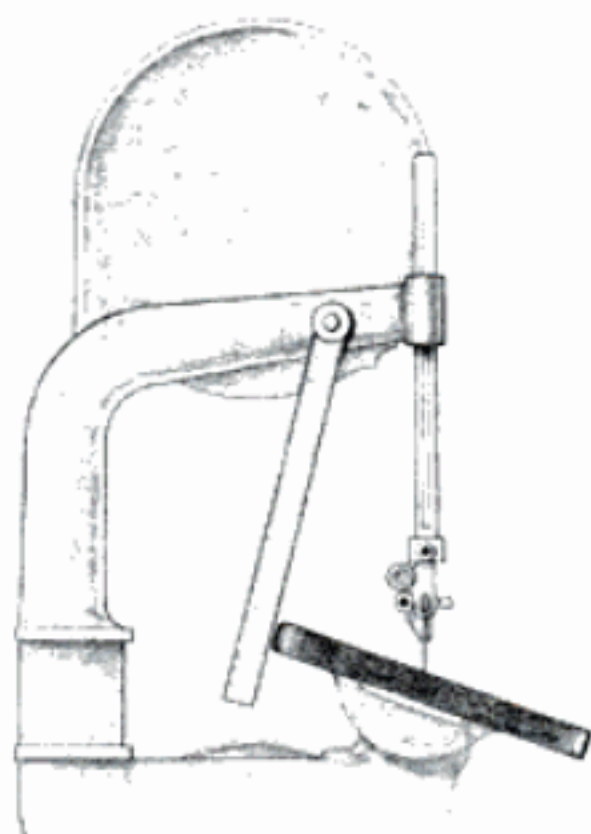
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TECH TIPS



Tilting the Bandsaw Table

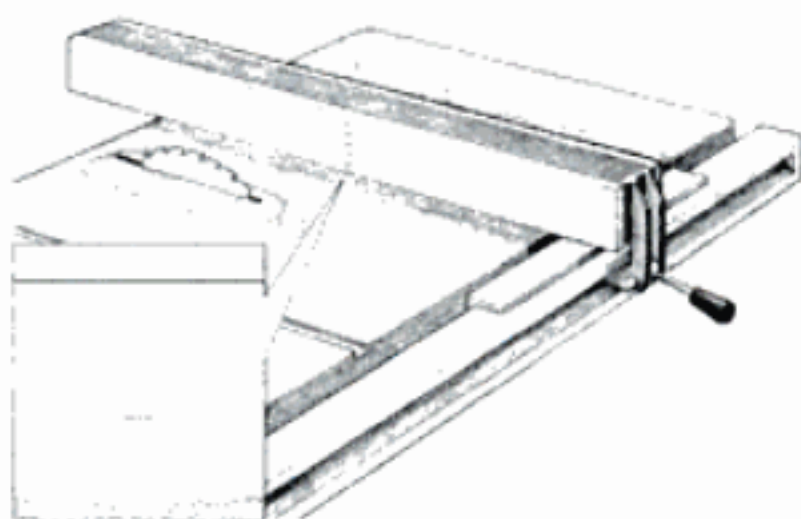
The tilting angle scale on most bandsaw tables is too small to read with any accuracy, so it's hard to make fine adjustments or re-establish an angle precisely. I attached a steel rule to the frame of the bandsaw as shown and can now make fine adjustments to the angle of tilt by reading the position of the table in relation to the rule. I can also re-establish any given angle by noting the distance on the scale or by attaching a piece of tape to its surface.

John Timby
Deming, NM

Blade-Height Scale

I had this idea for marking a scale on the side of a tablesaw fence so I can set the saw blade at the exact height I want. So, I mark my fence with a knife in inches. I also marked the other side of the fence so I can set the height of my router bit when I mount my router on that side of the table.

Yeung Chan
Millbrae, CA

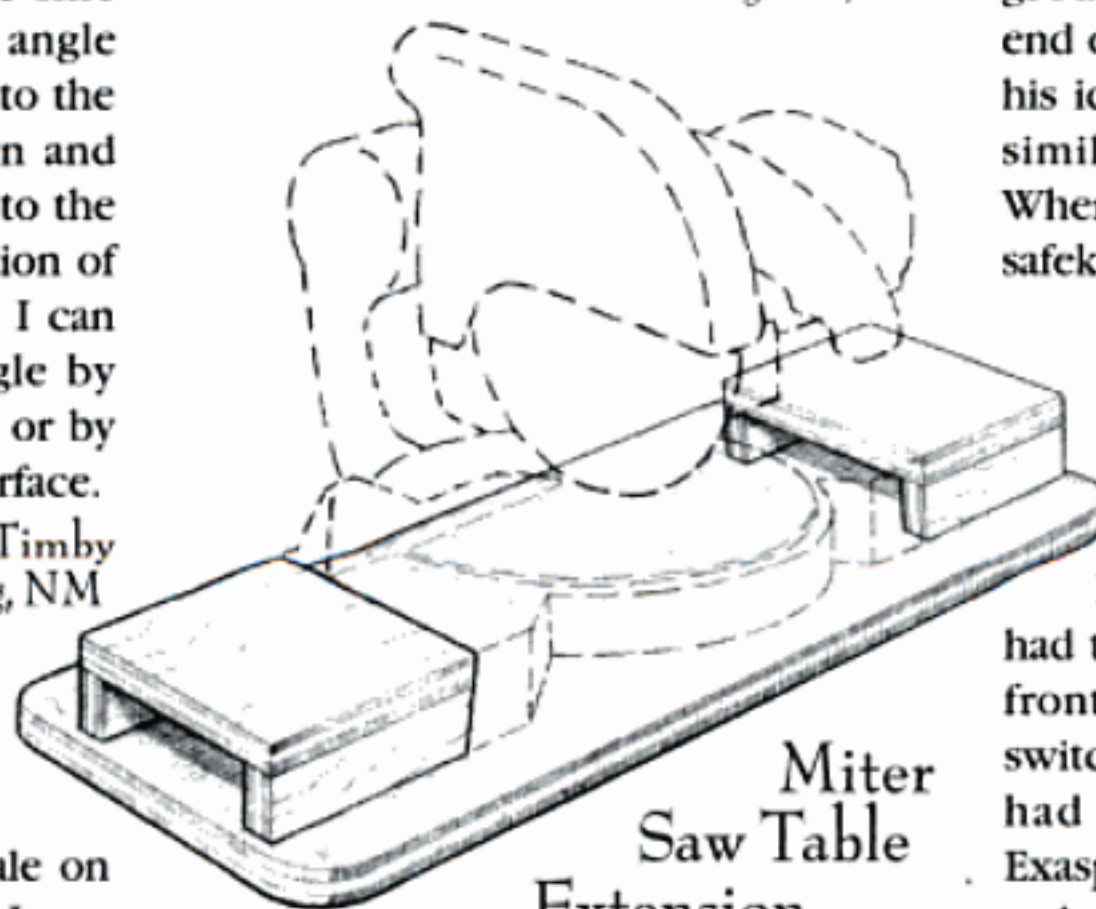


Shelf Support Holes

A fast, accurate method of drilling matching holes for adjustable shelves is to use a strip of Peg-Board. These holes are spaced on $\frac{1}{2}$ -in. centers so you may have to skip one or more holes to get the spacing you want.

To avoid drilling in the wrong holes while thinking about tonight's dinner, run a strip of masking tape over the holes and circle the ones you plan to drill with a felt-tipped pen. When through with that set-up, pull off the tape.

Larry Humes
Bellingham, WA



Miter Saw Table Extension

I like the portability of compound miter saws but find the base too small to conveniently crosscut long stock. Extending the base by adding tables on either side of the saw blade greatly improves its usefulness. I made my extension table base out of $\frac{3}{4}$ -in. plywood, bolted the saw in place, then fitted the two side tables. The illustration is for an 8-in. Delta saw but the same idea would work for other brands. Incidentally, the saw doesn't have to be centered: you may want to make the left side table longer (or shorter) than the right. If you keep the overall length to 28 in. you can still carry the whole assembly sideways through doorways.

Charles L. Alden
Burlington, NC



Eternal Scribe

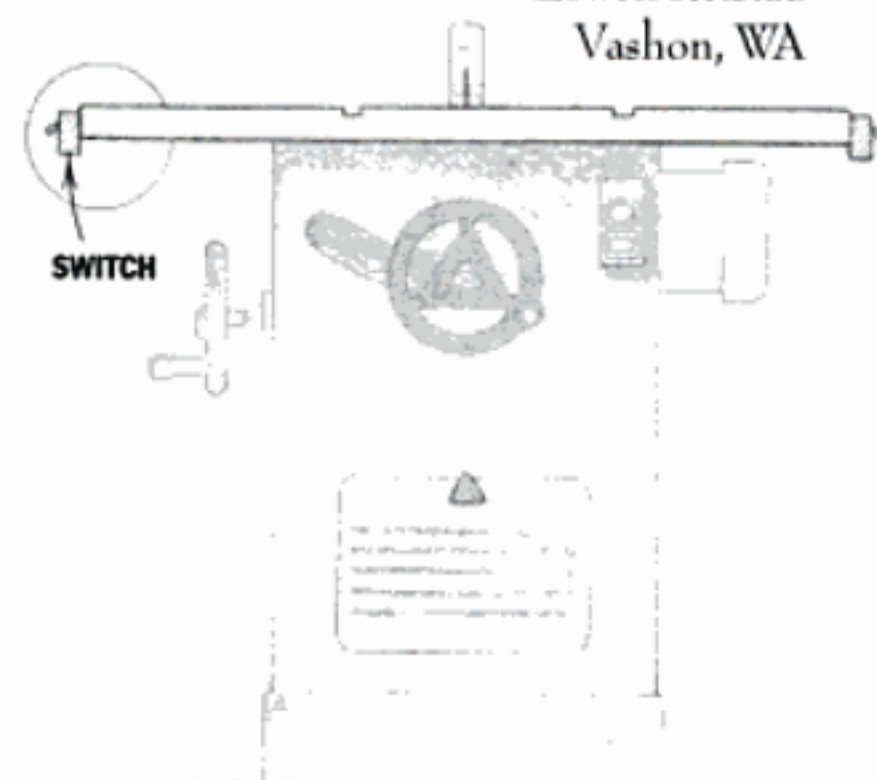
Years ago I worked with an old pattern maker who was never without his "scribe." This was just a draftsman's mechanical pencil with the lead replaced by a $\frac{3}{32}$ -in. drill bit. He had ground a sharp point on the chuck end of the bit for scribing lines. I liked his idea so much that I always have a similar scribe in my apron pocket. When not in use I retract the point for safekeeping.

Craig Bentzley
Chalfont, PA

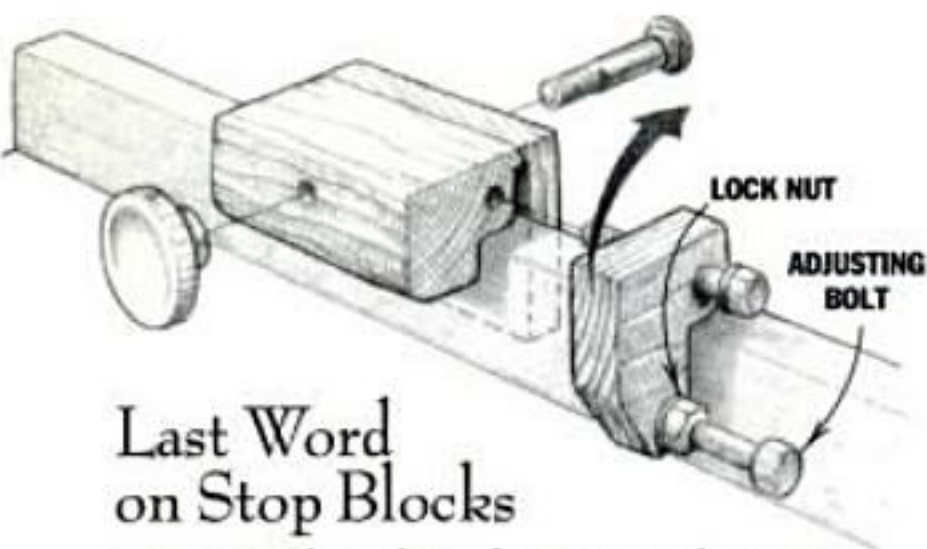
No-Grope Switches

Because my 10-in. carpenter's saw had the on/off switch mounted on the front of the base, I couldn't see the switch when cutting large stock and I had to blindly feel around for it. Exasperated, I mounted two, two-way switches, either side of the table, just below the surface. Now I can shut the saw off, with either hand, without having to grope around for a switch.

Lowell Reistad
Vashon, WA



TECH TIPS



Last Word on Stop Blocks

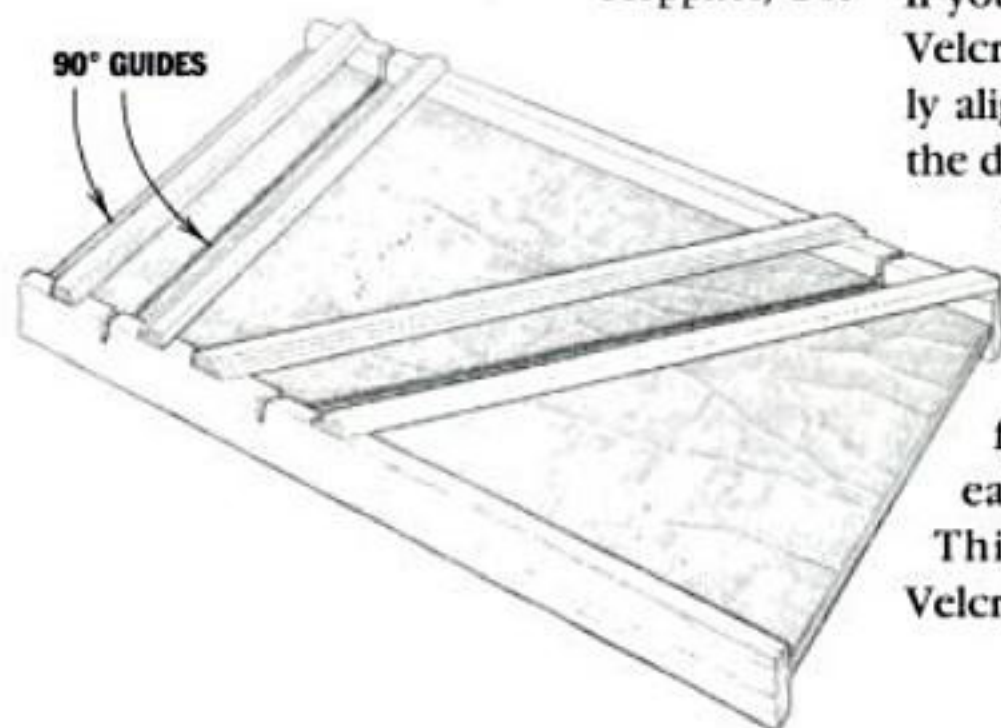
Everyone has their favorite style stop block. Here's mine. Slacking the large knob lets you move the block along your fence, while turning the machine bolt on the bottom of the stop fine-tunes adjustments. To give me greater control over adjustments, I drilled a $\frac{1}{16}$ -in. hole for the adjusting bolt and then cut threads directly in the wood with a $\frac{3}{8}$ -in. x 16 tap. That way, one full turn of the stop bolt equals $\frac{1}{16}$ in. and a quarter turn $\frac{1}{64}$ in. Using a hard, dense wood such as maple or walnut you'll never have a problem with stripped threads. You may wish to make a left-handed version or add a second flip-up block to the one illustrated. You could then use it either side of the saw.

Eugene Paules
Shelton, CT

More on Skilsaw Cut-Off Jig

I made Bruce Levine's dandy jig ("Tech Tips," AW #29) with the same size base, 24 in. by 48 in. Then I realized that if I moved the 90° guides down to the end of the base there was room enough for 45° guides as well. Left-handers can make 45° cuts from the near side of the jig, as it appears in the drawing. Right-handers work from the far side.

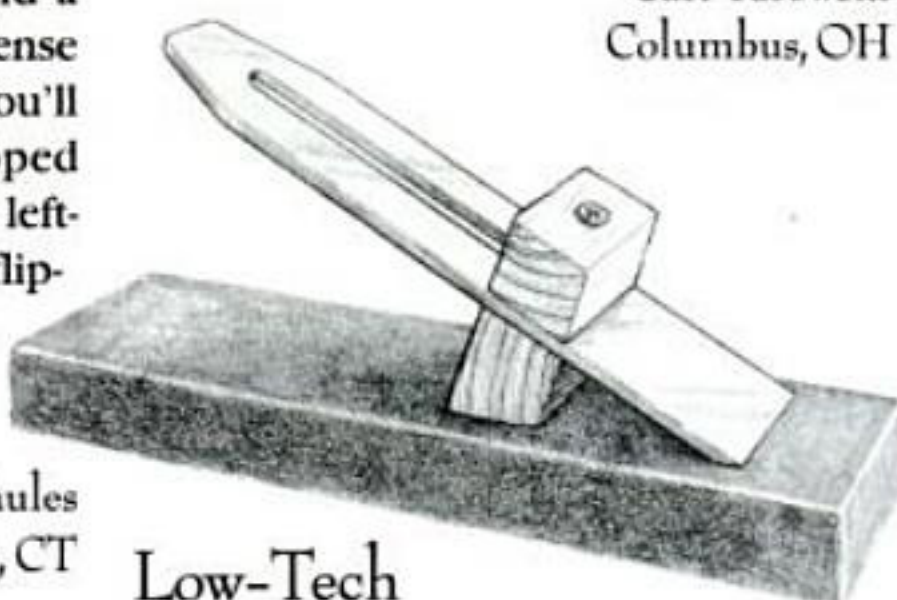
C.J. Ledoux
Heppner, OR



Tag That Wire

Most of my electric tools are connected to plug strips. Since all black electrical cords look alike it's hard to tell which one goes to which machine. This is not only a nuisance but could be dangerous. My solution is to wrap a colored tape around each end of the cord—at the plug and near the machine—so I can match the plug with the tool I want to use. When I run out of colors I'll use double or triple bands of colors.

Carl Yarowski
Columbus, OH



Low-Tech Honing Jig

I made this simple jig to hone plane irons while maintaining a constant angle. For chisels, or plane irons with no slot, I screw two drywall screws into the jig to hold the blade fast, one on each side of the blade.

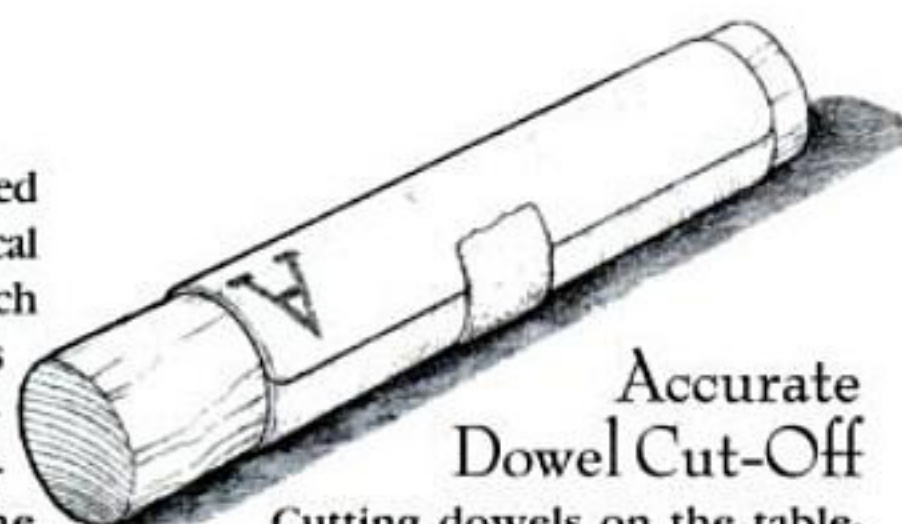
Howard Ires
Danbury, CT

Placing Sanding Discs Pronto

If you don't get the holes in Velcro sanding discs perfectly aligned the vacuum is impaired and the dust flies.

I now keep two short pieces of $\frac{3}{8}$ -in. wooden dowel in the same drawer as my sanding discs. When mounting a new disc I first insert the dowels opposite each other in the sander platten. This automatically registers the Velcro-backed disc.

George Swisher
Bowie, MD



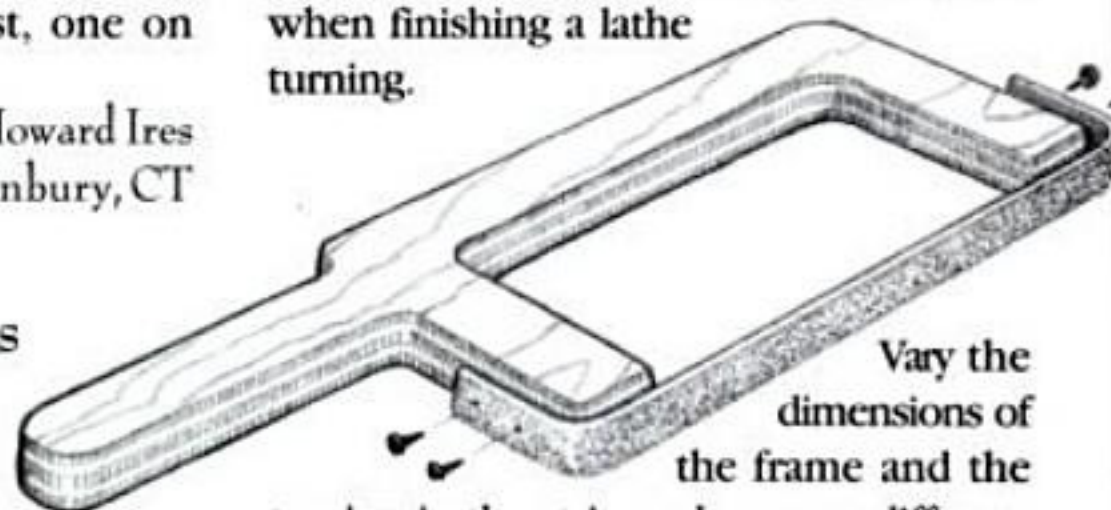
Accurate Dowel Cut-Off

Cutting dowels on the table-saw or bandsaw can be tricky—they tend to twist unexpectedly, even dangerously. It's safer to cut them by hand. To hold it tight and give myself an accurate cut line I wrap the dowel with a piece of a playing card about three times the diameter of the dowel. I either tape it in place and use it as a guide for my backsaw or trace a pencil line and saw to that.

Larry Smith
Warren, IN

Sanding Saws

These easy-to-make tools have almost replaced rasps and wood files in my shop. I bandsaw the handle out of $\frac{3}{4}$ -in. plywood, then tack a strip of cloth-backed sanding belt at each end. I keep different frames for each of the grits I commonly use. These sanding saws are especially useful on convex surfaces or when finishing a lathe turning.



Vary the dimensions of the frame and the tension in the strip and you get different degrees of grit contact with the work.

Karl Schuman
New York, NY

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.



MAKING A *BEDROOM SUITE*

BY SCOTT COOPER

Part 1: A Queen-Size Bed With a Chinese Flair

MITCH MANDEL

20 AMERICAN WOODWORKER



In this first article of a series, Scott Cooper explains how he designed and built a bedroom suite—bed, nightstand and chest of drawers.

In 1985, when I was still in college, I had the chance to take a summer language course in China. While traveling through the country I absorbed something I never anticipated—a love of Chinese furniture design. I don't mean the "court" furniture, so extensively decorated and self-important, nor what I'd call today's "tourist" stuff, which exaggerates traditional designs outrageously, but the ordinary furniture people use in their homes. To me, these pieces embodied a simple, clear purity of purpose and beauty that was similar to the European designs I'd grown up with, but refreshingly different.

Recently, I'd been idly sketching design ideas along these lines when, out of the blue, my mother decided to redecorate the old family home back in Tennessee. Her furniture already encompassed a number of styles and she planned to feature a different look in each room. She wanted me to design a suite of furniture for the guest bedroom based on my Oriental theme.

In keeping with the Chinese furniture that had so impressed me, I sketched designs with simple details that would impart a feeling of harmony. I chose curved rails with three short vertical members, a design element often used on Chinese low tables and chairs. On the nightstands and dresser I decided to use square Chinese legs with recurved feet. (See photo.)

In this first article of a series, I'll discuss how to make the bed, which takes a standard queen-size mattress.

Machining the Stock

The bed is made from 8/4 cherry though any even-textured hardwood would do. I used frame and panel construction on the headboard and footboard, joining the parts to the legs with mortise and tenon joinery. The long rails are attached to the headboard and footboard with standard bed hardware, while slats, which sit on ledger strips screwed to the long rails, support the mattress. (See drawing.)

My first step in preparing the stock was to plane it all to 1 1/4 in. and sticker it for a few days in the shop before milling the parts for the bed. This way, any warping or shrinkage that occurs would take place before the bed parts are cut to size.

After a few days, I inspected the wood and separated out the plainer pieces for the frame members (see drawing), then glued up the headboard and footboard panels from the boards that had more figure.

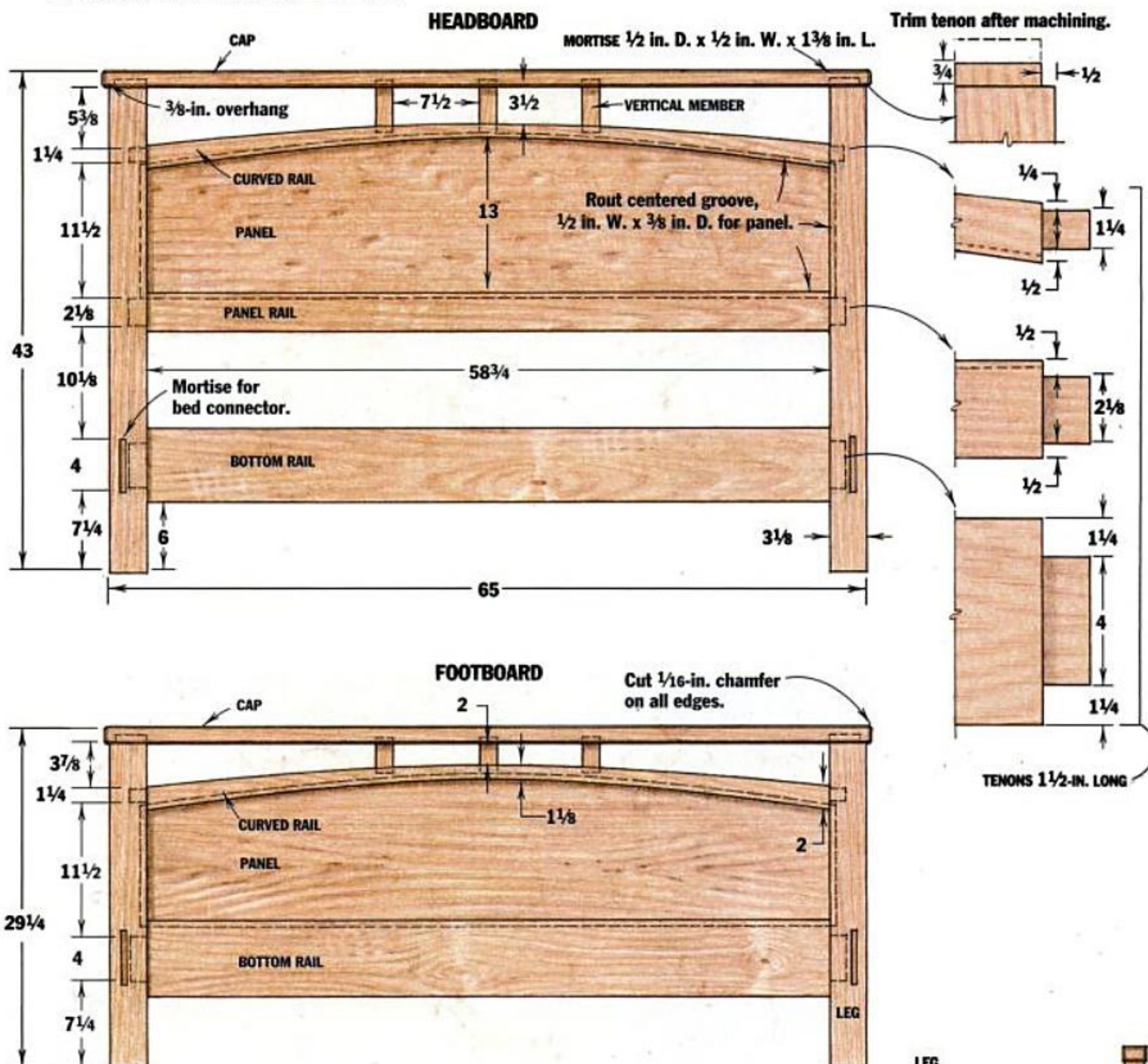
I ripped the frame parts to width and cut them to length (see drawing), but I left the wood its full 1 1/4-in. thickness at this point, even though the rails and caps would be planed thinner later. I find working with a uniform thickness saves time because it makes it possible to cut most of joinery without changing machine setups for different stock thicknesses.

Next, I cut the mortises in the legs. I used a 1/2-in., two-flute spiral cutter in my horizontal mortiser, centering the mortises in the legs. (See drawing.)

Then I drew the arcs for the curved rails, and before bandsawing the curve in the rails, I laid out and cut the mortises, in the tops of the rails, for the three vertical members. (See drawing.) These mortises are centered, but are only 1/2 in. deep. The corresponding mortises in the cap will come later. (Squaring the mortises for the vertical members and the legs takes special care because the vertical members and the inner edges of the legs have no shoulders to conceal gaps if you make mistakes.)

When making the rail and leg tenons I initially cut them all to a 1 1/2-in. length, using a dado blade in the tablesaw. Then later I

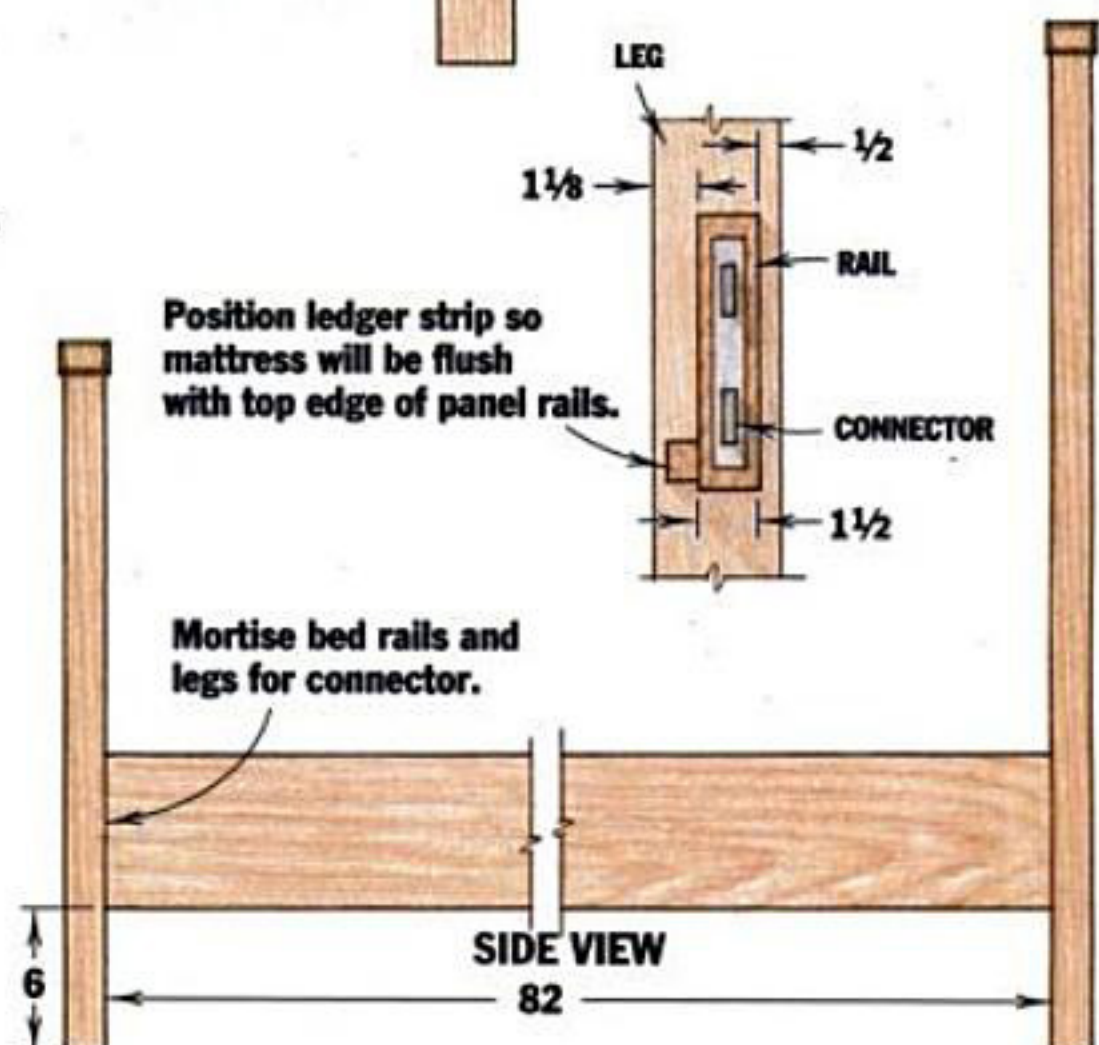
FIG. 1: QUEEN-SIZE BED



Notes: Bed designed for standard queen-size mattress. Unless otherwise noted, footboard details are same as headboard's.

BILL OF MATERIALS

HEADBOARD			FOOTBOARD		
PART	QTY.	DIM.	PART	QTY.	DIM.
Cap	1	1 1/4 x 2 x 65 1/4	Cap	1	1 1/4 x 2 x 65 1/4
Curved Rail	1	1 1/4 x 3 3/4 x 61 1/4	Curved Rail	1	1 1/4 x 3 3/4 x 61 1/4
Panel	1	Size to fit.	Panel	1	Size to fit.
Panel Rail	1	1 1/4 x 3 3/4 x 61 1/4	Bottom Rail	1	1 1/2 x 3 3/4 x 61 1/4
Bottom Rail	1	1 1/2 x 6 1/2 x 61 1/4	Legs	2	1 1/4 x 3 3/4 x 30 1/4
Legs	2	1 1/4 x 3 3/4 x 43 3/4	Vert. Member	3	1/2 x 1 1/4 x 4 1/2
Vert. Member	3	1/2 x 1 1/4 x 4 1/2	Bed Rails	2	1 1/2 x 6 1/2 x 82
NOTE: Where appropriate, lengths include 1 1/2-in. tenons.			Ledger Strip	2	3/4 x 1 x 82
			Slats	5	3/4 x 3 x 61



DRAWING BY VINCE BABAK

trimmed the tenons atop the legs to their finished length of $\frac{3}{4}$ in. I like working with a uniform dimension here because it lets me cut everything without resetting the tablesaw fence to cut the shoulders of the shorter leg tenons. (For more on tenons, see AW #18.)

Note that the tenons on the legs have only three shoulders. (See drawing.) I leave the inner edge of the tenon flush with the surface of the leg so I can use it as a reference when laying out the positions of the mortises in the caps.

After cutting the tenons, I switched back to my regular saw blade and cut the tenons on the tops of the legs to their final $\frac{3}{4}$ -in. length. (See drawing.)

Next I bandsawed the bottom arc in the curved rails and routed the grooves for the panels on the router table. I feel it's safer to rout the panel grooves at this point, before I thin the stock further by cutting the top arc. Take care when cutting this groove as it's easy to nip the tenon as it runs past the bit and this might send the workpiece flying.

I cut all the $\frac{1}{2}$ -in. grooves with a variable thickness wing cutter, called a grooving slot cutter (model #867, available from MLCS Ltd., Box 4053, Rydal, PA 19046, 800-533-9298). If you only have a $\frac{1}{4}$ -in.-wide slot cutter, you can make the grooves in two passes.

Once the curved rails were grooved, I cut the grooves in the other rails and legs. Again, having stock that's all the same thickness saves time, since I could groove all the pieces without changing the bit setting.

Assembling the Frames

At this point, I cut the caps to size and marked out and cut the mortises for the legs and vertical members. (See drawing.) To locate these mortises, I clamped up the headboard and footboard and checked for squareness. (It's important not to clamp across the curved rails too tightly or they will bow.) Then I set each cap on edge against the leg tenons and marked the locations of the mortises. After cutting the mortises, I assembled the frames without glue to check the fit.

While the frames were assembled, I measured and traced the profiles of the panels. To make sure there was a little



For safety and stability, rout the panel slot in the curved rail before sawing the upper arc of the curve.

room for expansion, I made the final size of the panels about $\frac{3}{16}$ in. shy of the distance between the bottoms of the grooves. I bandsawed the panels to size, and then adjusted the fit with a spokeshave.

With all the joinery completed, I disassembled the frames and ran the rails through my planer to reduce them to their final thickness. (See drawing.) To keep the joints centered on the rails, I removed an equal amount of wood from each side. I thin the rails for two reasons. Aesthetically, it creates a shadow line that makes for a more interesting look where the rails meet the legs. And it makes it easier to chamfer everything without worrying about where the parts overlap.

I believe that the first requirement for a clear, bright finish is a planed, rather than sanded surface. Hand-planed wood has clarity, whereas sanded wood is muddy because of the sanding grit and dust that fill the pores. So, I hand-planed each part of the bed before glue-up, using a small smoothing plane with a razor-sharp iron. This was also the time to lightly chamfer all the edges on the rails and legs. I cut about a $\frac{1}{16}$ -in. chamfer, working free-hand with a hand plane.

I assembled the bed by first gluing the curved rails into one leg and sliding the panel into the grooves. The panel is not glued, of course, which allows it to expand and contract with changes in humidity. Next, I slid the straight rail along the bottom edge of the panel until its tenon slipped home. Then I glued and clamped the other leg. After these parts were dry, I installed the vertical members and the caps.



For strength, bed hardware should be mortised tightly into the legs and rails. A simple jig gives the router stability.

When the frame was dry, I routed shallow mortises in the legs and in the ends of the long rails (see photo, above) for the bed connectors that secure the side rails to the headboard and footboard. (See drawing.) I used standard connectors (model #27101, available from Woodcraft, 210 Wood County Industrial Park, Box 1686, Parkersburg, WV 26102, 800-225-1153), and made a simple jig to help support the router base on the ends of the rails. (See photo.) It's important to get a good tight fit and use heavy screws (flathead steel sheet metal screws #10 or #12 and $1\frac{1}{2}$ in. long) to install the connectors since brass or drywall screws won't stand up to racking.

I finished my bed with Watco Danish Oil, applying five or six coats. If you use an oil finish, keep in mind that this bed has a number of shoulderless grooves and mortises that will hold excess. The oil will bleed out for hours and you'll have to wipe frequently.

As a final step, I glued and screwed the ledger strips to the bed rails. (See drawing.) These strips support five 3-in.-wide slats which hold the box spring. I positioned the ledger strips so that when the mattress was installed it would be level with the top of the panel rail on the headboard. I installed five screws per side, one under each slat. ▲



SCOTT COOPER

is a professional woodworker in Hilltown, Pennsylvania.

DUST HELMETS

*A Battery-Powered
Air-Filtration Unit
Is the Most
Effective Device
You Can Buy For
Keeping Sawdust
Out Of Your Lungs*

BY STEPHEN H. BLENK



ROSS HAMILTON

People have worked wood since long before Noah took up boat building, but it's only been in our lifetimes that they've started looking at the toll woodworking takes on the lungs. We now know that silicosis, various cancers, mold infections and emphysema are all linked to exposure to sawdust. And the chemicals we use in finishing wood only compound the dangers. It's clear woodworkers need to protect themselves; the question is what works best?

For me, the answer is a powered air purifying respirator (PAPR), or dust helmet to us woodworking types. First designed to protect workers against hazardous pollutants like asbestos and radioactive dusts, PAPRs are a major advance over the paper filter masks most woodworkers use.

With masks, you need to maintain an air-tight fit against the mouth and nose to protect yourself. The key phrase here is *air-tight*. If your mask leaks, you will draw dust through the gaps *around* the mask as you inhale. (See drawing at right.) And if you wear a beard or mustache you simply can't get a good seal. But with a PAPR, a fan pumps filtered air to your face (at 4 to 6 cfm), creating a slight over-pressure, or positive pressure, that keeps dust from entering. The air you don't use escapes through any gaps around the helmet, blowing dust *away* from your face.

As improbable as they may look, many PAPRs are actually quite easy to wear. Most of them don't fog eyeglasses as masks do, and all work well for folks who sport beards and mustaches. Further, the built-in "breeze" that PAPRs provide keeps you cool, unlike the masks, which are sweaty and tend to clog with moisture. As an added bonus, if you buy a system with a face shield that meets the American National Standards Institute's (ANSI) rating for impacts (see chart, pages 26-27), it will protect the face and eyes if a piece of wood or a tool happens to spit back at you.

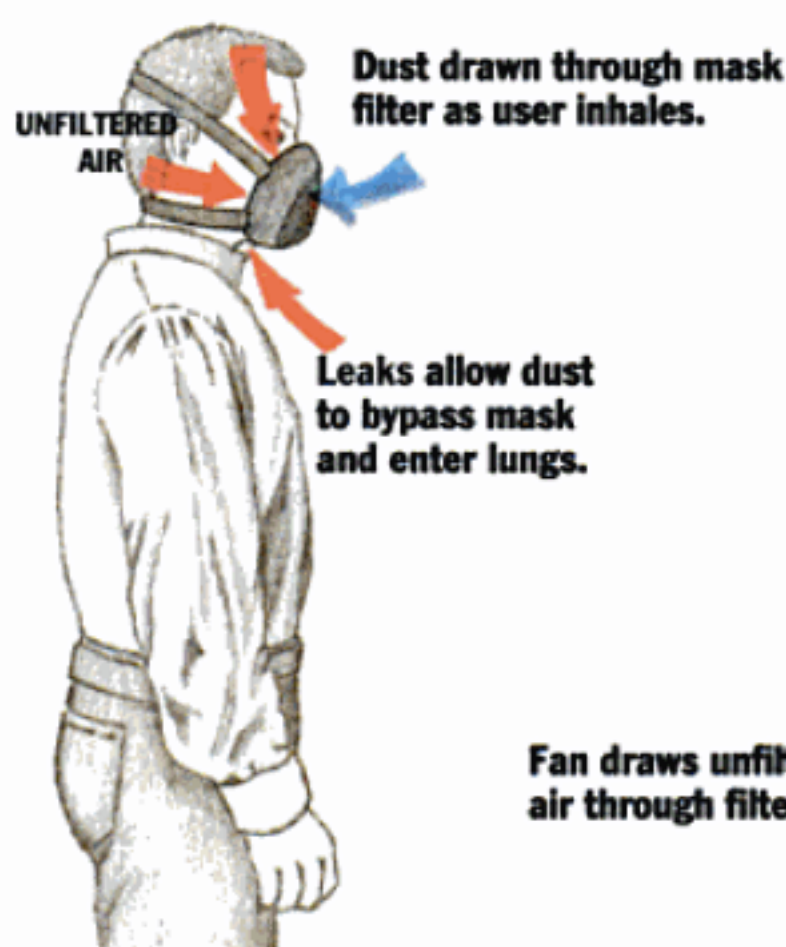
The Basic Parts

At the heart of all PAPR systems are one or more filters, a fan and a rechargeable battery pack that powers the unit. On some systems, these com-

ponents are all part of the headgear. On others you wear these parts around your waist as a blower unit and an air hose connects them to the headgear. Each design has its advantages. Belt units are heavier, but are quieter than all-in-ones, while the all-in-ones are less restrictive than two-piece units.

How the air actually reaches your face depends on the type of headgear you opt to buy. There are three basic models: helmets, which consist of a hardhat/face shield combination; the simpler Tyvek hoods, which drape over the head and have soft plastic windows; and the mask units. (See photos, page 26-27.)

Dust masks leak



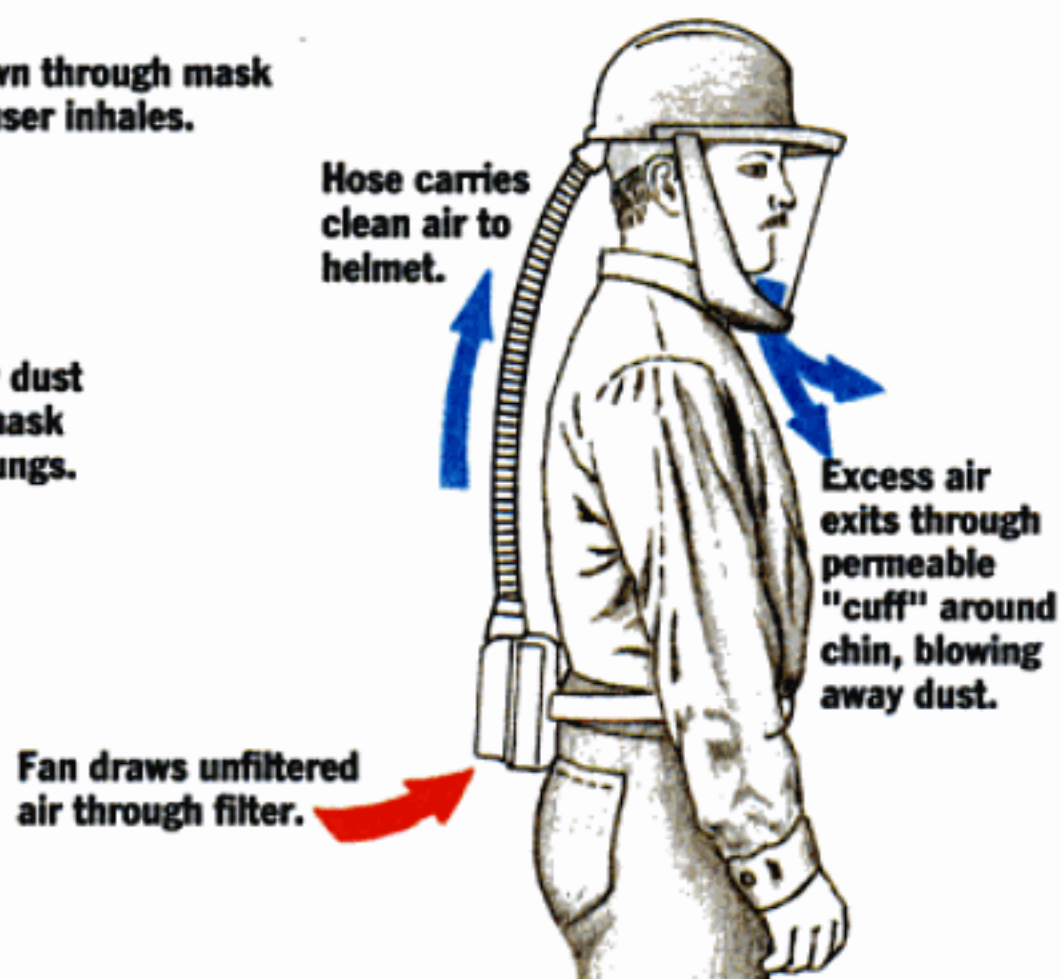
Helmets are comfortable and loose-fitting and protect the face from impact. The disadvantage is they're the heaviest of the three types. Units with **Tyvek hoods** are much lighter and provide just as good dust protection as the helmets. The disadvantages are they're harder to put on, you have to completely remove them to get access to your face and they don't provide impact protection. **Mask-type PAPRs** may provide the most complete protection to lungs, but having the air supply hose connected to the front of the mask impedes your movements. They're also the most uncomfortable of the PAPRs to wear because they're held tightly against the face by several straps.

Test Criteria

Being an experienced wearer, I had some specific ideas about what I did and didn't want to do in testing these creatures. First, I wanted to concentrate on the units that seemed most useful for woodworking, rather than looking at every conceivable system on the market. Second, I didn't want to get mired down in scientific lab tests that might not address real-life performance. (The chart shows the federal ratings for each unit.) Instead, I wanted to concentrate on practical issues such as weight, noise, visibility and comfort, battery life, and impact protection.

To test these units I wore each for at

Dust helmets don't



least two days in the shop and checked dust protection by power-sanding some work on the lathe with my built-in vacuum system turned off. That fogged my entire shop with dust—not a normal or recommended procedure, but a great test environment for a dust helmet.

All of the units approved by the National Institute of Occupational Safety and Health (NIOSH) to stop dust operated well in the fog I created, but there were distinct differences in the comfort and "wearability" of them. The results follow, grouped by type of headgear.

Helmet Models

Racal Breathe-Easy 1. Racal's top-of-the-line model is a good machine

PHOTOS BY JOHN HAMMILL



MODEL	AIRHAT Helmet Model: W-2975 Blower Model: W-3205 3M Corp. Tech. Advice (800) 328-1667 Circle #601	AIR-LITE Racal Health and Safety Inc. Tech. Advice (800) 328-1792 Circle #602	AIR-MATE 3 Racal Health and Safety Inc. Tech. Advice (800) 328-1792 Circle #603	BREATHE-EASY 1 Racal Health and Safety Inc. Tech. Advice (800) 328-1792 Circle #604
LIST PRICE (AS TESTED)	\$744.05	\$235	\$350	\$695
EFFECTIVENESS¹	Excellent	Poor	Excellent	Excellent
COMFORT	Fair	Fair	Excellent	Good
NOISE	Minimal	Loud	Minimal	Minimal
WEIGHT	Helmet: 3.50 lbs. Belt pack: 4.05 lbs.	1.25 lbs.	Helmet: 1.8 lbs. Belt pack: 2.3 lbs.	Helmet: 2.35 lbs. Belt pack: 5.6 lbs.
VISIBILITY	Good	Excellent	Excellent	Good
VISOR IMPACT RATING²	ANSI approved	ANSI approved	ANSI approved	ANSI approved
FILTER (TYPE/COST)³	HEPA TC-21C/\$88 (4 pack) 1 req.	Not NIOSH rated/\$12.50 1 req.	TC-21C/\$14.50 1 req.	HEPA TC-21C/\$126 (12 pack) HEPA TC-23C/\$134 (6 pack) 3 req.
BATTERY (TYPE/LIFE)⁴	NiCad/7 hours	NiCad/4 hours (8-hour battery available)	NiCad/8+ hours	NiCad/8+ hours

FOOTNOTES:

1 Indicates ability to stop dust.

2 Helmets that are ANSI approved for impact protection can withstand the force of a 3/4-in. steel bearing shot at 60 mph.

that provides reasonable visibility, although my peripheral vision was limited by the visor's design. The helmet is light enough to be worn continually with comfort and the flip-up visor is ANSI rated for impact protection. That means it can withstand the force of a 3/4-in. steel bearing shot at 60 mph without allowing penetration.

The headgear connects to Racal's Turbo unit, which consists of a belt-mounted blower and three filters, with a separate battery pack, also belt mounted. This separate battery is a bit cumbersome, making the job of getting the belt on and off like waltzing with a hippo. Also, on my test unit the battery tended to come unhooked from the belt so it can end up bouncing on the floor if you're not careful. An extra-long air hose is optional (\$1 added cost) and

I recommend you get it if you are more than 5 feet 10 inches tall. I tried using the shorter hose and at 6 feet 4 inches tall I found I had to wear the belt around my chest or have my head pulled back by the helmet.

The Breathe-Easy 1 is the only unit tested that is NIOSH rated for use with TC-23C HEPA/organic vapor filters. These have a layer of activated charcoal and can filter dust and mist particles down to 0.03 microns (between 0.01 and 0.0001 mm in dia.) as well as vapors, making them good for spraying some finishes. I tried out the vapor filters on Livos Kaldett oil finish. Livos has a *very* distinct odor, but I couldn't smell it. (A warning here from an OSHA industrial hygienist: even PAPRs with TC-23C type filters are not recommended for multiple-part automotive-type fin-

ishes. These finishes are so hazardous you are required to use a separate outside air source when spraying them.)

Racal Air-Mate 3. This unit was a real surprise. It's a step below the Breathe-Easy 1 in cost and intended use, but it is actually more comfortable to wear. The Air-Mate 3 uses a single filter with a TC-21C filter, meaning NIOSH rates it to stop dust and mists down to 2 microns, but not organic vapors.

The belt pack combines blower, filter and battery in one compact unit, making it much more convenient to wear than the Breathe-Easy 1. As with the other Racal unit, the headgear was light and comfortable to wear. It also has a flip-up visor that is ANSI rated for impact protection. Visibility was better than with the Breathe-Easy 1.

Racal Air-Lite. While the Air-Mate

DUST HOODS

DUST MASKS



PUREFLO PF-22
Crafts Supplies
Tech. Advice
(801) 373-0917
Circle #605



AIR-MATE 1
Racal Health and Safety Inc.
Tech. Advice
(800) 328-1792
Circle #606



SNAPCAP
Hood Model: W-3260
Blower Model: W-3205
3M Corp.
Tech. Advice
(800) 328-1667
Circle #607



FACE-MOUNTED PAPR
Model: 3265-S
3M Corp.
Tech. Advice
(800) 328-1667
Circle #608



WILLSON RP-41
Willson Safety Products
Tech. Advice
(215) 371-7728
Circle #609

\$495	\$250	\$570	\$492.65	\$200
Excellent	Excellent	Excellent	Excellent	Excellent
Good	Fair	Good	Fair	Fair
Moderate	Minimal	Minimal	Loud	Loud
2.2 lbs.	Hood: .35 lbs. Belt pack: 2.3 lbs.	Hood: 1.75 lbs. Belt pack: 4.05 lbs.	Mask: 1.75 lbs. Belt pack: 1.85 lbs.	Mask: 1 lb. Belt pack: 4 lbs.
Good	Good	Excellent	Good (No room for glasses)	N/A
Approved in UK	Not Rated	Not Rated	ANSI approved	N/A
Rated in UK/Pre-filter \$11.95, Main filter \$79.95 1 of each req.	TC-21C/\$14.50 1 req.	HEPA TC-21C/\$88 (4 pack) 1 req.	HEPA TC-21C/\$405 (case of 36) 1 req.	HEPA TC-21C/\$9.25 1 req.
NiCad/8 hours	NiCad/8+ hours	NiCad/7 hours	NiCad/8+ hours	Lead-Acid Gel/4-6 hours (8-hour battery available)

3 TC-21C filters stop basic dusts and mists down to 2 microns.

HEPA filters are rated to trap 99.97 percent of dusts and mists down to 0.3 microns in size.

TC-23C filters stop organic vapors as well as dust and mists.

4 Indicates life in hours between charges.

systems are NIOSH approved for dust protection, their little brother, the Air-Lite, was not when I tested it. (Racal is currently applying for a NIOSH rating on the Air-Lite version with an eight-hour battery.) This newest Racal system is basically an oversized safety shield. It's only rated to handle "nuisance dust" and after testing it with power sanding, I found some dust on the *inside* of the visor. Also, because the Air-Lite's blower is located in the headgear, this unit is a bit louder than the other Racal systems.

Nevertheless, the Air-Lite is comfortable to wear, provides good visibility, and is quite light. Its visor is ANSI rated for impact protection, which is good, but it has no flip-up feature, so you have to remove the entire unit if you want to adjust your glasses or scratch your nose.

The Air-Lite system is less expensive than the Air-Mate and Breathe-Easy units, but it may be a false economy to buy one if you are a professional who spends eight to 10 hours a day in the dust. Still, it would probably work better than most dust masks, and would be an excellent choice for the hobbyist woodworker.

3M Airhat. 3M uses a mix-and-match approach for the components in its PAPRs. Two of the systems I tested (the Airhat and the Snapcap) operated on the same model blower/battery pack. This pack features a belt-mounted blower housing, with a separate battery pack that also mounts to the belt. This waist pack is unique in that it has an audible/visible warning system that beeps and blinks a light to tell you when airflow is restricted or the battery

is low. The unit uses a single belt-mounted TC-21C HEPA filter element that can trap dust and mists to 0.03 microns. Like Racal's Turbo unit, the waist pack is clumsy to strap on, but 3M has a better belt clip for the battery, which prevents it from falling off.

The Airhat helmet was something of a disappointment after the Racal headgear. The visor is hinged, but the process of opening and locking it open is difficult, and the hinge itself is just a flexible piece of plastic. I would have doubts about its life expectancy. Further, the helmet is so unbalanced with the heavy visor assembly open that the need for the included chin strap is evident.

The visor is ANSI rated for impact protection and visibility is good although peripherally limited. But at

3½ lbs., the weight of the headgear is considerably more than either of the big Racal units. The air hose is long enough for comfort, and the visor had sufficient room for my eyeglasses.

Pureflo PF-22. This helmet is manufactured in the United Kingdom and imported to this country by Craft Supply USA. It carries impact and filtration ratings from Sweden and the UK that are comparable to the ANSI and NIOSH ratings for the other helmets, and in my power-sanding test it stopped all dust.

All the elements of the PF-22 system, the battery pack, motor and filters, are mounted in the helmet itself—a big plus. And even with the fan in the helmet, noise level was just a quiet hum. The unit has a couple other nice features. The blower automatically activates when you put on the helmet so you don't have to search around for a switch, and it has a nylon neck seal with a drawstring that is comfortable to wear. On the downside, I found the helmet clumsy to put on, and since the visor does not flip up it's impossible to get to your face without removing the helmet. Also, while the unit is extremely light (2.2 lbs.), it may sacrifice something in the way of durability to achieve the low weight. This was also the only unit that I found it difficult to wear hearing protectors with.

The PF-22 uses a two-step filtering system. There is an inexpensive pre-filter (\$11.95) that is similar in construction to a furnace filter, and a main filter. The main filter costs \$79.95, but changing the pre-filter regularly should increase the life of the main filter.

This is a good unit, but expensive and somewhat less convenient than the Air-Mate-3, because of its lack of a flip-up visor.

Hood Models

Racal Air-Mate 1. The Air-Mate 1 uses the same basic blower and filter as the Air-Mate 3, but without the helmet gear. The Air-Mate 1 doesn't have a full hood, just a soft Tyvek cap, which covers the hair, and a face shield with a soft, see-through plastic window. (See photo, previous page.) Be sure to order the "large" headgear if you opt for this unit. The "regular" size was so small the only person it fit in my house was

my 3-year-old daughter. The Air-Mate 1 is probably the best value for your dollar in the hood systems, though it's not the most comfortable.

3M Snapcap. The 3M Snapcap system consists of a molded plastic cap that is covered by a Tyvek shroud. The shroud has an elastic cuff around the neck, much like the top of a turtle-neck sweater, and the entire shroud snaps in place on the cap. This is by far the most convenient of the hood systems to assemble and wear. It is easy to don and remove, and with the shroud snapped to a solid cap, the window stays in front so you can see—an improvement over the Air-Mate 1. The Snapcap uses the same belt-mounted blower and battery units as the Airhat.

Mask Models

3M Face-Mounted PAPR. This unit is a full face mask that has the blower and filter built into the front of the headgear and a belt-mounted battery. (See photo, previous page.) The mask uses a six-strap system for holding it in place, with easily adjustable straps. The visor probably provides a good field of view, but I'll never know, as my eyeglasses didn't fit inside.

This system's face shield meets ANSI standards for impact protection. While it would certainly work for many woodshop applications, it was designed for high-hazard material like asbestos and is probably overkill for sawdust. As with all mask-type systems, comfort is somewhat sacrificed for fit.

Willson Mask PAPR. Willson's 6000 series RP-41 system is the most basic of PAPRs. It uses a simple nose/mouth mask without a face shield. (The company also offers a full face mask unit called the Marathon for \$350.) The battery, fan and filter are all belt-mounted. Unlike the other units, which all use NiCad batteries, this system runs off a lead/acid gel battery and that presents potential difficulties: The operator's manual says if it's not recharged within 24 hours (with the optional \$60 recharger), crystallization will occur inside the battery and it will no longer take a charge. The advantage with this system is the battery recharges twice as

fast as a NiCad.

The mask harness does not hold the mask well unless the straps are very tight and this makes it somewhat uncomfortable to wear. The hose compounded the problem by pulling at the mask whenever my head was turned.

Recommendations

Which unit you should buy will depend on the type of woodworking you do. If you spend a lot of time at the lathe or elsewhere where projectiles are a problem, I'd recommend the Air-Mate 3. It combines dust protection with facial impact protection and I found it to be the most comfortable and effective of the units tested.

If you only need a PAPR as protection from dust during heavy sanding, I'd recommend buying the 3M Snapcap for fit and comfort, or the Air-Mate 1 for value per dollar.

Beyond the basic helmet, you'll need to decide what type of filters to buy and what type of shield you'll need. (Some shields are available with a coating that makes them highly scratch resistant and some manufacturers sell a plastic film you can apply to the shield to protect it from splatters during painting and finishing.) For advice on those issues and more technical information on PAPRs, you're best off seeking the help of a knowledgeable industrial safety technician and/or sales rep.

Each manufacturer has a technical support number for customer assistance (see chart), but if the prospect of dealing with a huge company seems a little daunting, I'd recommend trying a retailer. Rice Safety (4930 Third Ave. S., Seattle, WA 98134, 800-426-8314) offered patient answers to my many questions about PAPRs and I've found them excellent folks to deal with. ▲



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DESK CADDY

*This Organizer Helps
Keep Your Desk Clutter-Free*

BY ELLIS VALENTINE

One of the benefits of being a woodworker is having the freedom to build "custom" furniture, with very specific features you wouldn't be able to find in a store. This desk "caddy," built by Fred Matlack in the AW Design Shop, is one such piece. It gives you the specialized storage of a secretary desk yet sits atop any regular desk or computer work surface. Pigeonholes keep incoming mail organized while a

variety of drawers accommodate stationery, office supplies and your computer's floppy disks, keeping everything at your fingertips but out of sight.

You can build the desk caddy just as you see it here, or adapt it to suit your own storage needs or available space. Even the construction is up to you. We chose sliding dovetail construction because it's strong,

invisible and can be accomplished with a router, but there's no reason you couldn't use biscuit joinery, or even fasteners, such as screws or nails. In short, this is an invitation for you to design your own furniture.

Construction Tips

All the information you need to build the desk caddy is shown in Fig. 1, but here are a few extra words of advice:



This desk organizer has plenty of room for office supplies and computer disks, and turns any work surface into a secretary desk.

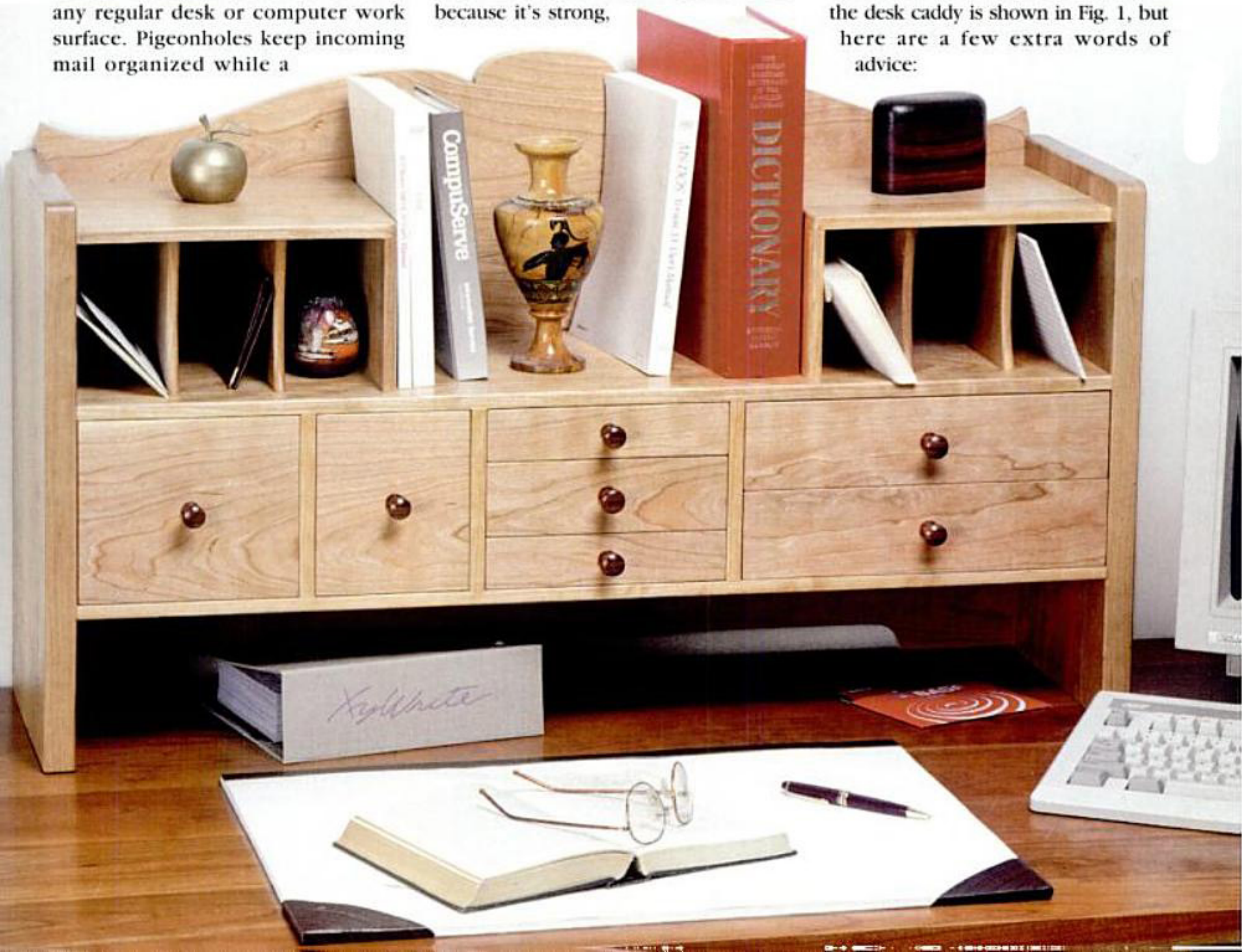


FIG. 1: DESK CADDY

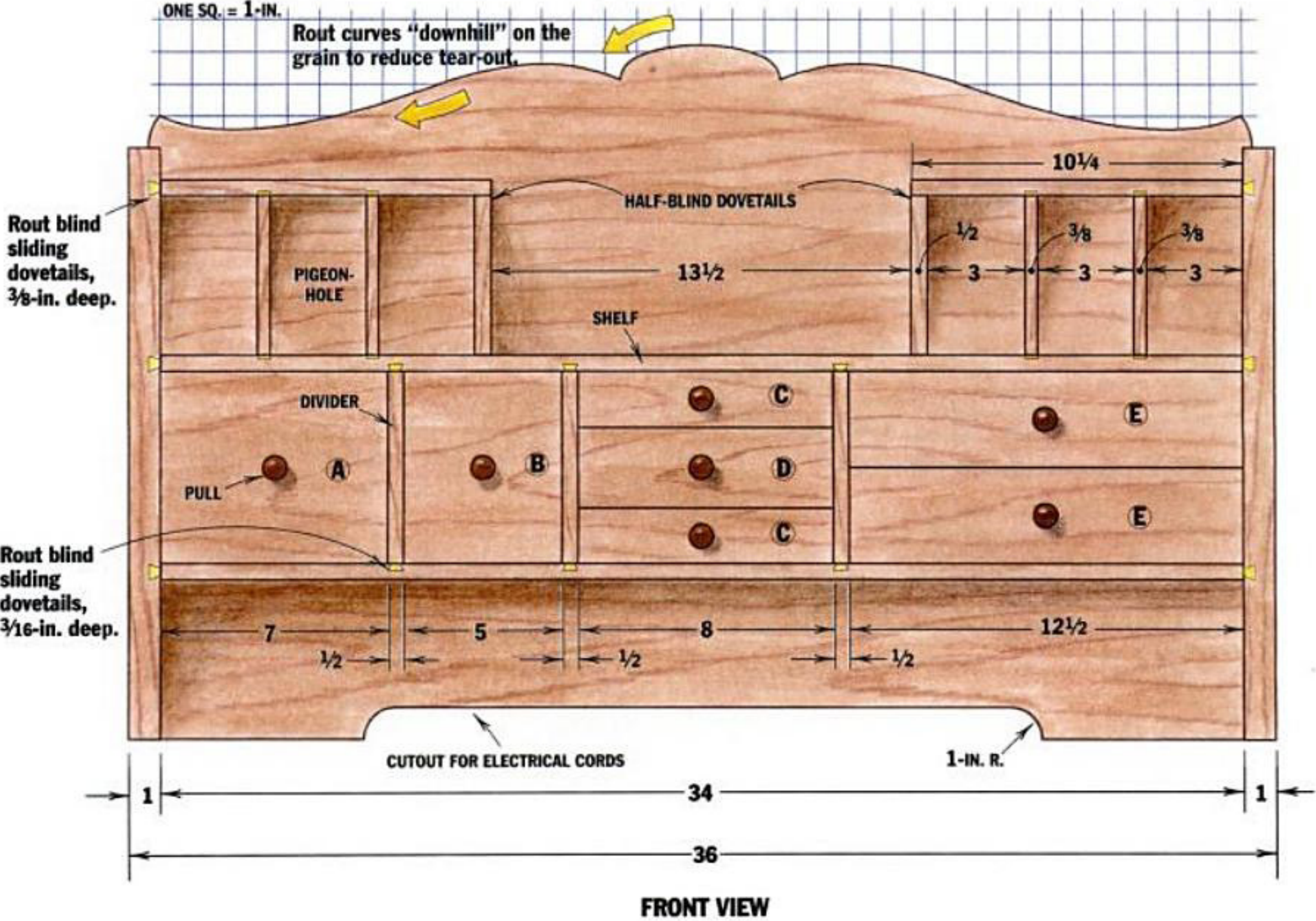
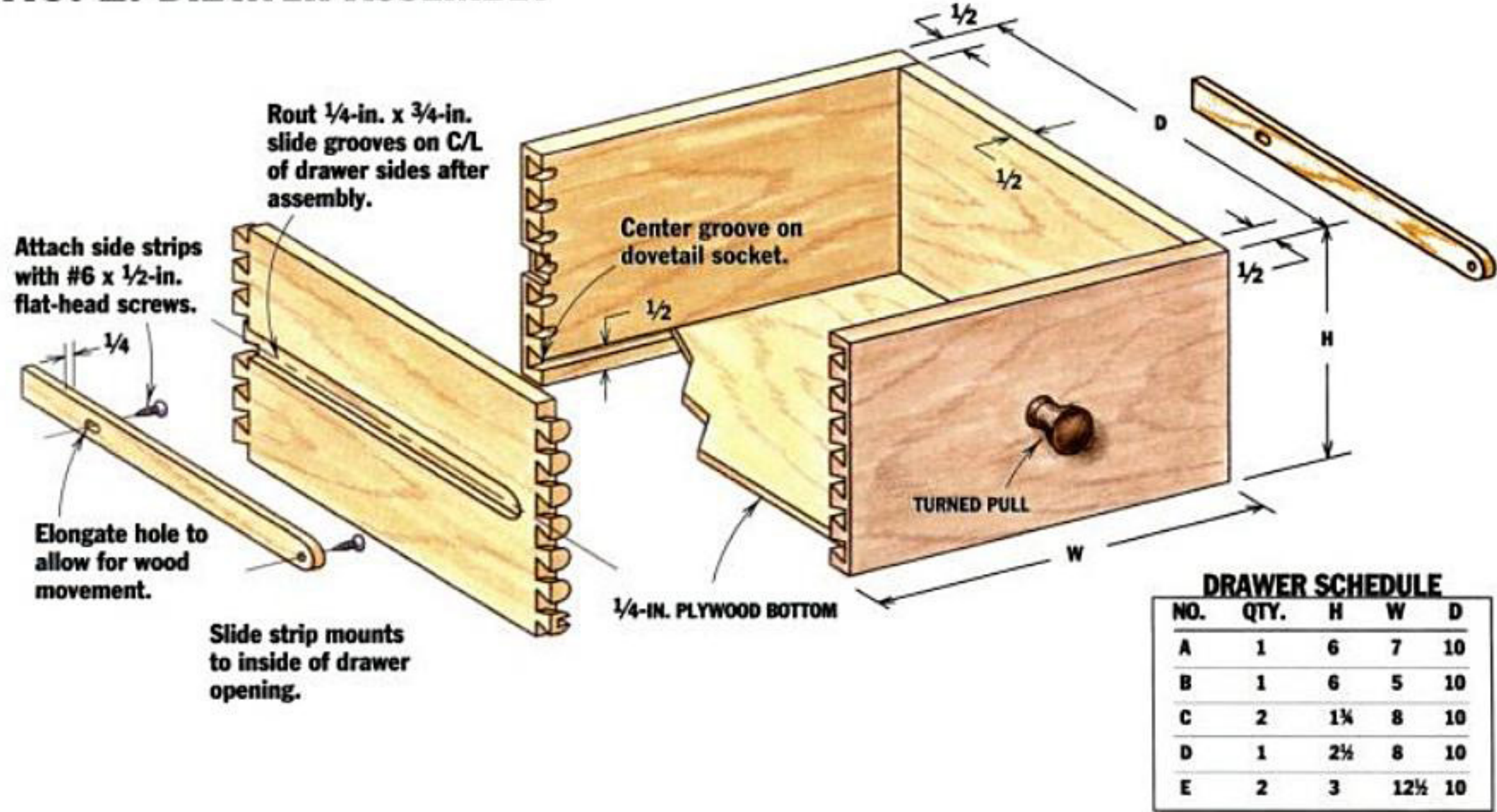
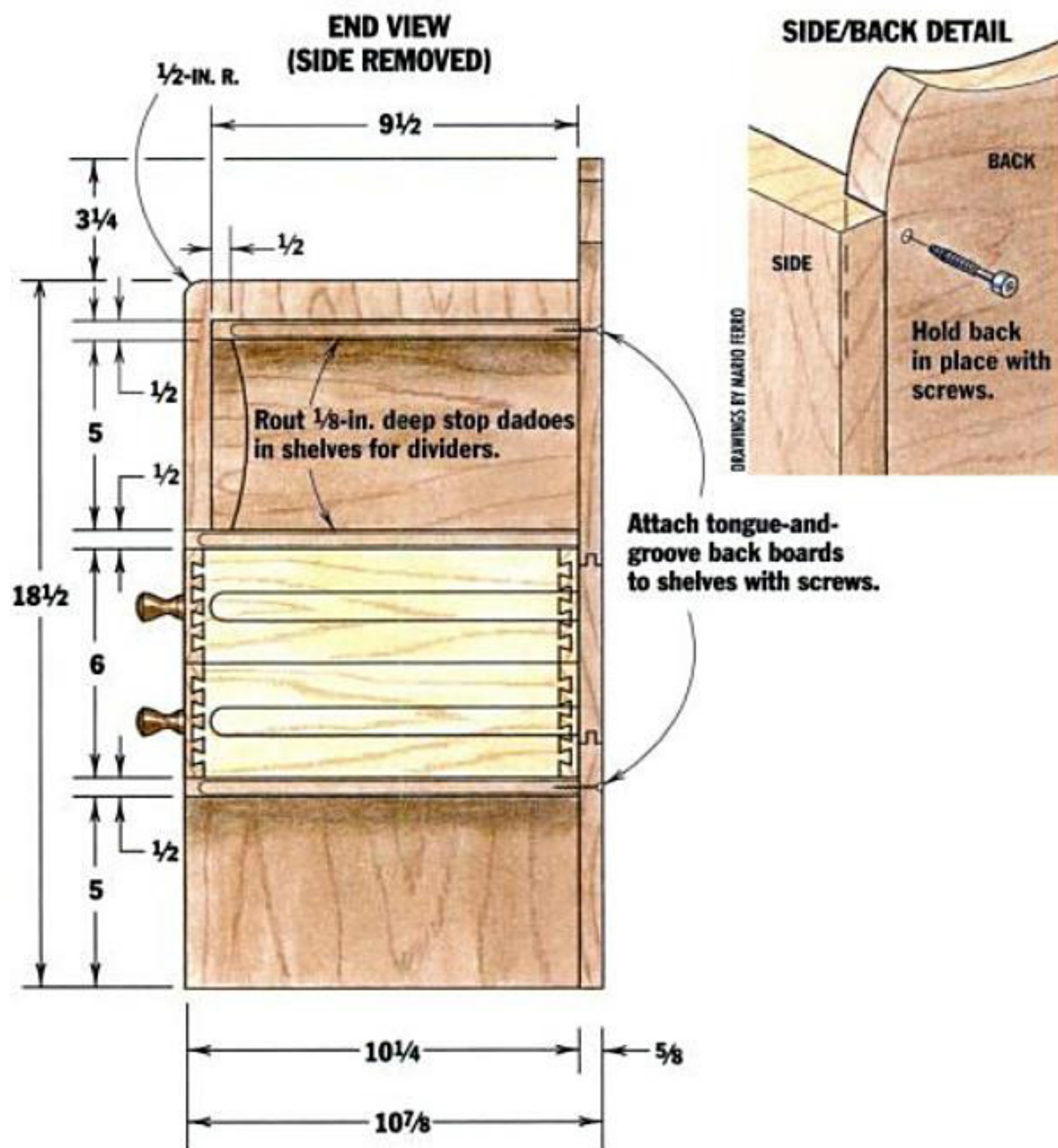


FIG. 2: DRAWER ASSEMBLY





To rout dovetail grooves, guide hand-held router against a fence clamped across the workpiece. Cut the mating tongues on a router table.

● If you'd like to take some liberties with the design, draw front and side views—either full size or to scale—similar to those shown in Fig. 1. Note the sizes of all openings, and use these to figure out the “shoulder-to-shoulder” dimensions of shelves and dividers. Then add the lengths of the tongues to determine the overall

lengths of the parts. Adjust drawer sizes to fit your new openings.

● If you decide to use sliding dovetail construction, as we have here, cut the grooves first, then finish-sand the grooved faces to 220 grit before dovetailing the mating tongues on the router table. (See photos, above.) Sanding afterward will remove

material from the shoulders of the dovetails and loosen the fit.

● Build the case before cutting your drawer parts to finish size. The drawer sizes shown in the schedule (see Fig. 2) are sized to the theoretical openings. Once you've built the case, you can size the drawers to the actual openings, then plane and sand them as needed to produce the fit you want.

● Make a plywood pattern for one half of the curved top edge of the back. Trace the pattern on your dimensioned stock, bandsaw the curve close to the line, then rout to the line with a pattern bit or flush-trimming bit, using your pattern to guide the pilot bearing. (You could skip the router and clean up the curve with a spokeshave and chisels, if you're so inclined.) To minimize tear-out when routing, clamp your half-pattern to the face of the workpiece that allows you to cut “downhill” on the grain. (See Fig. 1.)

● You can make the back in one of several different ways, but, if you're using solid wood, be sure to allow for expansion. We made a three-piece back with tongue and groove joints hidden behind the drawers. (See Fig. 1.) Or, you can avoid expansion problems by making the back of plywood, with a solid wood piece glued to the top edge so you can cut the curve in solid wood.

You might even prefer to omit the back entirely and hang the caddy on the wall. If so, reduce the width of the side pieces by the thickness of the back and add a stretcher below the bottom shelf to help keep the unit square in the absence of a back.

● I recommend a wipe-on finish (see AW #28 and AW #32) because it's natural-looking and easy to use. It's a good idea to prefinish all the case parts prior to gluing up; you'll find the openings are too small to finish after assembly. Be careful to keep the finish out of the sliding dovetails. ▲



ELLIS VALENTINE
is associate editor of AW.

SHARPENING HANDSAWS

*With Some Simple Tools
and a Little Practice You Can Keep Your Saws Sharp*

BY MARIO RODRIGUEZ

Woodworkers routinely sharpen their chisels and plane irons . . . so why not handsaws? The practice of sharpening a handsaw is simple—and it's a good exercise that adds to your skills in the shop. Even better, once you know the basics of sharpening you can customize your saws for optimum performance.

In this article, I'll describe how to sharpen the Western saws common to the cabinet-maker's toolbox. To do it right you'll need to gather a few tools, plus there are some special devices you can buy or make that will speed up the process. (See sidebar, page 35.)

The Basic Steps

The first step in sharpening is to **joint the saw** with a file so all the teeth are level. To hold the saw securely, I clamp the blade to a hardwood 2x4 with a pair of handscrews, letting the lowest tooth protrude $\frac{1}{32}$ in. above the top edge of the board. Then I clamp this assembly in my bench vise. (See photo, page 34.) Make sure the top edge of the board you use is straight. For large panel saws, I remove the handle to make it easier to clamp.

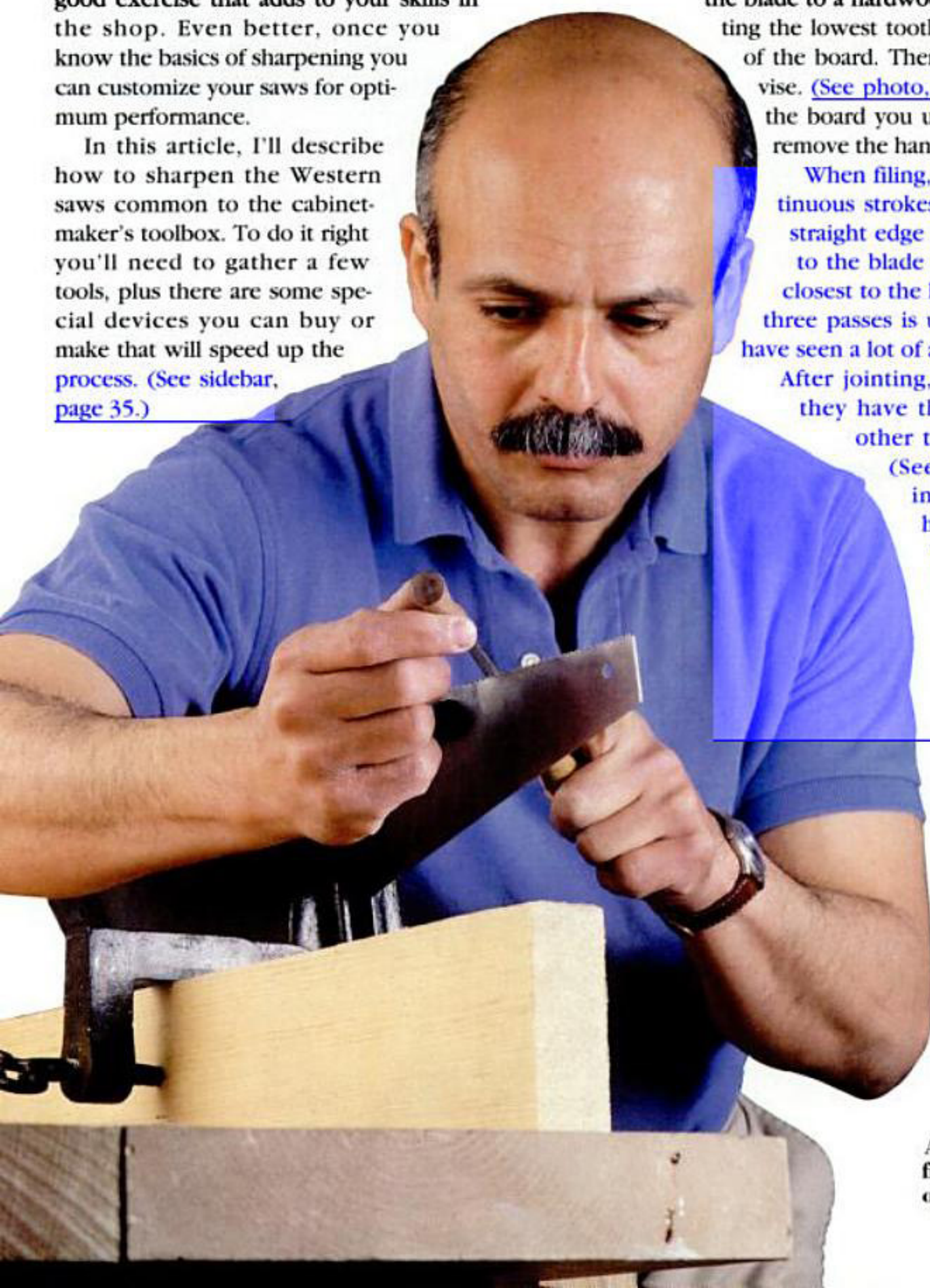
When filing, use a mill file and work in long continuous strokes. Level all the points flush with the straight edge of the board, keeping the file square to the blade and working from the heel, the area closest to the handle, to the toe of the saw. Two or three passes is usually sufficient, although saws that have seen a lot of action may require some extra work.

After jointing, use a saw set to **set the teeth** so they have the same degree of bend and every other tooth is bent in the same direction.

(See photo, page 34.) Clamp the saw into a saw vise like the one shown here, and start at the toe of the blade. When you reach the heel, turn the blade around and set the alternate teeth. A general rule of thumb is to set the teeth a maximum of one-third the thickness of your blade—any more than this and you risk breaking off a tooth.

Now you're ready to **file the teeth** to give them their cutting edge. When sharpening, you must keep the saw blade rigid. Otherwise, the teeth will flex, causing your file to chatter. How you clamp the saw depends on what kind of saw you're sharpening. For panel saws (both crosscut and rip), I use the saw vise, clamping the blade so only $\frac{1}{4}$ in. projects above the jaws.

A saw vise, saw set and a couple of files are all you need to sharpen your own handsaws.



For smaller saws, I clamp the blade between boards. More on that later.

Filing a Crosscut Saw

When sharpening a crosscut saw, your goal is to bring the teeth to a point while filing a bevel on the edges, and this is done in two steps. Begin at the blade's toe and file every other tooth, starting with the first tooth that is set *away* from you. Tilt the file 15° from horizontal and angle it 30° so the handle points back toward the heel of the saw. (See Fig. 1.) Unless the saw was badly sharpened before, you should be able to gauge the basic angles just by laying your file on the teeth. You want the file to contact the leading edge of the tooth first, then make contact with the back of the adjacent tooth as you push the file in long, forceful strokes. Since the file tapers, there is more play at the beginning of the stroke, which will ease the file into the cut giving you a chance to make small corrections in your angles.

Make the same number of strokes on each tooth and carefully file the leading edge just shy of a sharp point. You'll come back to finish the point in the next step.

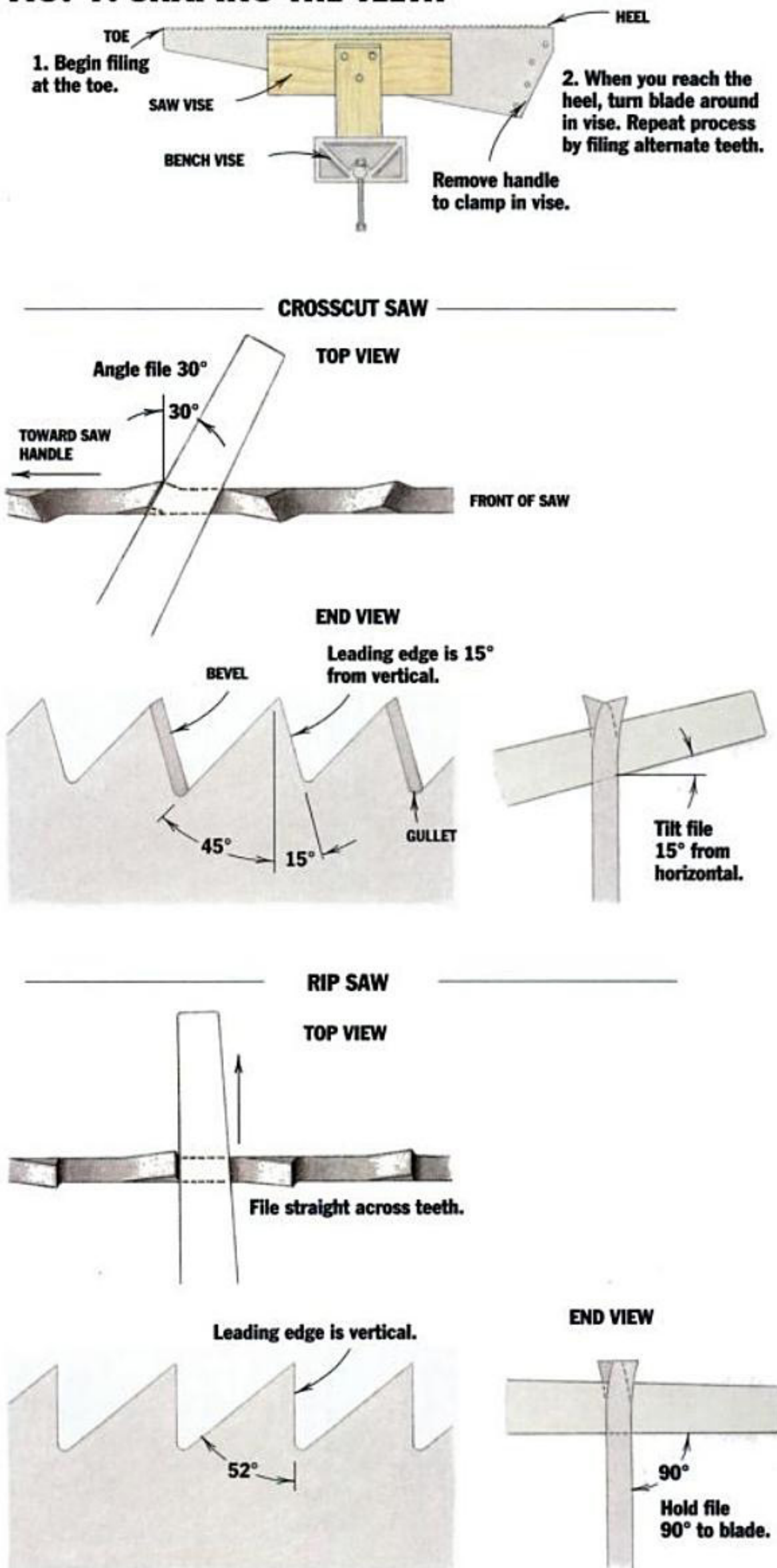
When you've filed all the teeth that are set away from you, turn the saw around in the vise, go back to the toe, and repeat the same process of filing. However, at this stage, you can bring all the teeth up to a sharp point, completing the job. I wear a magnifying visor (see sidebar) to inspect each tooth while I file.

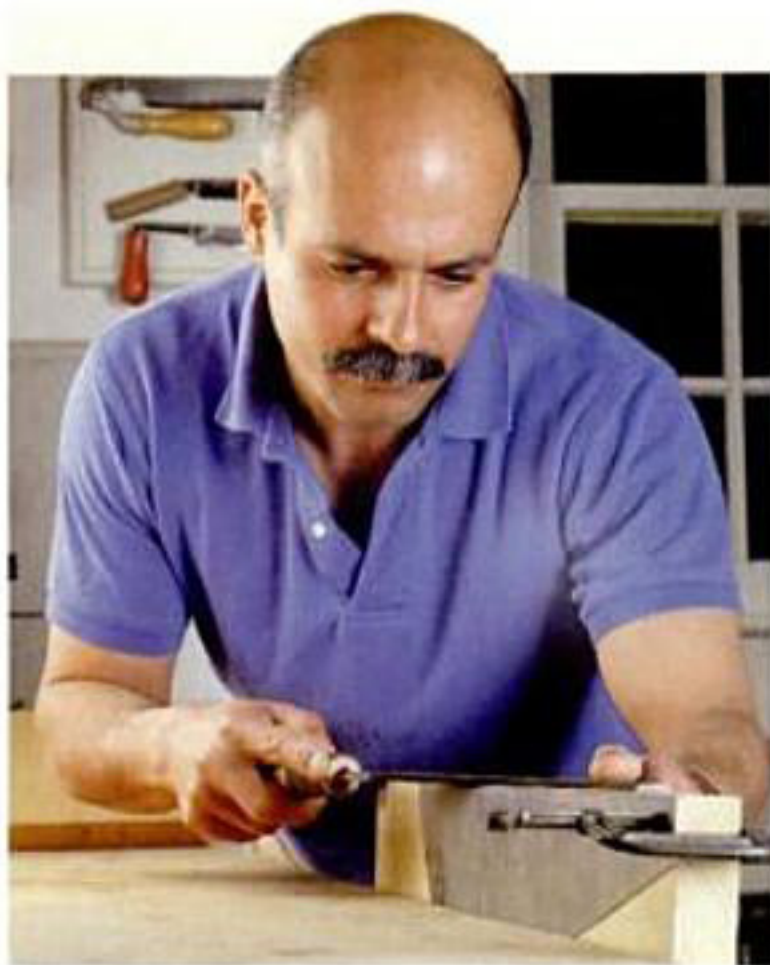
Although the teeth may appear sharp when you're done filing, they in fact have burrs on their edges. To remove them, pass a scrap of pine down the blade a couple times. An alternative method is to use a mill file very lightly along the sides of the teeth. At this point, inspect the teeth. If you find any flat, dull spots, go over these teeth again with your saw file until all the teeth are bright and pointed.

Filing a Rip Saw

To sharpen a rip saw, follow the same initial steps of jointing and setting. You don't have to set the teeth as much as you do on a crosscut: A bend of about one-quarter the thickness of the blade is sufficient. This is because a rip

FIG. 1: SHAPING THE TEETH





Before filing the teeth, use a mill file to joint the saw teeth level (left). Above, author uses a saw set to bend the teeth so they're set uniformly.

saw, with its fewer teeth and deeper gullets, is less likely to bind in the cut.

The major difference in sharpening a rip saw is in the angle you create on the teeth. Rip saw teeth come to a more acute point and are filed square rather than on a bevel.

Begin sharpening a rip saw by clamping it in your saw vise. Hold the file at 90° to the side of the blade and file each tooth straight across. (See Fig. 1.) Here, your aim is to create a vertical leading edge and a flat—not pointed—top edge. Again, use long, deliberate strokes until all the teeth look sharp. Then de-burr the saw and go back over any teeth you might have missed.

Filing a Backsaw

Backsaws, such as tenon saws, dovetail saws and other small saws, have teeth shaped with a mixture of crosscut and rip patterns. Their more numerous

teeth per inch (tpi) requires a delicate touch and some different techniques.

A **tenon saw**, sometimes called a “gents” saw (an archaic term describing tools for the hobbyist woodworker) has teeth configured like a rip saw’s. However, the teeth have less set so they’ll produce a finer cut.

You can sharpen this type of saw as you would a rip saw, but, because the teeth are so small and there’s a danger of filing too deep, I clamp the saw between two straight pieces of wood instead of putting it in the saw vise. This way, the wood limits the depth of the file’s cut. You begin filing straight across, and stop when the file makes a small kerf in the wood. (See photo, below.) In addition to controlling the depth of cut, this method also helps you keep track of which teeth have been sharpened and whether your file is cutting at 90°.

To sharpen a dovetail saw, you can use the same wood clamping technique. The teeth look just like a rip saw in profile, but you file their edges to create a bevel as on a crosscut saw. This makes the saw cut more cleanly than a tenon saw while still maintaining an aggressive action. When sharpening, file at a 30° angle to the handle of the saw while keeping the file perpendicular to the blade. To gain some confidence in maintaining the correct angle, you can pencil a few lines at 30° on your wooden clamp to help guide the file.

Modifying Your Saw

With all your saws properly sharpened, you can periodically do a rou-

tine tune-up by just sharpening the points of the teeth. However, there are some other changes you can make to your saws to help you get even better performance from them.

First, replace the factory handle. This will give you a more comfortable and beautiful tool. I pitch the angle of my handles forward 10° to 20° more than most commercial handles. That way, the force of my stroke is directly behind the saw, giving me better control through the cut. (See AW #26, page 21, and AW #29, page 47 for more on handle making.)

When you buy a new saw it usually comes with too much set. This makes for an easy cut because the blade is less likely to bind. However, the saw tends to wobble, and sawing a straight line becomes difficult. To make a more precise tool, reduce the amount of set by hammering the teeth. On a dovetail saw I remove the set altogether so I can get a thin kerf, similar to that created by Japanese saws.

On a crosscut saw, you can deepen the gullet slightly. This provides more clearance for the sawdust and thereby reduces binding. Do this by increasing the angle at which you file to roughly 20° from horizontal.

Another easy modification is to convert a crosscut saw into a rip tooth configuration by filing across the teeth at 90°. This is particularly effective on dovetail saws where most of the work is ripping; the result is a more aggressive cut that requires fewer strokes. You can still cut across the grain cleanly—for example, when sawing a shoulder—as long as you keep your saw sharp.

And keeping your saws sharp is what it’s all about. With a regular sharpening routine, the tool that used to gather dust will be a valuable part of your everyday tool chest. ▲



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When filing saws with small teeth, author clamps saw between blocks of wood, letting the teeth protrude above blocks. When the file cuts into the wood, he moves on to next tooth.



A magnifying visor, saw set and files (left) are some of the tools that make sharpening easier. To bring his antique saw vise to the proper height, author clamps it to a block of wood, then clamps wood in his bench vise (above).

TOOLING UP FOR SHARPENING HANDSAWS

There are many devices on the market for sharpening a hand-saw. Some are essential and some are just nice to have because they can help speed up the process. Here are several to consider:

A saw vise. This device (photo, top right) is a necessity for holding the saw blade for setting and filing. You can buy one used from an antique tool dealer or new (available from Frog Tool Co. Ltd., Box 8325, Chicago, IL 60680, 312-648-1270). Or you can save some money and make your own from shop scrap. (See drawing.) When making a scrapwood saw vise, be sure to spring the jaws somewhat by tapering their inside faces a little. This ensures that the vise will tightly grip the blade near the teeth.

A magnifying glass. Because most saw teeth are so small—especially on dovetail saws—you'll need some sort of magnifying glass to clearly see what you are doing. I find the Optivisor magnifying glasses are the best (available from Woodcraft, 210 Wood County Industrial Park, Box 1686, Parkersburg, WV 26102, 800-225-1153). Unlike a hand-held magnifying glass, this head-mounted gear keeps your hands free for sharpening.

A saw set. This pliers-like device (see photo, top left) bends the tooth to the proper angle when you squeeze the handle. Again, you can either try to find one used, or buy a new one through the mail (available from Garrett Wade, 161 Avenue of

the Americas, New York, NY 10013, 800-221-2942).

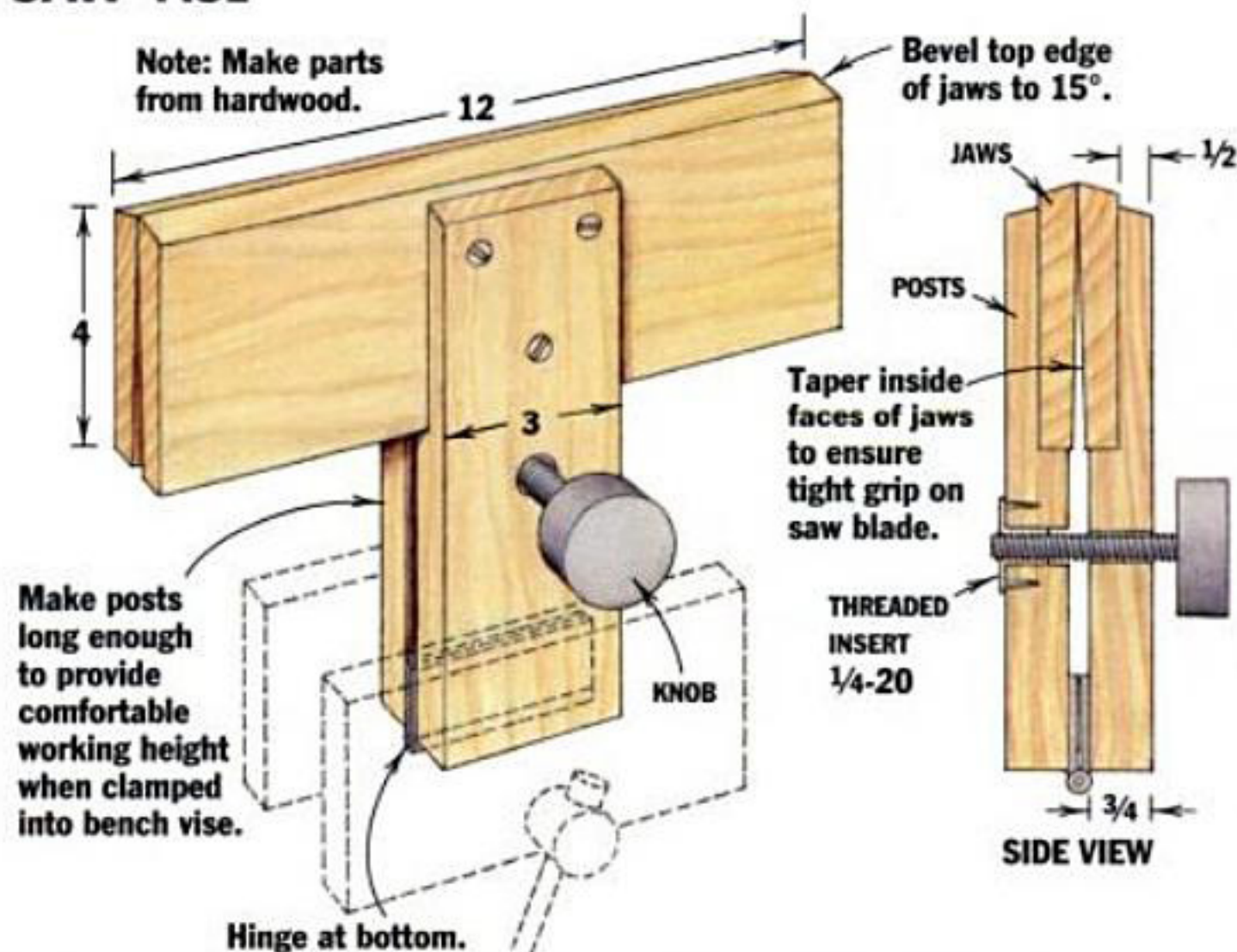
Files. You'll need a 10-in. mill file to joint the teeth, and to sharpen them you'll need a small triangular file called a saw file. This file tapers along its length, and comes in many sizes. Use the file chart as a general guide when selecting a file, but be aware that not all files are labeled similarly by suppliers. When in doubt, match the file directly to the size of the teeth on your saw. The proper size file will cut the front of one tooth and the back of the adjacent tooth with a single stroke. If it's too large it will widen the gullet,

creating too much space between each tooth. Too small, and the file will bounce around the teeth and sharpen only one surface at a stroke.

Always buy your files new (available from Garrett Wade). A used file is usually only good for cutting butter.—*M.R.*

TEETH PER IN.	TRIANGULAR FILE SIZE
4-8 tpi	7 in. regular
9-10 tpi	6 in. extra slim
11-12 tpi	6 in. double extra slim
13-19 tpi	4 in. extra slim
20-22 tpi	4 in. double extra slim

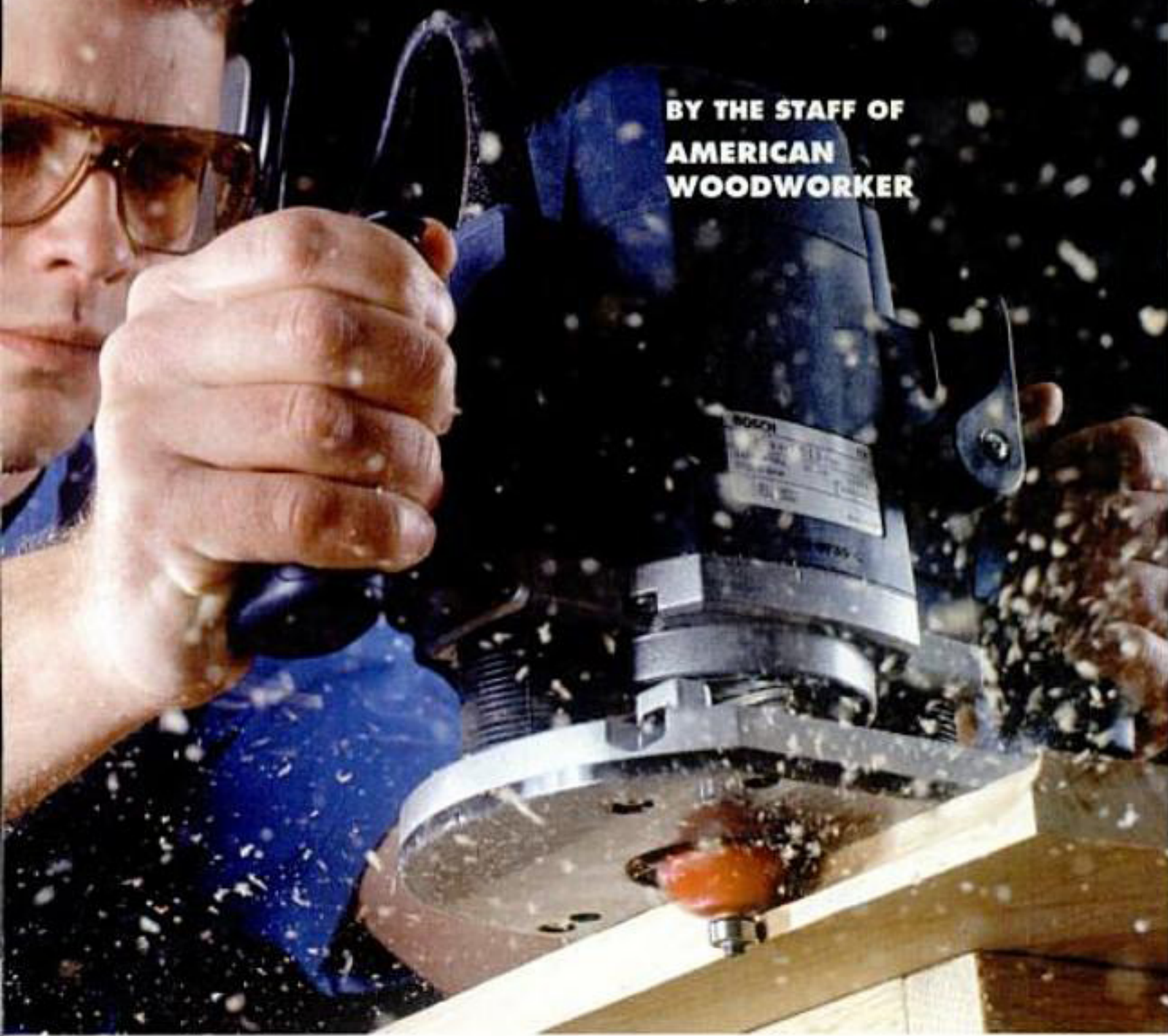
SAW VISE



BUYER'S GUIDE TO PLUNGE ROUTERS

*A Hands-On Test of
the Competition*

BY THE STAFF OF
**AMERICAN
WOODWORKER**



PHOTOS BY MITCH MAIDEL

Plunge routers were a simple curiosity when Elu introduced the first commercial model in 1949, but with the improved controls and features manufacturers have added in the last decade, they've caught on as one of woodworking's hottest tools. Today, there are some three dozen models sold in the United States. That's a lot to sort through in the hunt for the perfect router. And the only way to accurately compare performance and features is to look at *every* one—something most woodworkers can't do.

But **AMERICAN WOODWORKER** can. To provide you side-by-side comparisons, we gathered samples of every plunge router on the market in North America (five weren't available for our test), including some hot new units that will hit the stores about the time you read this.

We ran hands-on tests in the **AW** shop, where our editors and technicians checked out the routers and pushed them to their limits with a series of difficult cuts. We rated the routers for plunge action, ease of changing bits, convenience of controls, and ergonomics. Then we looked for additional features that added to a router's value. The results of our evaluation are summarized in the chart on pages 38 and 39, while the routers we rated highest are featured in the box on page 40. A more detailed analysis appears below, but before we get into that let's look at what makes a plunge router such a valuable tool.

Plunge Router Anatomy

Plunge routers sport the same basic motor, collet and base as fixed base

routers, but on plunge routers the motor and bit ride up and down on spring-loaded posts.

This means you can precisely plunge a spinning bit into the middle of a workpiece, lock the depth to make your cut, then let the springs safely retract the bit from the wood when you're through. You can also preset the depth of plunge, then quickly reset it to make stepped cuts by using the tool's depth scale and depth stop system.

Plunge routers are the perfect choice for cutting stopped grooves, sliding dovetails, mortises and the like. Yet you can also perform any operation a conventional router can do.

What To Look For

All plunge routers work basically the same way, regardless of their size and power. But as our tests showed there are some real differences in how easy they are to use. We identified seven key factors that affect operation. Below, you'll find an explanation of each one, along with tips to help you evaluate the market.

Plunge action: The most essential feature of a good plunge router is plunge action that is smooth and operates without slop—something that can affect your ability to precisely lower a bit into a cut. Also, since there will be times when you'll want to begin a cut with half the router base off the work, as when routing stopped dados, you'll want a router that won't hang up when the pressure on the handles is uneven. We found these types of cuts a problem with several of the routers.

The DeWalt routers had the smoothest plunge action by far, followed by the Elu and then the Porter Cable routers. The Black & Decker had the sloppiest plunge action because, instead of plunge posts, its motor rides loosely on two pins inside the base.

Our comparisons showed spring pressure varied widely, from stiff to very soft. Strong springs do the best job of retracting a bit from the workpiece, but they also make it harder to precisely control a plunge.

However, the springs must be strong enough to pull the bit out of the work. We downrated the small Hitachi routers because the springs on our two

[\(Continued on page 40\)](#)

HOW WE RATED THE ROUTERS

You can't rely on specifications alone when shopping for a router; you also want to know how it feels and performs in real-world routing situations. To evaluate this, we assembled a seven-man team of editors and technicians and spent the better part of a week putting our test routers through their paces, rating them on a scale from one (unacceptable) to five (excellent) for each of the criteria described in the main text. In the chart on pages 38 and 39, we've rated the three most important criteria—plunge action, changing bits and hands-on feel.

To arrive at the overall ratings shown in the chart, we factored in the rest of our criteria, weighting each factor according to its relative importance to performance. For example, plunge action, the most important feature, was given five times the weight of non-critical features like the depth scale and "fit and finish." To this weighted total we added bonus points for unique or desirable features, such as electronic variable speed control (EVS), micrometer depth adjustment and electronic braking.

Scores above 85 should be considered excellent; those ranging between 75 and 85, good; and, those under 75, fair. For practical purposes, routers within a given range should be considered roughly equal.



3-3 1/2 HP

Left to right, top row: Porter Cable 7538, Bosch 1615 EVS, Freud FT 2000E, Porter Cable 7539; Middle row: Hitachi M12V, Ryobi RE 600, DeWalt DW624, Bosch 1615, Bosch 1615 220-volt; Bottom row: Makita 3612 BRA, Sears 27506, Hitachi TR12, DeWalt DW625.



2-2 1/4 HP

Left to right, top row: Sears 27505, Elu 3338, Elu 3337; Bottom row: Skil 1875, Skil 1870, Bosch 1613 EVS.



1-1 3/4 HP

Left to right, top row: Bosch 1613, Black & Decker 7615, Porter Cable 693, Bosch 1614; Middle row: Skil 1835, Skil 1823, Hitachi M8, Hitachi M8V; Bottom row: DeWalt DW615, Bosch 1614 EVS, Makita 3620A.

PLUNGE ROUTERS

1HP - 1 3/4 HP

NAME/MODEL	MFR.'S HP	STREET PRICE	PLUNGE ACTION	CHANGING BITS	HANDS-ON FEEL	OVERALL RATING	COMMENTS	SWITCH TYPE
DeWalt DW615 (EVS)	1 1/4	\$175	●●●●●	●●●●	●●●●●	92.5	Knob handle doubles as plunge lock; exceptionally smooth plunge action	Slide
Porter Cable 693	1 1/2	\$187	●●●●●	●●●●	●●●●●	90.6	Very smooth plunge action; exceptional plunge lock lever	Toggle
Bosch 1614 (EVS)	1 3/4	\$159	●●●●	●●●●	●●●●●	89.4	Micro-adjust depth from any plunge position; bellows protect plunge posts	Trigger
Bosch 1613	1 3/4	\$175	●●●●	●●●●	●●●●●	87.9	Micro-adjust depth from any plunge position; bellows protect plunge posts	Trigger
Bosch 1614	1	\$141	●●●●	●●●●	●●●●●	87.9	Micro-adjust depth from any plunge position; bellows protect plunge posts	Trigger
Makita 3620A	1 3/4	\$129	●●●	●●●	●●●●	74.3	Electronic brake stops router instantly	Trigger (no lock)
Skil 1823	1 1/2	\$80	●●●	●●●	●●●	62.7	Shallow collet; awkward on/off switch	Toggle (On handle)
Skil 1835	1 3/4	\$85	●●●	●●●	●●●	62.7	Shallow collet; awkward on/off switch	Toggle (On handle)
Hitachi M8V (EVS)	1 1/2	\$164	●	●●●	●●	61.5	Plunge springs too weak to lift bit off wood; shallow collet	Slide
Black & Decker 7615	1 1/2	\$123	●●	●●●	●●●	61.4	No plunge posts-router motor slides within base; has work light	Trigger
Hitachi M8	1 1/2	\$120	●	●●●	●●	59.5	Plunge springs too weak to lift bit off wood; shallow collet	Slide
DeWalt DW614	1 1/4	\$150	Not available at time of test			—	Non-EVS version of Dewalt DW615	Slide
Elu 3303	1 1/4	\$150	Not available at time of test			—	Similar to Dewalt DW614	Slide
Elu 3304 (EVS)	1 1/4	\$175	Not available at time of test			—	Similar to Dewalt DW615	Slide

2HP - 2 1/4 HP

NAME/MODEL	MFR.'S HP	STREET PRICE	PLUNGE ACTION	CHANGING BITS	HANDS-ON FEEL	OVERALL RATING	COMMENTS	SWITCH TYPE
Elu 3338 (EVS)	2 1/4	\$300	●●●●●	●●●●	●●●●●	93.6	Very smooth plunge action; excellent depth scale	Slide
Elu 3337	2 1/4	\$265	●●●●●	●●●●	●●●●●	92.1	Very smooth plunge action; excellent depth scale	Slide
Bosch 1613 (EVS)	2	\$195	●●●●	●●●●	●●●●●	89.4	Micro-adjust depth from any plunge position; bellows protect plunge posts	Trigger
Sears 27505	2	\$189	●●●●	●●●●●	●●●	81.0	Plunge lock trigger in handle; collect machined on motor shaft; engaging spindle lock cuts power to motor	Trigger
Skil 1875 (EVS)	2 1/4	\$215	●●●	●●●●	●●●●	77.4	Wrench storage slot; bit storage in handle	Trigger
Skil 1870	2 1/4	\$192	●●●	●●●●	●●●●	75.9	Wrench storage slot	Trigger

3HP - 3 1/2 HP

NAME/MODEL	MFR.'S HP	STREET PRICE	PLUNGE ACTION	CHANGING BITS	HANDS-ON FEEL	OVERALL RATING	COMMENTS	SWITCH TYPE
Porter Cable 7539	3 1/4 (5 speeds)	\$288	●●●●●	●●●●●	●●●●●	96.7	Heavy production router, exceptional plunge lock lever	Trigger
Porter Cable 7538	3 1/4	\$253	●●●●●	●●●●●	●●●●●	95.2	Heavy production router, exceptional plunge lock lever	Rocker & Trigger
DeWalt DW625 (EVS)	3	\$315	●●●●●	●●●●	●●●●●	93.6	Exceptionally smooth plunge action; excellent depth scale	Slide
DeWalt DW624	3	\$285	●●●●●	●●●●	●●●●●	92.1	Exceptionally smooth plunge action; excellent depth scale	Slide
Bosch 1615 (EVS)	3 1/4	\$265	●●●●	●●●●●	●●●●●	91.8	Long depth adj. knob handy for router table No sliding cursor for zeroing depth scale	Trigger
Bosch 1615 (220 volt)	3 1/4	\$265	●●●●	●●●●●	●●●●●	90.3	More reserve power than 110-volt version No sliding cursor for zeroing depth scale	Trigger
Bosch 1615	3	\$240	●●●●	●●●●●	●●●●●	89.5	No sliding cursor for zeroing depth scale	Trigger
Freud FT2000E (EVS)	3 1/4	\$217	●●●●	●●●●●	●●●●●	85.7	Very responsive EVS; plunge lever locks when pulled up	Slide
Sears 27506 (EVS)	3 1/2	\$249	●●●●	●●●●●	●●●●	83.8	Plunge lock trigger in handle; collect machined on motor shaft; engaging spindle lock cuts power to motor	Trigger
Makita 3612BRA	3	\$217	●●●●	●●●●●	●●●●	79.1	Electronic brake stops router instantly	Toggle
Ryobi RE-600 (EVS)	3	\$215	●●●●	●●●●●	●●●	77.9	Long depth adj. knob handy for router table	Toggle
Hitachi M12V (EVS)	3 1/4	\$244	●●●●	●●●●	●●●	74.2	Soft plunge springs make fine depth control easy	Slide
Hitachi TR12	3	\$184	●●●●	●●●●	●●●	72.3	Soft plunge springs make fine depth control easy	Rocker
Bosch 1615 (EVS) (220 volt)	3 1/4	\$299	Not available at time of test			—	EVS version of Bosch 1615 220 volt	Trigger
Elu 3339 (EVS)	3	\$315	Not available at time of test			—	Similar to Dewalt DW625	Slide

* Optional collet

RATED

AMP RATING	SPEED (RPM)	PLUNGE DEPTH	DEPTH STOPS	FINE DEPTH ADJ. KNOB	PLUNGE LOCK	SPINDLE LOCK	COLLET DEPTH/ MAX. BIT LENGTH (IN.)	COLLET SIZES (DIA. IN IN.)	WEIGHT (LBS.)	NOISE (DB)
8.0	8,000-24,000	1 ¹⁵ / ₁₆	3 Adj.	Optional	Knob on handle	Yes	1 ¹ / ₈ - 3 ¹ / ₄	¹ / ₄	6.55	89.4
10.0	23,000	2 ¹ / ₂	3 Adj.; 3 Fixed	No	Push to unlock	No	1 ¹ / ₄ - 3 ¹ / ₄	¹ / ₄ , ¹ / ₂ , (³ / ₈)*	11.05	94.4
7.8	12,000-23,000	2	8 Fixed	Yes w/graduations	Push to unlock	Yes	1 ¹ / ₂ - 3 ¹ / ₂	¹ / ₄	8.25	89.6
10.4	25,000	2	8 Fixed	Yes w/graduations	Push to unlock	Yes	1 ⁷ / ₈ - 4 ³ / ₈	¹ / ₄ , ¹ / ₂ , (³ / ₈)*	10.15	91.2
7.5	27,000	2	8 Fixed	Yes w/graduations	Push to unlock	Yes	1 ¹ / ₂ - 3 ¹ / ₂	¹ / ₄	8.05	92.8
7.8	24,000	1 ³ / ₈	3 Adj.	No	Push to lock	No	1 ³ / ₈ - 2 ¹ / ₂	¹ / ₄	6.1	96.4
8.5	25,000	2	1 Adj.	No	Push to lock	Yes	⁷ / ₈ - 2 ³ / ₄	¹ / ₄	6.9	100.2
9.0	25,000	2	1 Adj.	No	Push to lock	Yes	⁷ / ₈ - 2 ³ / ₄	¹ / ₄	6.95	101.2
7.3	10,000-25,000	2	2 Adj.; 1 Fixed	No	Push to lock	Yes	⁷ / ₈ - 2 ¹ / ₂	¹ / ₄	7.65	96.4
9.0	25,000	2	1 Adj.	No	Push to lock	Yes	1 ¹ / ₈ - 2 ³ / ₄	¹ / ₄	7.75	97.4
7.3	25,000	2	2 Adj.; 1 Fixed	No	Push to lock	Yes	⁷ / ₈ - 2 ¹ / ₂	¹ / ₄	7.5	96.0
6.6	24,000	1 ¹⁵ / ₁₆	3 Adj.	Optional	Knob on handle	Yes	1 ¹ / ₈ - 3 ¹ / ₄	¹ / ₄	N/A	N/A
6.6	24,000	2 ¹ / ₂	3 Adj.	Optional	Knob on handle	Yes	1 ¹ / ₈ - 3 ¹ / ₄	¹ / ₄	N/A	N/A
8.0	8,000-24,000	2 ¹ / ₂	3 Adj.	Optional	Knob on handle	Yes	1 ¹ / ₈ - 3 ¹ / ₄	¹ / ₄	N/A	N/A

AMP RATING	SPEED (RPM)	PLUNGE DEPTH	DEPTH STOPS	FINE DEPTH ADJ. KNOB	PLUNGE LOCK	SPINDLE LOCK	COLLET DEPTH/ MAX. BIT LENGTH (IN.)	COLLET CAPACITY (IN.)	WEIGHT (LBS.)	NOISE (DB)
12	8,000-20,000	2 ⁷ / ₁₆	3 Adj.	Optional	Push to lock	Yes	2 ³ / ₈ - 4 ¹ / ₂	¹ / ₂ , (³ / ₈ , ¹ / ₄)*	12.95	98.4
12	20,000	2 ⁷ / ₁₆	3 Adj.	Optional	Push to lock	Yes	2 ³ / ₈ - 4 ¹ / ₂	¹ / ₂ , (³ / ₈ , ¹ / ₄)*	12.65	97.2
11.3	12,000-23,000	2	8 Fixed	Yes w/graduations	Push to unlock	Yes	1 ⁷ / ₈ - 4 ³ / ₈	¹ / ₄ , ¹ / ₂ , (³ / ₈)*	10.35	88.8
12	25,000	2 ¹ / ₂	3 Adj.	Yes	Trigger lock/ thumb release	Yes	1 ¹ / ₄ - 3 ¹ / ₈	¹ / ₄ , ¹ / ₂	11.95	98.1
11.5	10,000-23,000	2 ¹ / ₂	3 Adj.	No	Push to lock	Yes	1 ³ / ₄ - 3 ³ / ₄	¹ / ₄ , ¹ / ₂	10.25	94.4
12	23,000	2 ¹ / ₂	3 Adj.	No	Push to lock	Yes	1 ³ / ₄ - 3 ³ / ₄	¹ / ₄ , ¹ / ₂	10.15	94.8

AMP RATING	SPEED (RPM)	PLUNGE DEPTH	DEPTH STOPS	FINE DEPTH ADJ. KNOB	PLUNGE LOCK	SPINDLE LOCK	COLLET DEPTH/ MAX. BIT LENGTH (IN.)	COLLET CAPACITY (IN.)	WEIGHT (LBS.)	NOISE (DB)
15	10,000-21,000	3	3 Adj.; 3 Fixed	No	Push to unlock	No	2 ¹ / ₈ - 4 ³ / ₄	¹ / ₂ , (¹ / ₄ , ³ / ₈)*	17.7	99.0
15	21,000 (soft start)	3	3 Adj.; 3 Fixed	No	Push to unlock	No	2 ¹ / ₈ - 4 ³ / ₄	¹ / ₂ , (¹ / ₄ , ³ / ₈)*	17.7	100.4
15	8,000-22,000	2 ⁷ / ₁₆	3 Adj.	Optional	Push to lock	Yes	2 ³ / ₈ - 5	¹ / ₄ , ¹ / ₂ , (³ / ₈)*	13.45	98.8
15	22,000	2 ⁷ / ₁₆	3 Adj.	Optional	Push to lock	Yes	2 ³ / ₈ - 5	¹ / ₄ , ¹ / ₂ , (³ / ₈)*	13.15	100.0
15	12,000-19,000	3	8 Fixed	Yes	Push to unlock	Yes	2 ³ / ₄ - 4 ³ / ₄	¹ / ₄ , ¹ / ₂ , (³ / ₈)*	13.95	94.2
7	25,000	3	8 Fixed	Optional	Push to unlock	Yes	2 ³ / ₄ - 4 ³ / ₄	¹ / ₄ , ¹ / ₂ , (³ / ₈)*	13.1	101.2
14	25,000	3	8 Fixed	Optional	Push to unlock	Yes	2 ³ / ₄ - 4 ³ / ₄	¹ / ₄ , ¹ / ₂ , (³ / ₈)*	13.0	99.6
15	8,000-22,000	2 ⁵ / ₈	3 Adj.	Yes	Push to lock	Yes	1 ¹ / ₂ - 4 ¹ / ₄	¹ / ₄ , ¹ / ₂	12.1	97.4
15	10,000-25,000	2 ¹ / ₂	3 Adj.; 3 Fixed	Yes	Trigger lock/ thumb release	Yes	1 ¹ / ₄ - 3 ¹ / ₈	¹ / ₄ , ¹ / ₂	12.7	100.0
14	23,000	2 ⁹ / ₁₆	3 Adj.	No	Push to lock	Yes	1 - 3 ¹ / ₄	¹ / ₄ , ¹ / ₂	13.45	99.8
15	10,000-22,000	2 ³ / ₈	3	Yes	Push to lock	Yes	1 ¹ / ₄ - 3 ³ / ₈	¹ / ₄ , ³ / ₈ , ¹ / ₂	14.5	96.8
15	8,000-20,000	2 ⁷ / ₁₆	2 Adj.; 1 Fixed	Optional	Push to lock	Yes	1 - 3 ¹ / ₂	¹ / ₂ , (³ / ₈ , ¹ / ₄)*	12.85	97.6
12.2	22,000	2 ¹ / ₂	2 Adj.; 1 Fixed	Optional	Push to lock	No	1 - 3 ³ / ₄	¹ / ₂ , (³ / ₈ , ¹ / ₄)*	12.2	98.4
8	12,000-19,000	3	8 Fixed	Yes	Push to unlock	Yes	2 ³ / ₄ - 4 ³ / ₄	¹ / ₄ , ¹ / ₂ , (³ / ₈)*	N/A	N/A
15	8,000-22,000	2 ⁷ / ₁₆	3 Adj.	Optional	Push to lock	Yes	2 ³ / ₈ - 5	¹ / ₂ , (³ / ₈ , ¹ / ₄)*	N/A	N/A

units were the weakest in the test. In fact, with a 1/4-in. two-flute straight bit in the collet, the springs in the test routers were too weak to lift the bit off the work—a major safety problem in our opinion. The larger Hitachi TR12 and M12V worked better and their soft spring action is an advantage for delicate work.

Changing bits: Changing bits is one of the most time-consuming and irritating parts of dealing with any router, but the problem is heightened with plunge routers because you have to fit the wrench between the plunge posts and other projections. With that in mind, you'll want to look for wrench systems that are easy to use.

Nearly every router we tested (the Hitachi TR12 and the Porter Cable machines are the exceptions) has gone to a one-wrench system in which you activate a spindle lock with one hand, while using a wrench in the other to loosen the collet. The Sears router even took this technology a step further. Its collet lock stays on when you take your hand away, and there is a warning light to remind you it is engaged and an electronic lock-out that prevents the motor from turning. Most of us felt the one-wrench systems were easiest to use. However, two editors argued for the two-wrench system, saying it gives you greater control over the wrenches when you're trying to break loose a tight collet.

To reduce the chance that bits will stick in the collet, all plunge routers but the Makita 3620 and the two smaller Skils now feature a self-releasing collet. With this system, loosening the collet nut automatically draws the collet out of its socket so the bit can't stick. The only drawback is that on some routers, you have to turn the nut several turns after it is loose—a time-consuming inconvenience when using the wrench in the small space between the plunge posts.

On the Hitachi routers and the two larger Skil routers, the collets are inte-

OUR PICKS

Five routers deserved the title of Editors' Choice. Here's why we chose each:

The DeWalt DW625 EVS 1/2-in. router has plenty of power, bullet-proof construction and the smoothest plunge action of any router we tested.

At 17.7 lbs., the heavyweight Porter Cable 7539 1/2-in. router isn't your everyday router. But it's our first choice for all-day production routing.



Left to right, top row: DeWalt 625 EVS, Porter Cable 7539; Bottom row: Porter Cable 693, DeWalt DW615 EVS, Bosch 1613 EVS.

Porter Cable's 693 router with both 1/2-in. and 1/4-in. collets had tight construction and smooth plunge action. As an added plus, the slick plunge base is sold separately (about \$75) and will fit any 3 1/2-in.-dia. router body.

DeWalt's DW615 EVS, 1/4-in. router was the most versatile of the small routers and it showed the same quality construction and smooth action as its big brothers. The lock knob was a hit with editors as well.

The Bosch 1613 EVS router with 1/2-in. and 1/4-in. collets has solid features like micro-positioning, which allows you to make minute adjustments in depth even when the router is bottomed out in a cut.

gral with the collet nut so they release the bit easily with a fraction of a turn. We also found it extremely easy to remove bits from the Sears routers, but we downrated these tools because their collet was machined onto the motor's armature shaft, meaning if the collet becomes worn or damaged, you'd need to replace the entire armature.

Collet depth: Collet depth determines the length of bit you can safely use in a router, and as a general rule you want the collet to be deep enough to grip a bit's shank completely. If the collet is shallow, the bit may stick out too far, which increases vibration and tends to cause chattering during the cut. (This is less a concern with 1/4-in. routers because the bits are shorter.)

We gave bonus points to the routers with the deepest collets. (See chart for maximum bit length.) The small routers from Hitachi and Skil had the shallowest collets in the group.

Plunge lock levers: There are two major things to consider when evaluating a plunge lock lever. It should be easy to reach the lever without removing your hand from the router's handle and

you should be able to actuate the lever without interfering with the on/off switch (a problem on the Makita 3612). Routers that had lock levers and switches on opposite handles seemed the easiest and safest to use, since you can access the controls independently.

Most lock levers must be pushed to lock and pulled to unlock. But the Porter Cable and Bosch routers use a spring actuated lever that's always locked until you pull on it. After plunging you simply release the lever and it locks automatically. We gave this system high marks, as well as the DeWalt DW615's unique locking knob that doubles as a handle.

Switches: Our testers agreed that handle-mounted trigger switches were more convenient and safer than toggle or rocker switches mounted on the router body. However, for router table use, trigger switches can be difficult to reach and require a lock button to lock

on. (The Makita 3620A's trigger switch had no lock.) The Porter Cable 7538 featured both trigger and rocker switches.

Depth stops and depth scale: Depth stops allow you to quickly make multiple passes at incremental depths by turning a turret fitted with stops. These all worked reasonably well, however, the clear winners in this category were the Bosch 1613 and 1614 series routers. These units have an advanced system, with eight stops fixed at 1/8-in. intervals and a micro-positioning knob that allows you to make minute adjustments in depth even when the router is locked on a stop, or bottomed out in a cut. This would prove handy when doing inlay work, or when making dovetails with a jig, where a few thousandths means the difference between a sloppy and a perfect fit.

Frankly, though, our editors find they rarely use multiple depth stops for incremental cuts since exact depth isn't critical. It's just as easy to vary the depth by eye.

Every plunge router has a mechanism to let you preset plunge depth. On most routers you adjust a vertical rod in relation to a scale so the rod will strike one of the depth stops when you reach the desired plunge depth. The depth scales are easiest to use on routers that allow you to "zero" the rod to the scale after locking the bit on the work surface. All but the Freud, Ryobi and the small Skil machines had systems that worked this way. Setting the depth rod was easiest on the Elu, DeWalt, Hitachi and Black & Decker routers, which feature rack-and-pinion adjustment. The DeWalt and Elu also sport a magnified pointer that lets you see the scale easier.

We find routers with long, top-mounted depth adjustment knobs work best in router tables.

Fit and finish: On a few routers we discovered that either the plastic baseplate was slightly smaller than the cast-metal base it was screwed to or the base was not perfectly concentric with the bit. These things can create problems when you're depending on the baseplate to have a constant diameter as you run it against a stationary fence. Also on the Sears routers, there were projections sticking out from the metal base that could strike the fence

SOURCES

Plunge routers are available from the following companies:

- ▶ **Black & Decker**
(800) 762-6672
CIRCLE #613
- ▶ **DeWalt Industrial Power Tools**
(800) 433-9258
CIRCLE #614
- ▶ **Elu**
(800) 762-6672
CIRCLE #615
- ▶ **Freud**
(800) 334-4107
CIRCLE #616
- ▶ **Hitachi**
(404) 925-1774
CIRCLE #617
- ▶ **Makita**
(714) 522-8088
CIRCLE #618
- ▶ **Porter Cable**
(901) 668-8600
CIRCLE #619
- ▶ **Robert Bosch Power Tool Corp.**
(919) 636-4200
CIRCLE #620
- ▶ **Ryobi**
(800) 323-4615
CIRCLE #621
- ▶ **Sears**
(See your nearest Sears store)
- ▶ **Skil**
(312) 286-7330
CIRCLE #622

and throw off your cut depending on how you turn the router.

Special Features

Beyond the basics of a good router, you'll want to consider special features that add to its value. We found two that were especially good: electronic variable speed (EVS) and electric brakes.

Thirteen of our test routers had EVS, which enhances performance in three ways: First, "soft start" circuitry brings the motor up to speed gradually rather than accelerating with a jerk. (Porter Cable's non-EVS 7538 model also has "soft start.") Second, a variable speed dial allows you to select lower speeds for operating large diameter bits more safely and for performing deep plunge cuts in hardwood where the bit may

overheat. Third, at slower speed settings EVS acts like a governor to keep the rpm constant even under varying loads and feed rates. EVS adds \$20 to \$50 to the cost of a router, but we feel it's worth it.

Only the two Makita routers had electric brakes, which instantly stop the routers when you release the trigger. But this is such a strong safety feature other manufacturers should consider adding it as well.

In addition, some routers deserve special mention for individual features. The new Sears routers showed innovation in the design of their handle-mounted plunge lock levers, and collet lock warning lights. And we especially liked Bosch's 1613 and 1614 series routers for their micro-adjusting depth knobs and their quick-change system for template guides.

Our Recommendations

So which router is the best? Overall, we named five as our Editor's Choice. (See opposite page.) But we chose these without concern for price, only looking for which routers represented the best mix of features and performance in their power ranges. All the routers we tested will get the job done, and ultimately, that, along with cost and features, should influence what router you choose.

As for general recommendations, if you're a professional who needs a router for continuous duty and wants years of service, look for a high horsepower unit in the higher price range.

If you can afford two routers (and you'll probably be happier with the results if you can), buy a small, lightweight unit for precision work like dovetails and inlay, and a heavy-duty, high-horsepower machine for panel raising and router table work. If you can only afford one router, look for a versatile medium-size machine in the 2 to 2½ HP range.

Also, don't write off the less-costly routers. Though they tended to have poorer fit and finish than their larger, costlier brothers, when viewing their lower ratings, keep in mind that these routers might be perfect for the woodworker on a budget, or the tradesman who's looking for a knock-about jobsite router. ▲

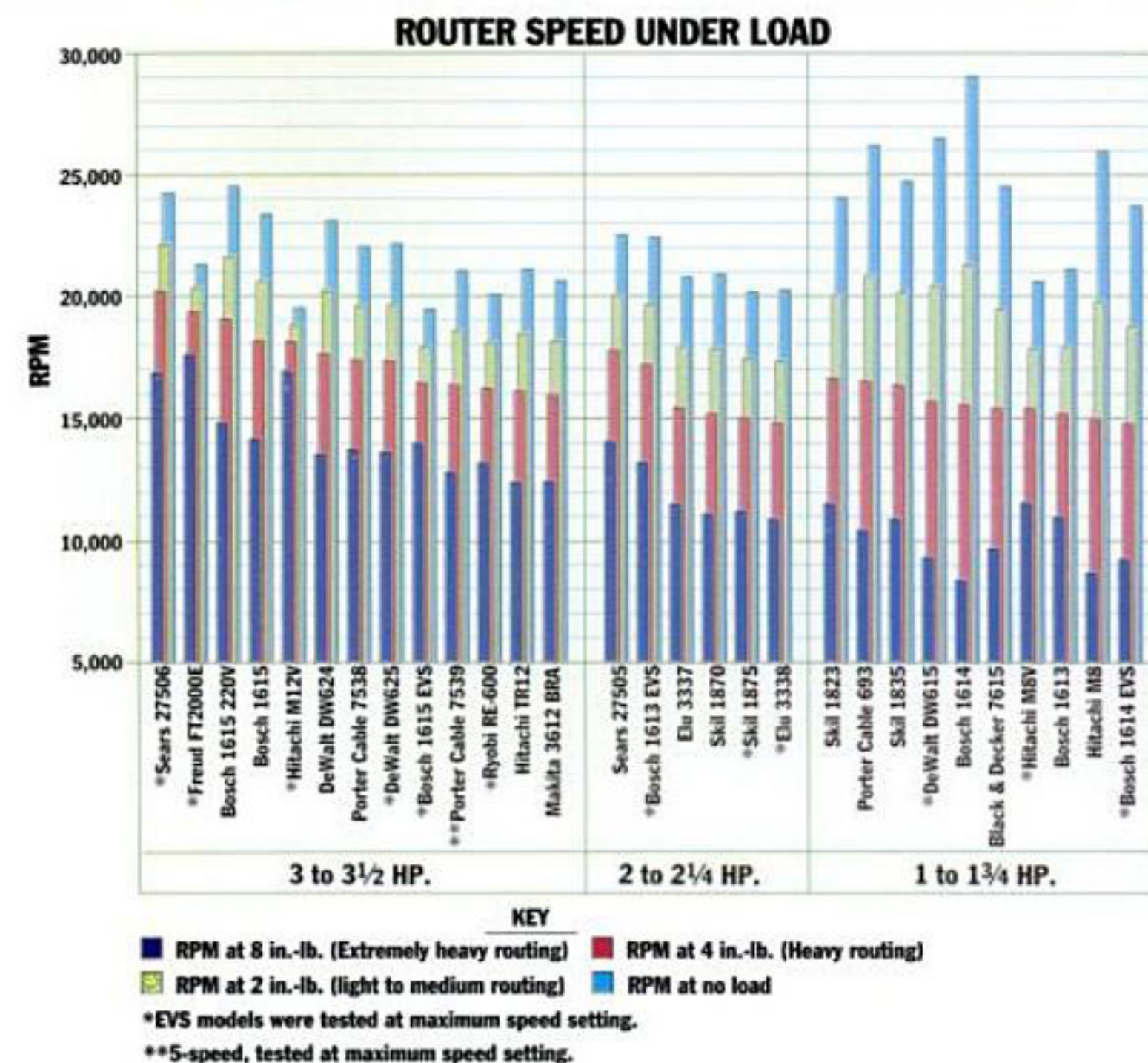
Power is usually one of the first considerations when you shop for a router. But, how do manufacturers' horsepower ratings relate to real-world router performance? Is there any difference between routers with the same horsepower ratings? Our tests showed that there is.

Manufacturers rate routers according to "peak horsepower," the maximum horsepower the motor can produce under abnormally heavy loads. At peak HP, a router draws so much current (as much as 70 amps for a 3½-HP router rated at 15 amps) that it can sustain peak HP for only a few seconds before blowing the fuse or burning the motor. Since you rarely, if ever, push a router that hard, peak HP ratings aren't a good measure of realistic router performance. Peak HP ratings *are* useful for grouping routers into power classes, as we've done on the charts, but they don't help you compare between identically rated routers.

Nameplate amp ratings can also be misleading for making power comparisons. These ratings indicate a current level (amps) at which the router can run continuously without exceeding temperatures stipulated by Underwriters Laboratories. Manufacturers can choose whatever rating they like, and some routers are rated more conservatively than others. For example, a large router rated at 15 amps might be able to pass the UL test at a higher amp rating, but then it would have to be equipped with a 20-amp plug, making it difficult to sell. So, a higher amperage rating on the nameplate doesn't *necessarily* mean that router can do more work than another.

A Real-World Power Test

For a better index of relative power, we first had to determine the current draw (amps) at which real work occurs. To do this, we took amp readings for several typical router tasks, from light edge work and shallow grooves to some very aggressive passes with large cutters. Although rpms dropped and the routers drew more amps as the work load increased, we tended to compensate for the slowdown in motor speed by reducing our feed speed, allowing rpms to climb back to accept-



able levels. (There is a limit to this strategy, though: Too slow a feed rate can cause burning.)

Next, we tested the plunge routers—29 in all—on a *dynamometer* similar to those used by manufacturers to rate router power. By accurately (+/-3 percent) measuring voltage, amperage, rpm and output torque of these routers at actual routing loads, we were able to get a more realistic picture of router performance than peak HP or amp ratings alone could provide.

We found that at their rated amperage (equivalent to heavy routing), the routers delivered only about 50 percent of their peak horsepower. But, since router amperage isn't rated consistently, we couldn't trust these measured horsepower figures to point out real differences between routers.

A better indicator of relative power is *rpms at load levels equivalent to typical router tasks*. (See chart.)

At light-to-moderate loads (2 in.-lbs. torque), equivalent to light edge work and shallow grooving operations, we found all the routers equal to the task. At heavier loads (4 in.-lbs.) the 1 to 1¾-HP routers began to slow down. (See chart.) And, at very heavy loads (8 in.-

lbs.), like you'd encounter if you suddenly cut into a knot, even the more-powerful routers slowed noticeably and drew more than their rated amps.

We concluded that, for general-purpose routing, any of the plunge routers we tested will do; but, for heavy routing with large bits, or for router table applications, we recommend a router from one of the higher horsepower groups. (See chart.) These routers slow down less under heavy loads.

In the final analysis, power isn't everything, and we didn't factor it into our overall ratings. Small differences in power within a given class are not as important, in our view, as the other factors we evaluated in the chart on pages 38-39.

Thanks to: Robert G. Flower, ASQC-certified quality control engineer at Applied Science Associates, Lehigh Valley, Pennsylvania, for designing and running our dynamometer tests; Tom Gavigan, registered professional engineer and assistant professor of general engineering at Penn State University, for reviewing our test procedure and Ametek Instruments, for supplying the precision digital phototachometer used in our tests. ▲



PHOTOS BY MITCH MANDEL

*Accent Your Furniture
With These Crisply
Shaped Edges*

EDGE TREATMENTS

BY DICK BURROWS

When I was first learning to build furniture, I was proud of the sharp, square edges on the pieces I made. Then I stumbled across an article that explained how woodworkers could improve their work just by shaping those edges.

It was a simple enough tip, so I bought a router and a few bits and set to work. Soon I was deep into a shaping binge, embellishing every edge on every piece I made.

I came back to reality after my wife pointed out that the little table I had made for her looked "a little busy." That's code in our house for UGLY. So I reread the article, and this time noticed the parts about "restraint," and "components relating to each other." I began to understand that, to be successful, edge treatments had to be more than an afterthought or a router trick.

Later, I learned I didn't need a router to create interesting edges. There's a variety of hand tools, from planes to scratch stock, that can help you make profiles that display your personal flair.

Why Mess With the Edges?

There are a number of good reasons you should work your edges. First, they can be dangerous if left square. Bumping your elbow or finger on a sharp edge is painful. And edges can be downright hazardous to the foreheads of children running through the dining room. Sharp edges also tend to break off if the furniture is subjected to much use. Open grain woods like oak often splinter along a sharp edge, creating a needle-like hazard that will draw blood until someone tears it out.

But more importantly, edge treat-

ments can dramatically affect the tactile and visual qualities of furniture. A gentle curve or bevel feels better to the touch. And visually, edge treatments pull a piece of furniture together, the way a pleasing harmony of colors make a shirt, tie and jacket match. Edge treatments can also accent a certain feature of your design, as padded shoulders accent a coat.

One way edge treatments create harmony is by changing the way light reflects from the piece, leading your eye from one detail to another. Look at how a bevel cut along the inside of a picture frame leads you around the picture and emphasizes its importance. The size and pitch of an edge treatment greatly affects its impact. (See Fig. 1.) Generally, sharper curves and thinner projections reflect more brightly than more massive, gently rolling contours.

Finally, you can use edge treatments to create illusions. Say you have a table with a 2-in.-thick top, but you don't want the edge to look like a 2x4. You



When routing edges, these bits (cove, round-over, ogee, chamfer) will make most basic profiles.

can trick the eye into perceiving the top as being thinner than it really is by simply undercutting or chamfering it. (See Fig. 2.)

Designing Edge Treatments

The choice of shape and contour in edge treatments is limited only by your imagination and the time and energy you have to spend. Fig. 1 shows some basic shapes and variations. If you don't want to work out your own shapes, take advantage of the hundreds of sizes and configurations of available router bits (see photo) or the shapes of old molding planes and build on those.

Most common edge treatments are derived from Greek and Roman architectural styles, which are still good sources of inspiration for design. When I create new edge treatments, I like to sketch them out freehand. Then I practice cutting them on some scrap until I get the result I'm after.

There's another reason to make trial cuts: It helps you avoid the pitfall of mistaking a treatment's appearance on a drawing with its appearance on a finished piece. An edge treatment might look great staring back at you from your drafting table, but nobody is likely to see the real piece from that angle. You need to consider the edge treatment's relationship to the viewer's eye.

To understand this principle, think of the moldings seen at the top and bottom of large carcasses. Moldings above eye level are arranged so the highest component protrudes most and the decorative elements below it face downward. The opposite is true for moldings near the bottom: the individual components recede as you go up the piece, so the decorative effect is visible from above.

The species of wood you use is another consideration to keep in mind when planning edge treatments. Woods like maple can take fine details because they cut crisply and cleanly and aren't prone to splintering. Open grain woods like oak work better with larger curves and chamfers.

The treatment must also suit the style of the piece and be in proportion to its other components. You wouldn't want to put a fancy Victorian edge on a Shaker-style trestle table.

FIG. 1: EDGE TREATMENTS

BASIC SHAPES	VARIATIONS		
 ROUND-OVER	 ROUND-OVER WITH FILLET	 BULLNOSE	 THUMBNAIL
 CHAMFER	 CHAMFER TOP AND BOTTOM	 CHAMFER TOP AND BEVEL BOTTOM	
 COVE	 COVE AND FILLETS	 COVE AND QUARTER ROUND	
 OGEE	 ROMAN OGEE WITH FILLET	 REVERSE OGEE WITH FILLET	
 BEAD	 SIDE BEAD	 COCKED BEAD	

DRAWING BY FRANK ROHRBACH



PHOTOS BY DICK BURROWS



Author cuts small grooves or beads with a Dremel-type tool mounted on a base that has a guide fence (above left). A simple shop-made guide block and chisel makes it easy to cut crisp ends on a stopped chamfer (above right).

Methods of Making Edge Treatments

Chances are you'll never run out of ways to shape an edge. Routers and shapers are probably the most common power tools used, but there are many alternatives. To form small grooves and beads, I often use a Dremel-type tool mounted in a stand that has a fence. It works like a mini-router. (See photo.)

Hand tools serve equally well for shaping an edge, and they take almost

no set-up time for quick jobs. Hand planes are a natural—from a simple block plane to an elaborate Multi-plane with numerous cutters. Carving tools and scratch stocks can decorate an edge, but the process is somewhat tedious. I also have a couple of old wooden molding planes designed to cut hollows and rounds that I use to carve out all kinds of shapes. Hand tools will also help you avoid the "manufactured look" of perfect routed edges.

I like to work with these other tools

FIG. 2: DESIGNING WITH EDGE TREATMENTS

Uppercut edge makes top appear more massive.



Undercut edge makes top appear thinner.



but I still find a router is easiest to use when creating standard edge profiles. When routing, I always form the edge in several passes to ensure the final result is clean and crisp. Even if I only have to remove a small amount of wood, I'll still use two passes: the first to clear out most of the waste, the second with the bit set just a whisker deeper to polish the edge.

If you tire of the stock shapes offered by router bits, try creating new profiles by combining the shapes from two or more router bits. (See Fig. 3.)

Be careful when sanding routed edges. A power sander can obliterate the shape in a hurry if you're not careful.

Working With Chamfers

I used to be pretty casual about chamfers until my son took shop in junior high. "A properly shaped chamfer is two passes with a sharp block plane. Not one. Not three. Two passes," he would recite. That works, as long as you hold the plane at a consistent angle and take the same amount of wood off each of the corner's faces.

An easier way to get a chamfer with the proper proportions is to scribe lines along each surface with a cutting gauge, then cut to the lines with a plane, draw knife, flat-bottomed spoke-shave or scraper. (Don't scribe the lines too deeply or you'll be stuck with a slit on the flat surface.) You can also rout a chamfer with a V-groove router bit or bearing-guided chamfering bit.

Stopped chamfers are common in

traditional woodworking. They look best when the stopped ends are cut at the same angle. To cut the angled chamfer ends, I use an L-shaped guide block that is notched out to guide a chisel as shown in the photo on the previous page. Then I remove the waste in between with a plane or draw knife.

Another interesting variation is a chamfer that tapers. This can be very effective on a tapered leg, if the width of the chamfer decreases as the leg gets smaller. I create this effect with a draw knife and just reduce the depth of cut as I move along.

Round-Over Treatments

The simplest round-over treatment is what we used to call "breaking the edge." You can do this freehand by slightly rounding the apex of the edge with sandpaper. Or run an electric pad sander along the edge, wiggling it left and right to get the round-over effect.

For a more pronounced effect, use a round-over bit in a router. Evenly rounding over the top and bottom will create a *bullnose* edge. Or, if you don't like such symmetry, you can change the radius of the curves by using different bits for the top and bottom.

You also can accent a round-over by adding a fillet, or small step, to mark the end of the curve. Some round-over bits have a flat above their curved cutting edge to cut a fillet at the same time they round the edge.

Coves and Ogees

Coves and ogees are more detailed than simple round-overs, and they'll give your piece a feeling of elegance.

An ogee router bit forms a classical S-shape contour. Roman ogee bits are similar, but they cut a fillet and recess the S-shape slightly. A simple cove can be embellished by adding fillets as shown in Fig. 3.

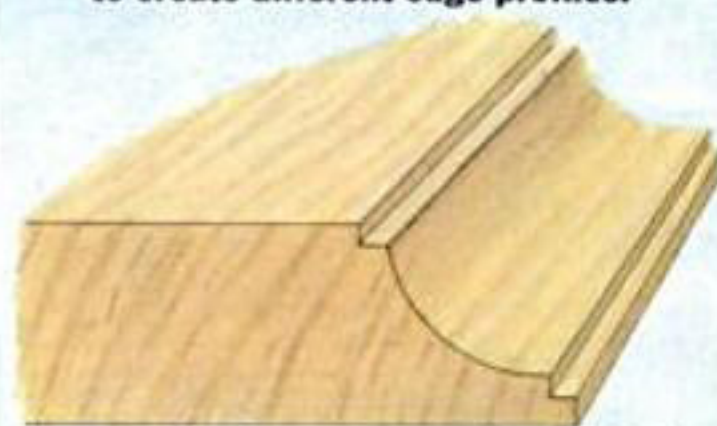
Handling End Grain

Shaping long grain edges with routers or hand tools is no problem. But end grain can give you trouble because it's prone to chipping when cut with hand tools, especially dull ones. The best way to handle this is to use razor-sharp tools and back up the edge with a piece of scrap to keep it from tearing.

Though less of a concern with

FIG. 3: CREATING COMPLEX SHAPES

Combine two or more router bits to create different edge profiles.

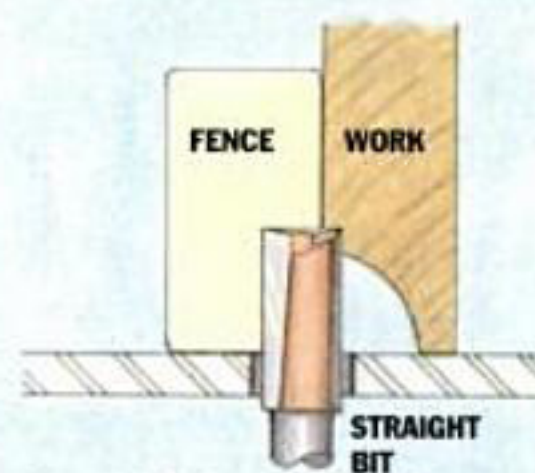


For example, to produce a cove with fillets:

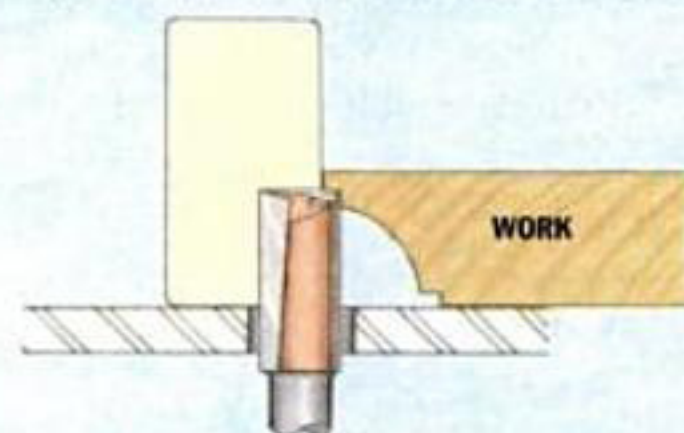
Step 1. Cut cove.



Step 2. Cut one fillet on router table.



Step 3. Cut second fillet on router table.



router bits, tear-out is still possible. I usually sidestep the problem by routing the end grain sections before the long grain ones. That way the long-grain cut smooths out any tear-out on the end grain. You can also back up the end grain section with a piece of scrap, or rout from the edges toward the center. ▲



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ROUTER SAFETY

*Carelessness and
Common Mistakes
Are to Blame for
Most Router
Accidents*

BY ELLIS VALENTINE

In their brief history, routers have had a good safety record, compared with tablesaws, radial saws, lathes—even drill presses. Still, any sharp object spinning at speeds from 10,000 rpm to 25,000 rpm deserves some respect. At these speeds, two-flute router bits make 333 to 833 cuts per second, with rim speeds up to 250 mph, depending on bit diameter. That's fast enough to produce a fine cut on wood—or a disastrous one on a finger.

Avoid Common Mistakes

Most router-related injuries are caused by the same handful of operator mistakes. Some of these are simply carelessness, like forgetting to pull the plug when changing bits or plugging in a switched-on router. Other common mistakes aren't so obvious, especially to beginners. Here are some ways you can make your router work safer:

Never pick up a fixed-base router from the work while the bit is still moving. This practice accounts for more injuries than any other. If you lift the spinning bit, it's very likely to catch on the workpiece and instantly twist the router. Sometimes, the bit will snap (especially one with a 1/4-in. shank), or you will lose control of the router. Plunge routers were developed largely in response to this hazard. They allow you to accurately raise the bit from the work at the end of a pass, without moving the router base.

Never start the router when the bit is touching the work. This rule applies to edge work, such as rounding over or chamfering, as well as to grooving or mortising. If the bit is in contact with the work, the initial force of starting the router can cause the bit to run quickly along the groove or

the edge, again causing loss of control.

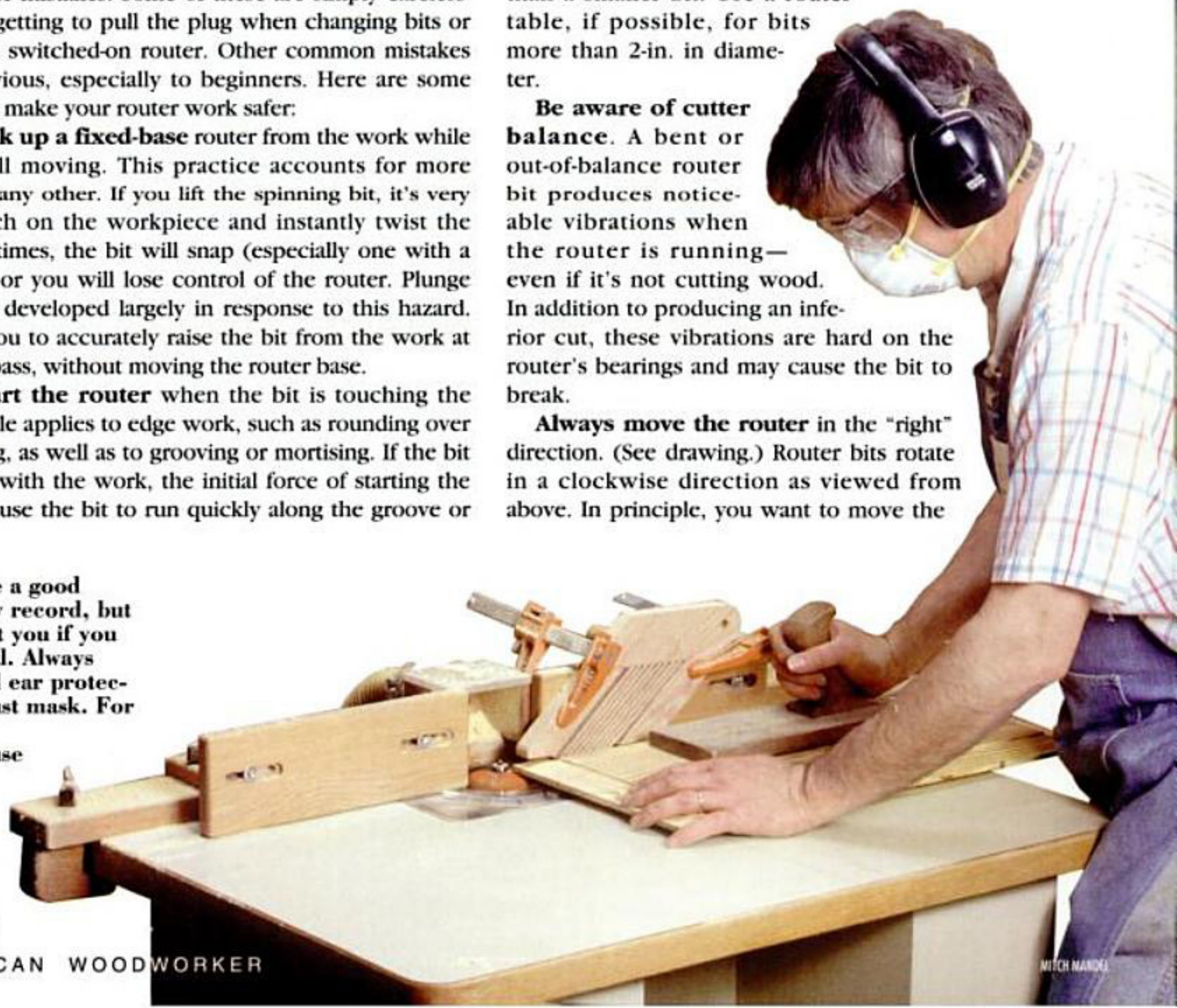
Don't let the router base tip as you cut. Tipping is a concern when you're routing the edge of a board and more than half the router base is off the work. Try to keep one of the router handles over the workpiece and consciously exert downward pressure on that handle while routing.

Be extra careful with larger bits. Larger-diameter bits are more dangerous than smaller ones because they have larger cutting edges and more momentum (a measure of force that increases with mass). When a large bit bites too deeply into the work, it produces a more violent kickback than a smaller bit. Use a router table, if possible, for bits more than 2-in. in diameter.

Be aware of cutter balance. A bent or out-of-balance router bit produces noticeable vibrations when the router is running—even if it's not cutting wood. In addition to producing an inferior cut, these vibrations are hard on the router's bearings and may cause the bit to break.

Always move the router in the "right" direction. (See drawing.) Router bits rotate in a clockwise direction as viewed from above. In principle, you want to move the

Routers have a good overall safety record, but they can hurt you if you aren't careful. Always wear eye and ear protection and a dust mask. For router table operations, use feather boards and a push stick to keep your hands away from the bit.



router in the same direction as the cutting edge of the bit. If you rout in the other direction, the bit could "climb" away from the wood and run out-of-control along the edge of your workpiece.

A qualified exception to this rule is a technique called *climb-feeding*. Here, you purposely move the router in the "wrong" direction to reduce tear-out on wood whose grain is sloping outward (toward the cutter's edge) at the point of cut rather than inward.

To climb-feed successfully, you should not force the router bit into the work; rather you should let it seek its own depth of cut, while you firmly restrain the router from taking off along the work. Depending on how much material you have to remove, it may take several passes to reach the desired depth. If possible, use one of the new "anti-kickback" bits. (See page 53.) These limit the depth of cut to about 1 mm and make climb-feeding safer.

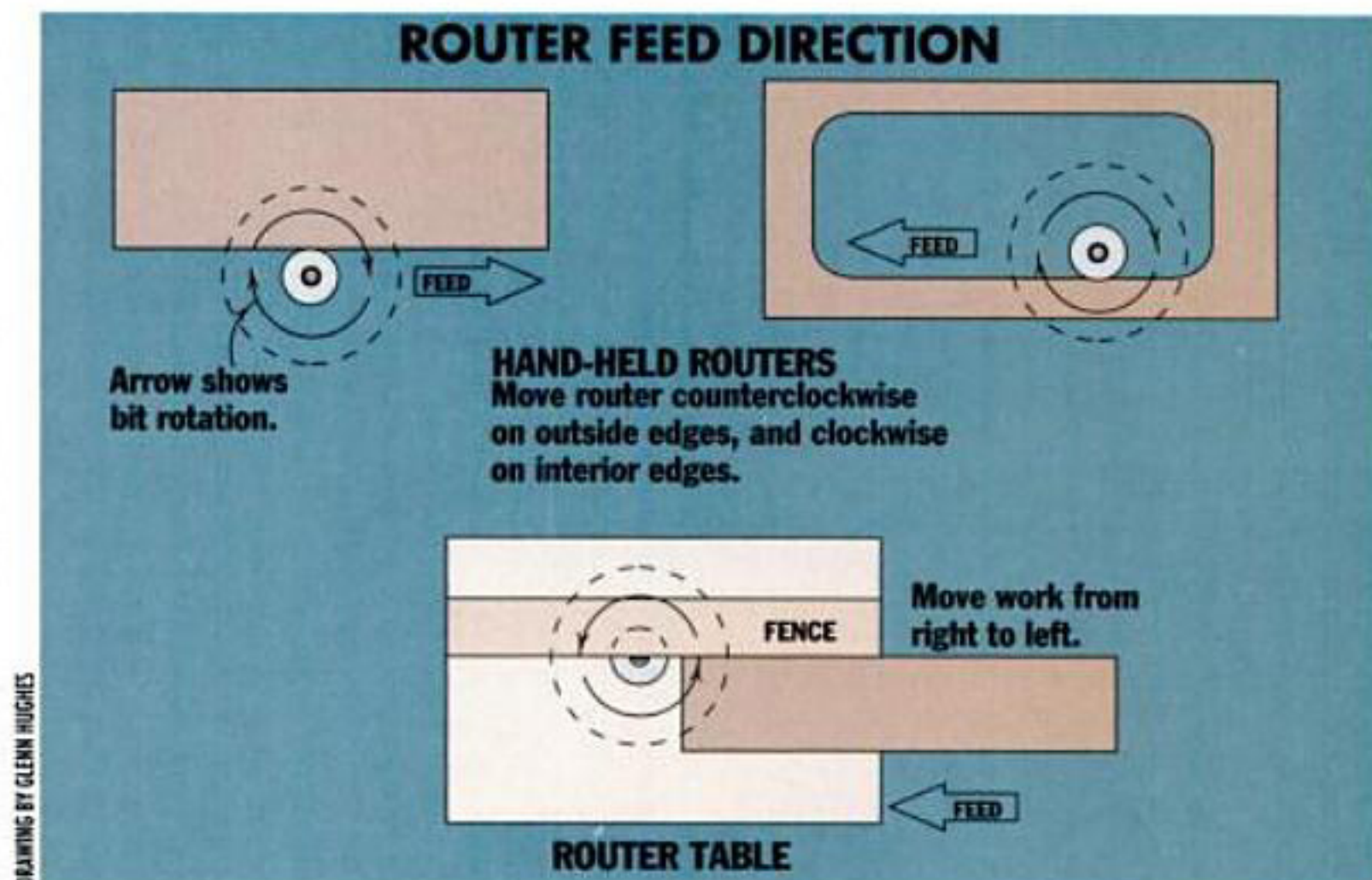
Keep cutters sharp. Dull cutters, in addition to leaving burn marks on your work, can cause a variety of problems. For one, they increase *feed resistance*, so you're forced to exert more pressure on the router, which, in turn, strains the router motor and puts you off balance. Another danger of dull cutters is the possibility of fire, especially when cutting grooves. Dull bits heat up quickly and may cause accumulations of dust to smolder or ignite.

Select an appropriate speed for your cutter. Most straight bits and small-diameter cutters perform best at top speeds, but large-diameter bits will cut more smoothly and burn less at slower speeds. If you plan to use large cutters (2-in. dia. or larger), consider purchasing a variable speed router.

Don't use a longer bit than necessary. Straight cutters and flush-trimming bits in particular are available in many flute lengths. The longer the bit, the more it will deflect in use. This could lead to chatter and bit breakage.

Don't make deep plunge cuts with a fixed-base router. It's relatively safe to ease a fixed-base router into a shallow groove, but save those deeper mortises for your plunge router.

Don't "bottom out" the bit in the collet. Leave a gap of at least $\frac{1}{16}$ in. below the bit to help the collet grip the bit evenly.



DRAWING BY GLENN HUGHES

Tighten the bit in the collet. Though this rule may seem obvious, it's not unusual for a bit to work itself loose. Be particularly careful when using an auxiliary collet bushing to hold a $\frac{1}{4}$ -in.-dia. shank in a $\frac{1}{2}$ -in. collet. Phenolic (fiber) bushings are more likely than steel ones to allow bits to slip.

Be careful with spiral bits. These are available in two basic configurations—*up-spiral* (left-handed twist) and *down-spiral* (right-handed). Down-spiral bits are handy for routing thin or brittle veneers cleanly, as when you plan to inlay a feature strip in a veneered tabletop, because they shear the edges of the cut downward. Up-spiral bits are good for mortising because they eject chips well.

Either type of spiral cutter can give you a nasty surprise if you don't take its cutting action into account. Down-spiral bits tend to push the work away while up-spirals pull the work into the bit. When mortising with an up-spiral bit, be sure you control the plunge rate by setting the incremental depth stops (all plunge routers have these) to manageable steps. If you don't, the bit can pull itself into the wood very quickly and ruin your whole day.

Router Table Dangers

A router table turns a router into a small shaper, and, while it allows you to rout small parts with control and accuracy, it shares many of the hazards of shapers—and merits similar safety precautions:

Make sure the router motor is

properly secured in its base. If, because of vibration or any other reason, the mechanism holding the router motor in the base fails, the motor can drop out of the base and wreak havoc. This is more likely with plunge routers because people are tempted to release the locking mechanism and rely on the adjustment knob to hold the router at the desired height.

Use a fence, chip guard, hold-downs and dust collection whenever possible. Safety shields and dust collection attachments help keep flying chips out of your face, and feather boards will help you produce smoother, more consistent cuts while keeping your fingers away from the spinning bit. Remember that smaller workpieces are more likely to kick back or to dive into the opening in the table or fence.

Make Safety a Habit

Safety is everyone's business. Employers and tool manufacturers go to great lengths to provide safe workplaces and tools, but ultimately, every person who operates a power tool or machine must assume responsibility for his or her own safety. With practice, the "rules" will become second-nature to you, and you'll go on to new levels of proficiency. But if you don't work defensively, you'll find yourself learning safety a bit more pointedly—through your mistakes. ▲

ELLIS VALENTINE
is associate editor of AW.

ROUTER

STORAGE CABINETS

Here Are Two Ways To Organize Your Bits and Pieces

BY ELLIS VALENTINE

Like many hand-held power tools, routers present a storage problem. Besides finding a home for the tool itself, you have to store the wrenches, bits, edge guides and a variety of other accessories. Here are two simple storage cabinets, one for bits and accessories that you can hang on a Lally column (or wall), and another wall-mounted or bench unit that holds three routers as well. You can alter the sizes

to suit your own collection of router gear. Just be sure you plan for future acquisitions, especially bits.

Construction is easy, and materials should be inexpensive—wood scraps, odd pieces of plywood and miscellaneous hardware. Large hose clamps like those shown in Fig. 1 are available at many auto parts stores. Depending on how you feel about glass in the shop, you might consider substituting

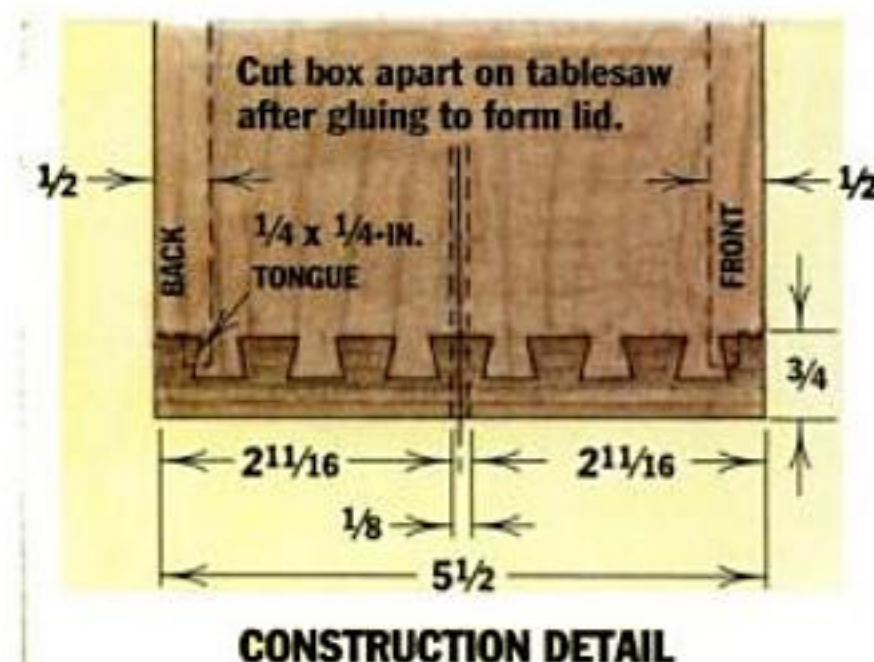
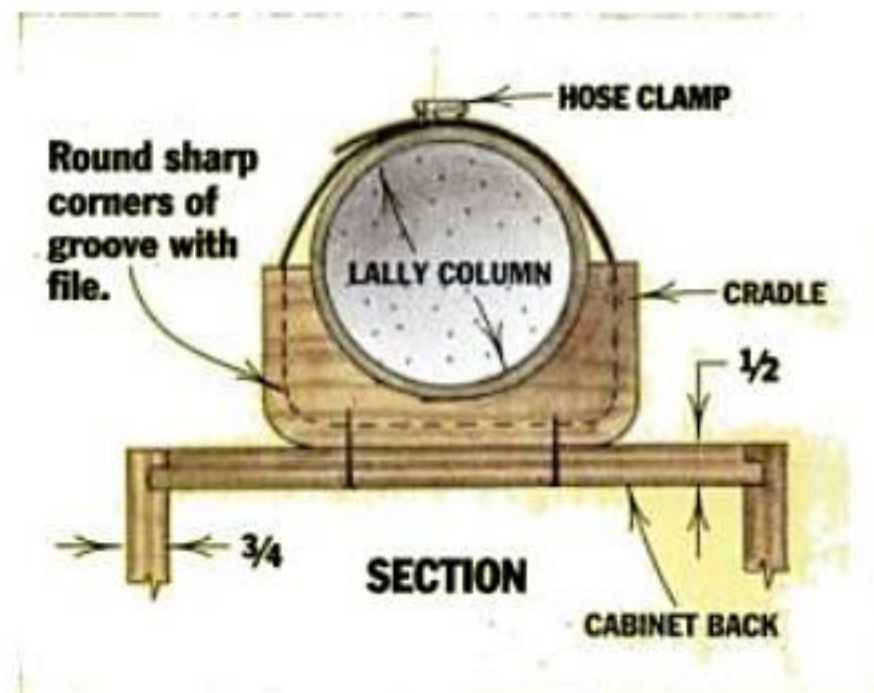
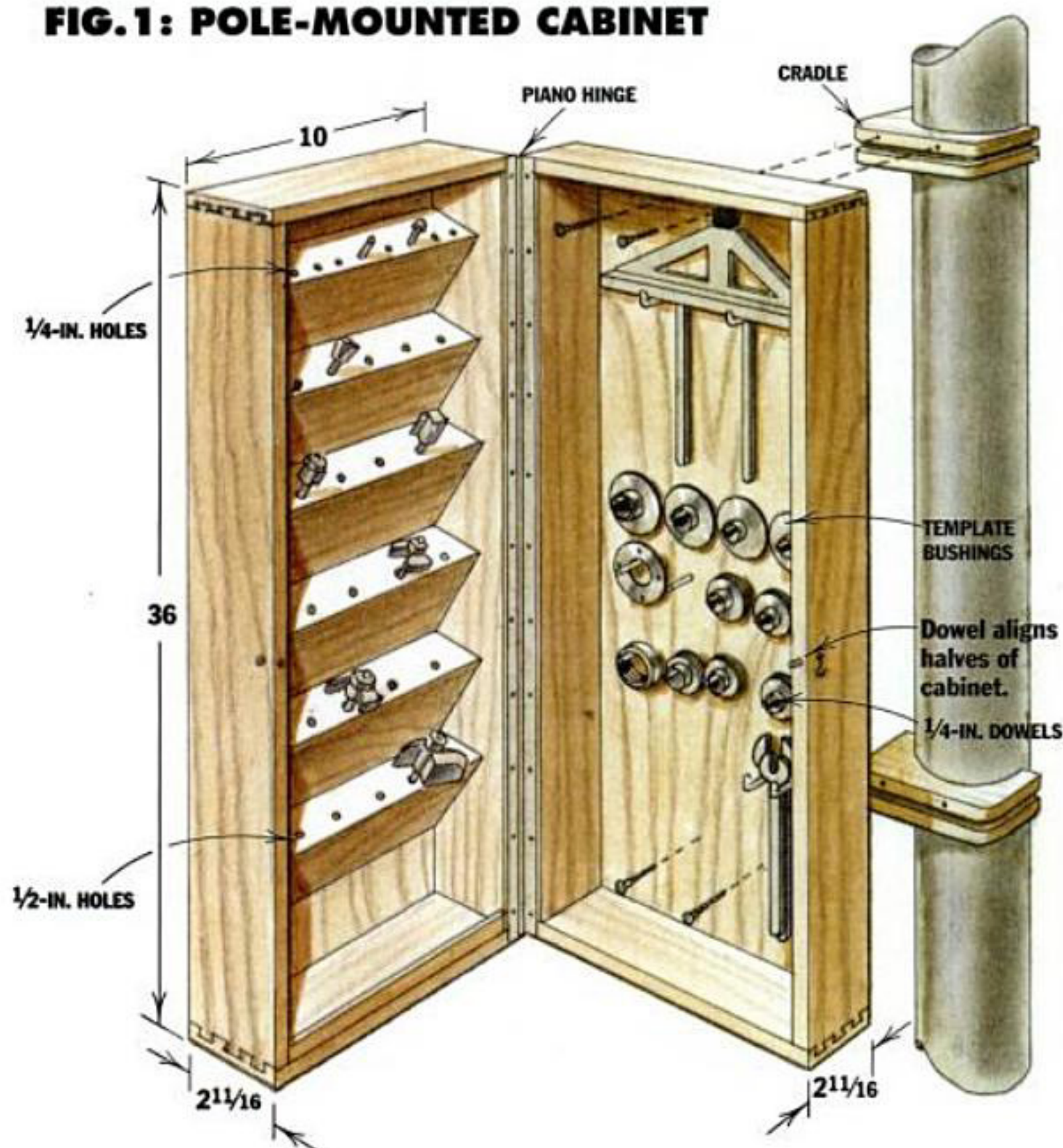
Plexiglas in the doors of the cabinet.

Join the cases your favorite (or most convenient) way. Dovetails, tongue-and-groove, biscuits—even nails or screws should do the trick.

I find it easiest to make the Lally column cabinet as a box, and then cut it apart to form the lid.

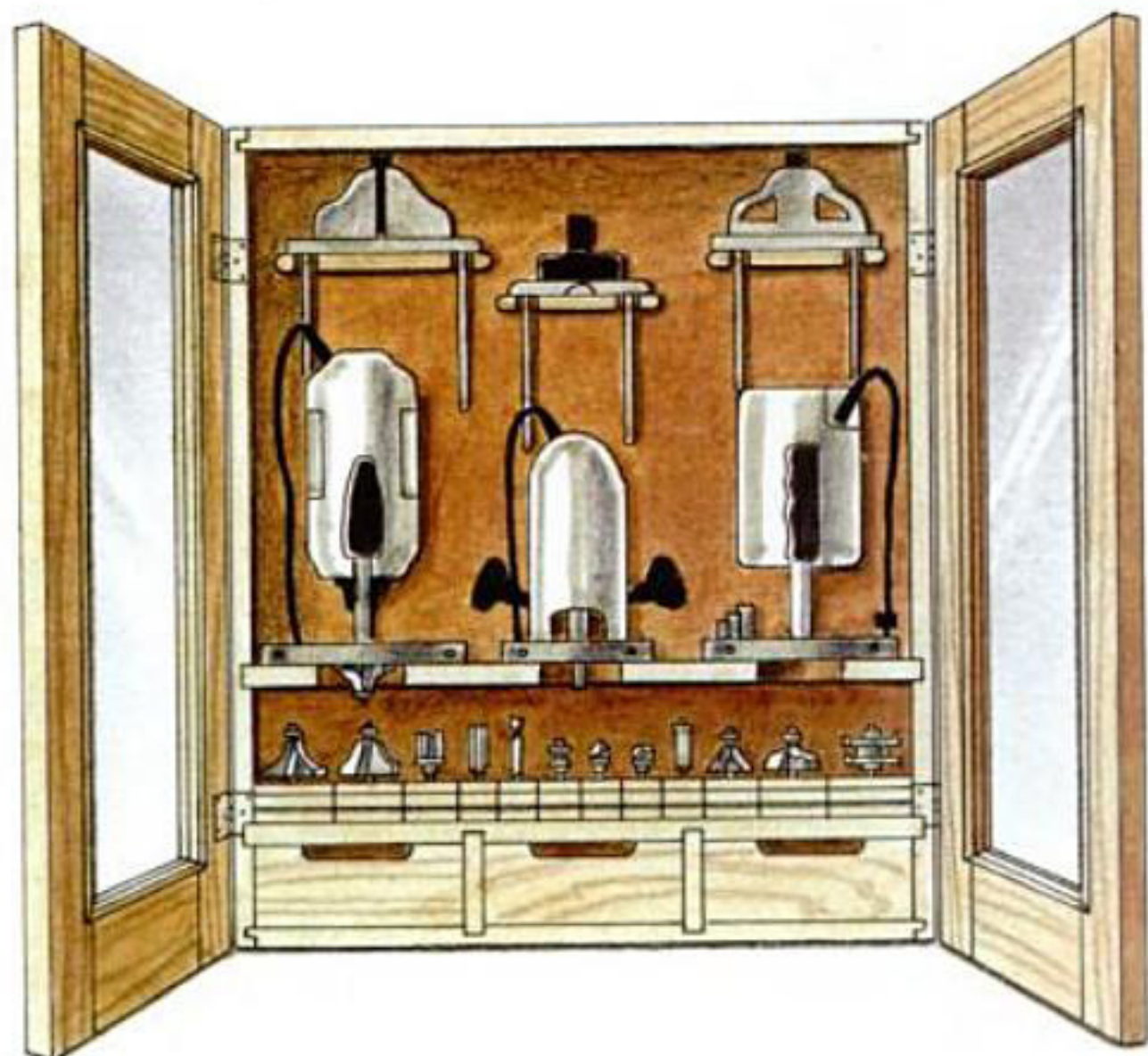
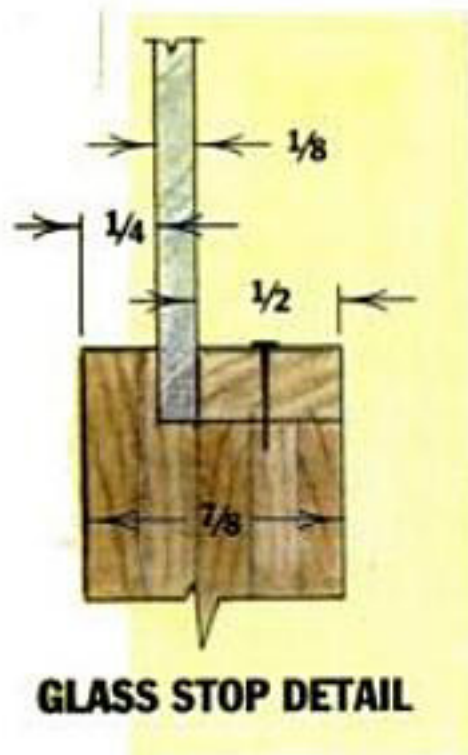
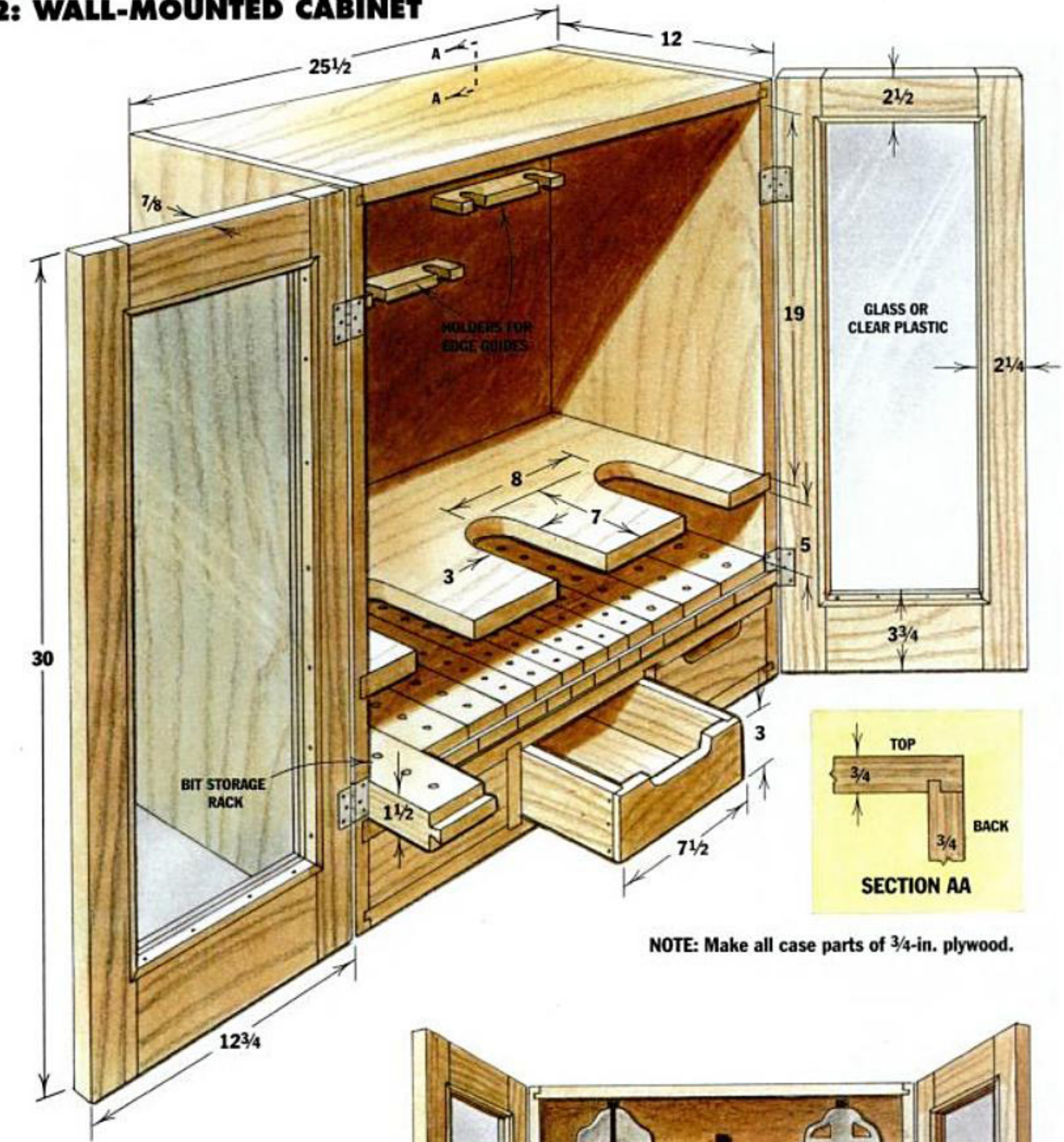
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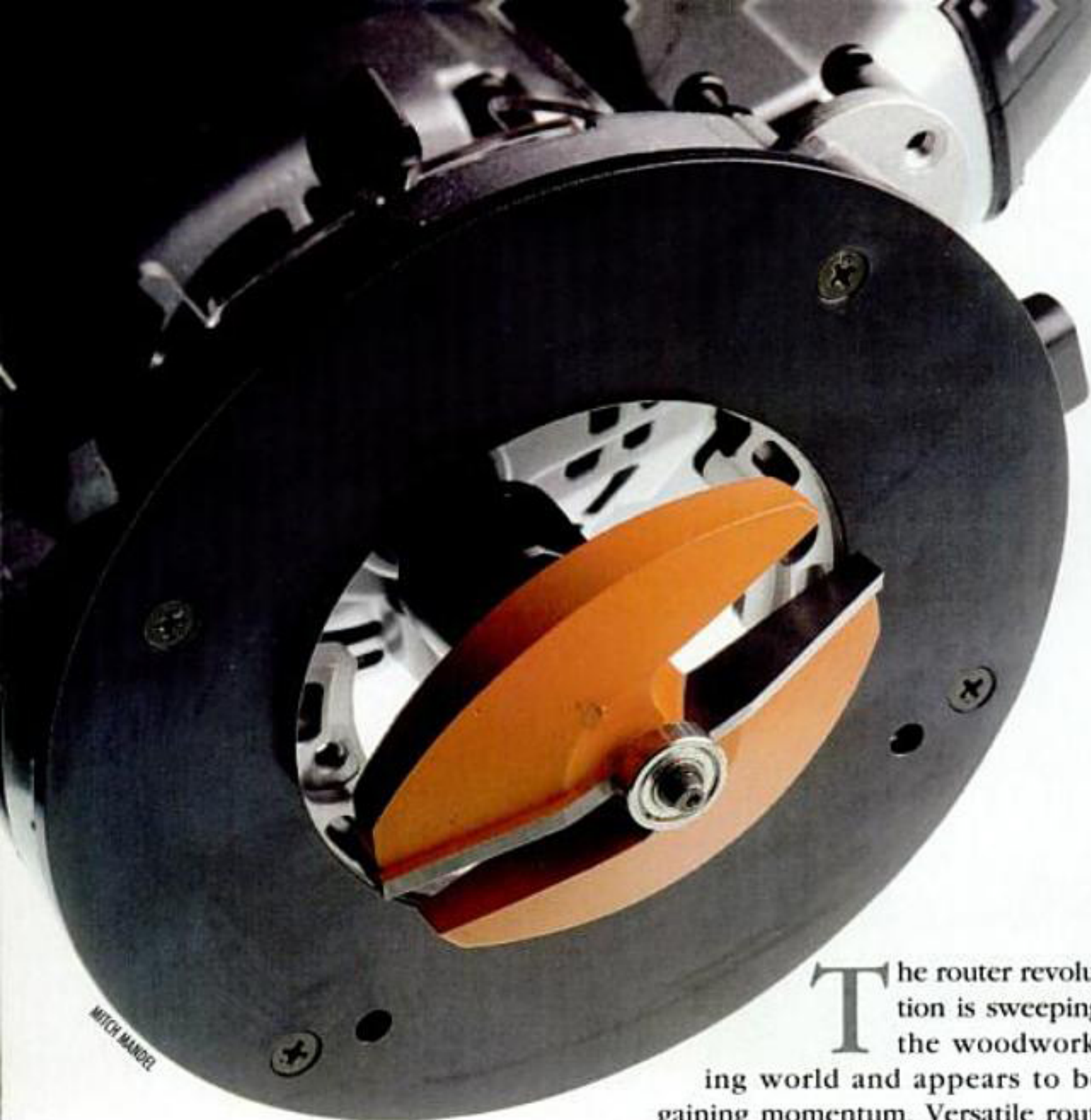
FIG. 1: POLE-MOUNTED CABINET



DRAWINGS BY SALLY ONOPA

FIG.2: WALL-MOUNTED CABINET





BUYER'S GUIDE TO ROUTER BITS

BY PATRICK SPIELMAN

*Buying Bits
Doesn't Have
to be a
Crapshoot.
Here's a
Checklist of
Features to
Look For.*

The router revolution is sweeping the woodworking world and appears to be gaining momentum. Versatile routing equipment is taking on an ever-increasing share of the tasks once reserved for shapers, molders and other expensive machinery. Projects that used to require a well-equipped mill shop—raised panel doors, sash windows, intricate molding and the like—now can be produced with a relatively small investment in router-based carbide tooling.

Taking full advantage of these options means making some important decisions about routers, accessories and most especially, router bits.

Why do I say the bits are most important? As a router user for most of my life, I've learned that I can compensate for the little quirks or peculiarities of my router, table, fence and so forth but there's no way to compensate for a defective or inferior bit. I like the analogy of an archer and his arrows. The archer may be able to adjust for the shortcomings of his bow, but the arrows must be straight and true or they're useless.

A Checklist for Quality

How do you recognize truly superior bits and weed out the so-called

"economy" bits that may put your work, your money and even your safety at risk? Can you spot a good carbide-tipped bit when you see it, before you buy it?

I think the answer to that question is yes, if you know what to look for. A keen eye, a magnifying glass and some common sense along with this checklist will help the next time you shop for a bit.

● Check the Cutting Edge

Finish—Look for a smooth, polished surface without roughness, irregularities and grinding marks. Irregular surfaces can be an indication of poor production techniques and careless workmanship. What's more, rough surfaces provide a great place for pitch and gum to build up and hinder performance.

Sharpness—Rotate the edge gently against a fingernail. A good edge will shave the nail with little effort.

Straightness—On a straight bit or a rabbeting bit, sight along the edge to check the carbide for straightness.

Brazing—Check the braze that holds the carbide to the bit's body. If you notice gaps or voids in the brazing, beware! (See photo, page 52.) Weak or sloppy brazing may fail at high speed, creating a very dangerous situation. You want clean, voidless flutes without

A VISUAL GUIDE TO CARBIDE ROUTER BITS



Left to right: V-grooving, downcut spiral, round nose or core box, straight plunging, dovetail, decorative grooving.

GROOVING BITS cut in the middle or edge of a board for milling grooves, dados, rabbets, inlays and mortises, depending on the shape. Shapes include straight, dovetail, V-groove, round nose and decorative profiles such as ogees, etc. Grooving bits must be used with a fence for edge cuts.

PHOTOS BY JOHN HAMEL

EDGING BITS cut on the edge of a board. Shapes include round-over, bead, chamfer, cove, rabbeting bits, slot cutters, and many different decorative molding profiles. Edging bits without a pilot bearing must be used with a fence.



Left to right: round-over, anti-kickback rabbeting, anti-kickback cove, slotting, anti-kickback chamfering.



Left to right: straight plunging, spiral flute.

FLUSH TRIM BITS trim laminates, veneer or wood flush with the surface on which the pilot bearing rides. Bearings can be mounted above or below the cutter. Flush trim bits are useful for pattern routing where the bearing rides against a template to guide the cut.



Flush trim bits with bottom mounted bearing (left) and top-mounted bearing (right).

SPECIALTY BITS are a catch-all category that includes combination pilot panel bits for cutouts and template routing, stile-and-rail sets for making doors, sash sets for making windows, panel-raising cutters, tongue-and-groove sets, panel pilot bits, glue-joint bits, lock-miter bits, keyhole bits, drawer-pull cutters and bits for cutting solid surface materials such as Corian.

MORTISING BITS include any straight bit that cuts a flat-bottomed hole. Upcut spiral-flute bits are best-suited for deep mortises because the spiraling flute pulls the chips up out of the hole.



Left to right: rail cutter, lock-miter, anti-kickback panel raising, stile cutter, anti-kickback glue-joint.

rough spots in the brazing that can interfere with chip ejection.

Carbide quality—All carbide-tipped bits are *not* created equal, because the grade of carbide may vary substantially from manufacturer to manufacturer. Unfortunately this crucial component is very difficult to analyze unless you have a testing laboratory at your disposal. However, there are some ways you can protect yourself from inferior carbide.

Insist on bits with *micrograin* carbide. Tungsten carbide is actually composed of tiny granules of carbide powder chemically bonded together. As the bit is used, the carbide gradually wears away and this wear produces a dull edge. Cheap, coarse-grained carbide crumbles quickly taking the quality of your cut right along with it. Micrograin carbide wears very slowly so the edge stays sharp longer. What's more, less carbide is removed when a fine-grained carbide edge is sharpened, so you'll get more resharpenings out of a micrograin bit.

You should also compare the thickness of the carbide tips on bits from more than one manufacturer. More carbide means more support for the cutting edge and more resharpenings before the bit must be replaced or retipped. Thinner carbide is one indicator of a manufacturer's cost-cutting policy that will show up later in the performance of the bit.

If you're concerned about the quality of carbide, try one relatively inexpensive bit from a manufacturer before buying in quantity. A good test would be to run just a portion of a brand new straight bit's cutting edge against particleboard. Compare the unused portion of the cutter with the portion of the carbide that did the work. If you immediately notice wear or a dull edge, you may wish to invest your hard-earned dollars elsewhere.

Radial relief—Radial relief is a subtle refinement I look for in a high-quality router bit. If you look directly

at the end of a radially relieved bit with a magnifying glass, you'll notice that the back side or "bevel" of the cutting edge will be very slightly rounded, instead of flat like a plane iron or chisel. This rounded surface provides slightly better support for the cutting edge with less tendency for it to chip than an edge with a flat-ground relief surface.

Another advantage of the radially

Thus it will not rotate concentrically to the router shaft causing high-speed vibration. This is not only dangerous but it puts strain on your router bearings and collet.

Look at the shank. Is it smooth, polished and carefully chamfered at the end? Looks aren't everything, but the care shown in a well-machined shank may be a reflection of the manufacturer's attention to harder-to-check criteria like concentricity and dimensional accuracy.

Body—Some router bits are formed by casting, others are machined from a solid block of steel. While the cast bits are perfectly acceptable, it's been my experience that bits machined from a single bar of steel offer the well-finished shanks and bodies discussed above as well as perfect balance.

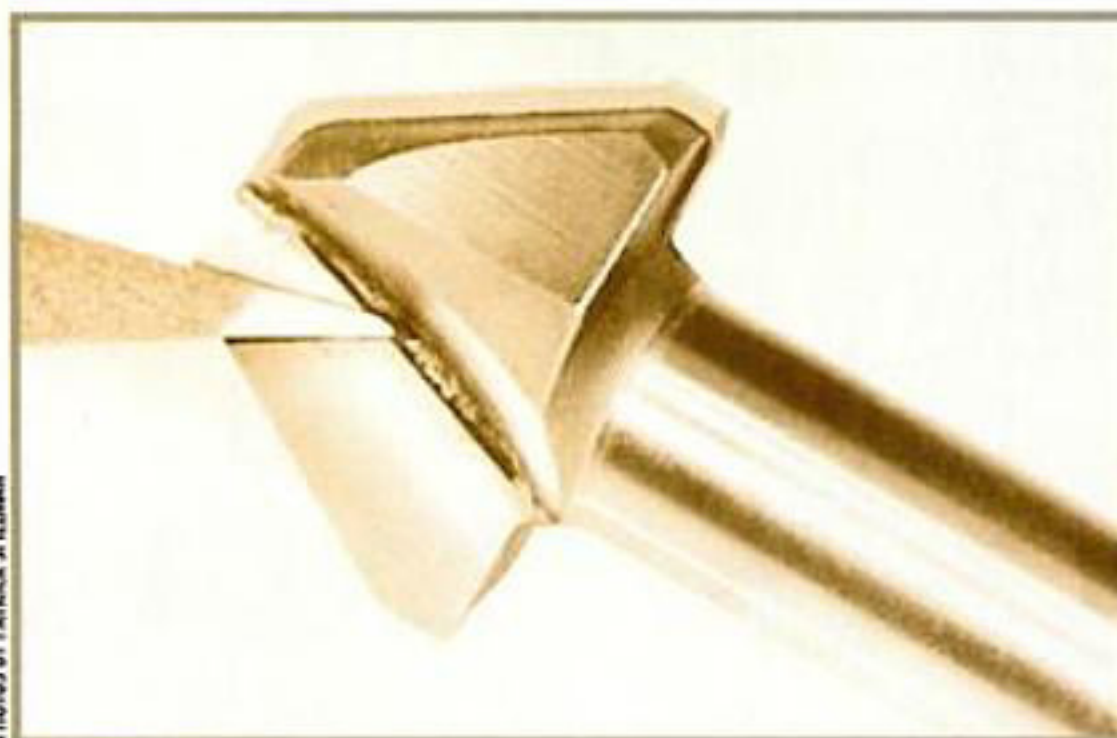
You should also look at the surface of the body. A rough surface provides a perfect place for pitch and gum build-up, especially if you're routing softwoods.

Steel quality—You don't need much expertise in metallurgy to appreciate the importance of the steel used in a router bit's shank and body. And believe me, there are differences in the quality of the steel used by various manufacturers.

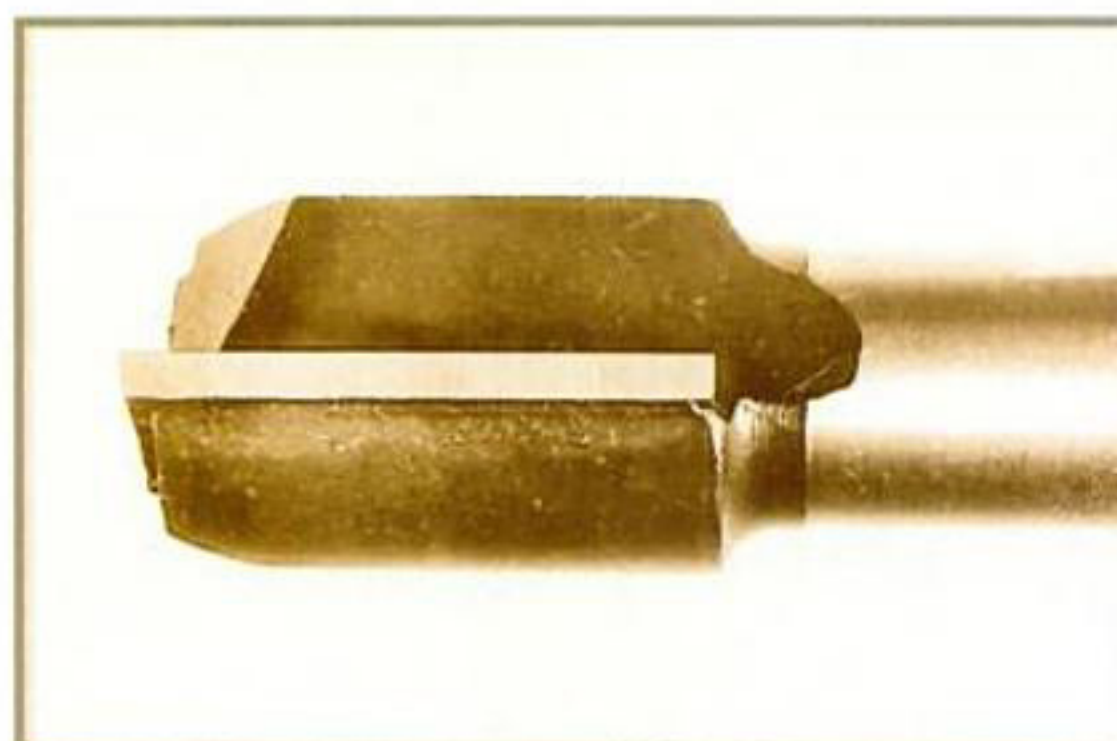
Some "economy" bits are produced with very soft steel because it's cheaper and easier to machine. Unfortunately, those economies only benefit the manufacturer. Soft steel is

much more likely to bend under heat and stress, leading to early bit replacement or worse. On the other hand, steel which is too hard can be brittle and may break. The vision of a bit snapping at 22,000 rpm will give just about any woodworker chills.

Steel quality is important but it's pretty hard to evaluate. That doesn't mean you're helpless however. Stick to reputable, established suppliers and name brands. Read the manufacturer's literature or talk to their salespeople to glean some basic facts.



Check the braze that holds the carbide to the body. Gaps or voids in the brazing like these fill up with pitch and may fail at high speed.



A plunge bit should have carbide tips that extend beyond the end of the bit's body.

relieved carbide shows up at resharpening time. Since the carbide is rounded, the diameter of a radially relieved bit will be reduced a few thousandths of an inch less at each sharpening than a flat-ground bit.

● Check Shank and Body

Shank machining—The very first requirement for a good bit is a shank that is machined as precisely as possible to tolerance. If it is slightly undersized it will not be gripped uniformly by the router's compression collet.



ANTI-KICKBACK BITS

BY ELLIS VALENTINE

Over the past few years, a new breed of router bits has appeared on the U.S. market. Known as "anti-kickback" bits (and sometimes called "safety bits" or "chip-limiting bits"), these cutters were designed to comply with German standards for power tool safety, which limit how deeply various tools may cut, thereby reducing the risk (and velocity) of kickback. And, 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 millimeters off the tip. (WARNING: Any router bit can hurt you—badly. Don't let anti-kickback bits make you overconfident.)

The most visible difference between an anti-kickback bit and a conventional bit is its mass. Instead of having two thin wings of steel supporting the carbide tips, the anti-kickback bit has a solid body milled to the same profile as the cutting edge, with just a narrow throat (gullet) in front of each cutting tip for chip clearance. (See illustration.) As the bit rotates (at speeds up to 400 times per second!), the massive body allows only about 1/8 in. of material to meet each cutting edge. This lowers the cutting force and results in less splintering and far fewer kickbacks. Also, the narrow gullets offer scant opportunity to jam wood too deeply into them.

JOHN HAMEL

In addition to these safety advantages, anti-kickback bits lessen vibration and dissipate heat more efficiently than conventional bits because of their greater mass. Better heat dissipation prolongs edge life. Plus, according to one manufacturer, the bits' aerodynamic design lessens air resistance, leaving more power for the router.

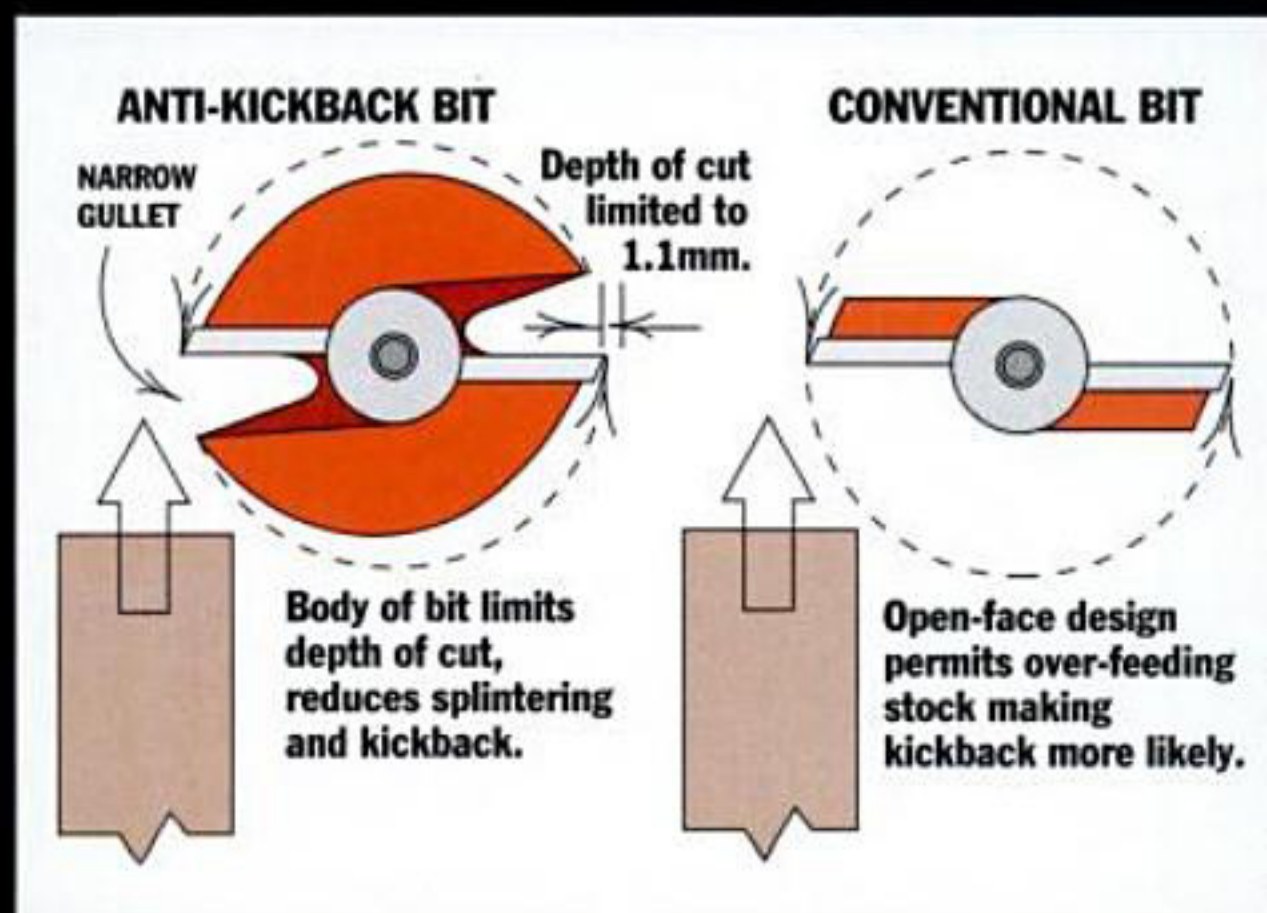
Anti-kickback bits have some drawbacks, too. In theory, they limit how fast you can feed your stock because at some feed rate you will exceed the maximum cutting depth. In my infor-

mal tests however, I found they removed material as quickly as I cared to feed it. Another potential problem is sharpening and re-tipping these cutters; not all sharpening shops are properly equipped to handle them. And then there's cost: Most safety cutters currently on the market cost from 30 percent to 50 percent more than the least-expensive bits available, but, on the other hand, they're likely to last longer. All told, anti-kickback bits represent a significant development in router safety and performance.

Who Needs Them?

Unless breakneck feed speed is your main concern when buying router bits, you'll probably find something to like about safety cutters. Beginners will benefit most because these bits are more forgiving of mistakes. But, even experienced woodworkers, who are very comfortable with router technique and conventional tooling, will appreciate the heftier feel and better climb-feed control of safety bits.

Technically, no one really needs anti-kickback bits, but, like air bags in automobiles, they seem destined to become the standard in coming years. Two manufacturers, Freud and CMT, already offer comprehensive lines of safety cutters, and a third, Eagle America, expects to switch its line over to anti-kickback bits this year. Can everyone else be far behind?



SOURCES

Anti-kickback bits are available from:

FREUD, Box 7187, High Point, NC 27264.
(800) 472-7307, CIRCLE #610

CMT TOOLS, 5425 Beaumont Center Blvd., Suite 900, Tampa, FL 33634, (800) 531-5559, CIRCLE #611

EAGLE AMERICA, Box 1099, Chardon, OH 44024, (800) 872-2511, CIRCLE #612

HOW TO KEEP YOUR BITS AT THEIR BEST

A complete review of the proper use and care of router bits could take a series of articles. But here are a few crucial points to remember.

Storage—The best router bits won't survive long if they're dropped on the floor or left to rub shoulders with other tools. If your bits don't include a protective case, consider building or buying one. ([See article, page 48.](#))

Cleaning—Keep heavy pitch and gum build-up off your bits. Use a pitch and resin remover (available from Cascade Tools Inc., Box 3110, Bellingham, WA 98227, 800-235-0272) or regular household oven cleaner.

Sharpening—Manufacturers differ in their advice on sharpening carbide-tipped bits. Some suggest that the owner occasionally "touch up" the edge with a 600-grit diamond stone, others insist that all reshaping be performed by a professional sharpening service. My advice is to read the warranty before sharpening and, if necessary, consult the manufacturer. I touch up my bits with a fine diamond hone. Just hone the edge as a carver would touch up a knife on a leather strop. As an alternative, you could try a router driven diamond hone from Furnima (Furnima Industrial Carbide, Box 308, Barrys Bay, Ontario, Canada K0J 1B0, 800-267-0744).—P.S.

● Check Bit Design and Geometry

In addition to the quality-control issues I've addressed above, here are some design factors to consider when you're shopping for bits.

Anti-kickback design—Anti-kickback design appeared on the European market years ago but it's been slow to reach North America. Safety enhancements are important so I strongly suggest you demand this feature in your bits. ([See sidebar, previous page.](#))

Flutes—Most of the carbide tipped bits you encounter probably will have two flutes, meaning they have two cutting edges. There are bits on the market with one, three or even four flutes. Multiple-flute bits deliver a smoother cut and are usually easier to control than single-flute cutters. The trade-off is less-aggressive cutting and a somewhat slower feed rate as the number of flutes increases. If you need very fast cuts and you aren't worried about a smooth finish, you may wish to consider a single-flute bit. For most applications however, I've found two-flute bits the most logical and cost-effective choice.

Shear angle—Shear angle is another important element of bit design,

especially if your goal is a very clean edge. With the bit held vertically at eye level, look at the cutting edge. If the bit has a shear angle, the cutting edge will appear to slant in relation to the axis of the bit. If the edge looks vertical and aligns with the center axis of the bit, there's no shear angle.

Bits with shear angle slice the wood much as a knife or plane slices stock when you skew it at an angle to the workpiece. This action produces a smoother cut than bits without shear angle which tend to "chop" the wood.

Hook angle—Sometimes called "rake angle," the bit's hook angle determines the angle at which the cutting edge meets the stock. To check the hook angle, look directly at the end of the bit. Visualize a line extending from the tip of the cutting edge through the centerline of the bit. The angle formed by this imaginary line and the front face of the cutting edge is the hook angle. Bits with higher hook angles tend to feed more aggressively and produce smoother cuts.

Plunge capability—Plunge routers are becoming more and more popular ([see article, page 36](#)), but to really reap the benefits you need bits that are designed to plunge. Look at the tip of

the bit. A plunge bit will have clearance between the tips of the carbide and the end of the bit body. ([See photo, page 51.](#)) ([Caution: if the cutting edge extends too far the carbide may break.](#)) The cutting tips should be ground with a relief angle, not straight across, for efficient plunge cutting. The ideal plunge bit also has cutting edges that extend completely across the end of the bit.

Coatings—Several manufacturers now apply a coating of some sort to their bits, ranging from a simple paint job to more sophisticated coatings such as Teflon or titanium nitride. Eagle America says titanium nitride provides a sixfold increase in the life of their high-speed steel spiral bits. CMT Tools applies a non-stick Teflon coating to the bodies of their carbide bits to keep resin and pitch from "gumming up" the bit.

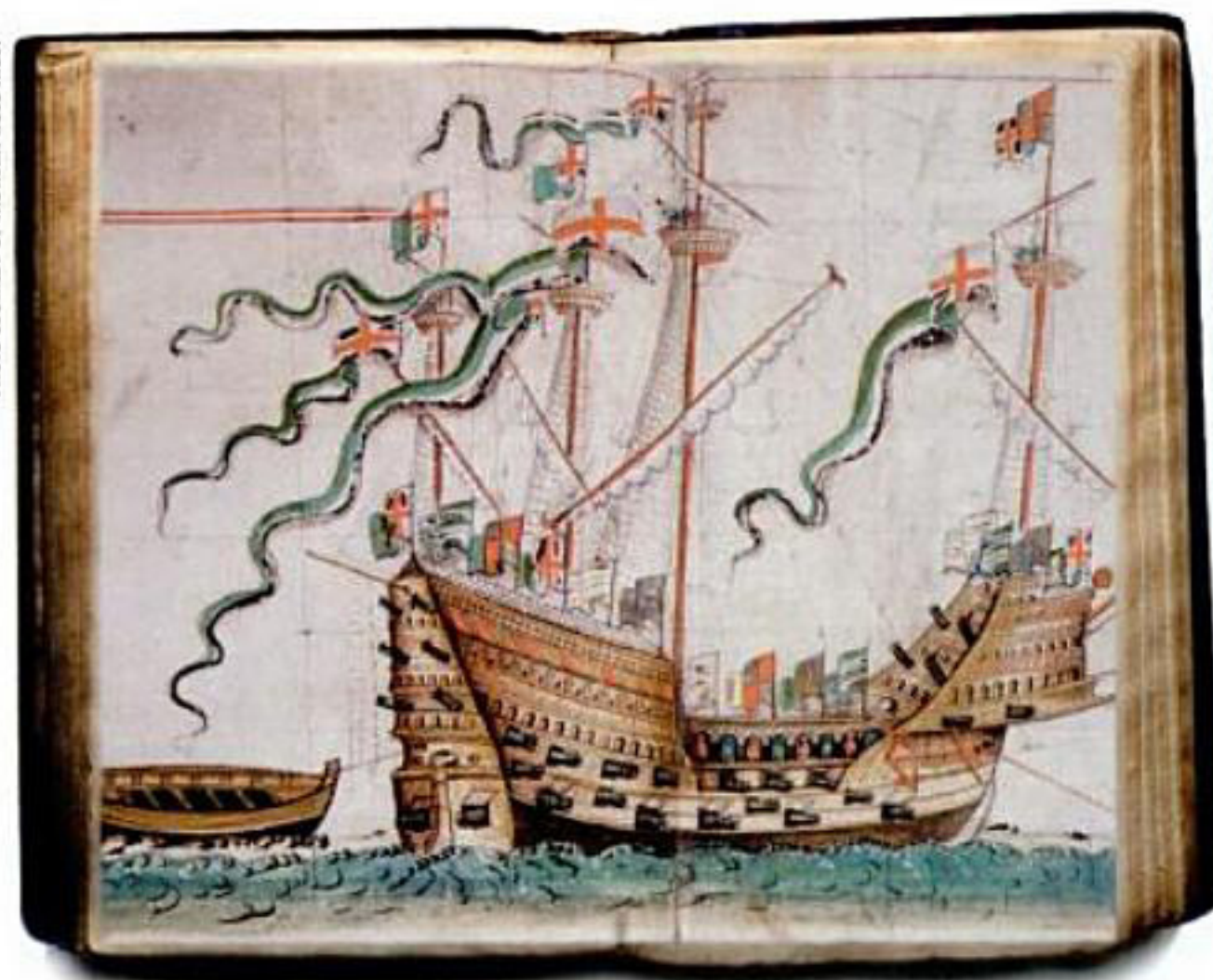
At least two manufacturers offer bits with high-visibility finishes: CMT's Teflon is orange and Freud's router bits are bright red. These colors are much more than a cosmetic touch. They help keep your attention focused on the bit.

● Check the Price

Now take a look at the price. It would be easy to say, "you get what you pay for" and advise you to pay top dollar for top-quality cutters. Unfortunately there's really no hard-and-fast rule here. When you're buying a car, you probably can't get a Cadillac for the price of a Chevy, but you certainly can find someone with a Chevy who will sell it to you for a Cadillac price. In other words, in router bits, as in automobiles, the most expensive bit may not always be the best buy. My advice here is to evaluate the criteria I've listed above (it's no accident that price is last on my list) then choose the best bit for the money. ▲



PATRICK SPIELMAN is a woodworker in Wisconsin. He's written 40 woodworking books, including *Router Handbook* (1983, Sterling Publishing Co.).



The Mary Rose, captured in all her magnificence in this painting, is thought to have sunk because the additional weight of 300 men-at-arms made the ship unstable.

TOOLS
FROM
THE

Mary Rose

BY RICHARD WOOD

Trapped in a Watery Grave for Nearly 450 Years, the English Warship, Mary Rose, is Now Yielding Tools and Artifacts That Show What Life was Like in the 16th Century

On a calm summer's day in 1545, English king Henry VIII watched from shore as his fleet of warships left Portsmouth harbor to do battle with the French. Even before the opposing ships had engaged, disaster struck. As Henry's flagship, the heavily laden Mary Rose, was hoisting her sail, the vessel began to list to starboard. Water poured in through the open gun ports, the ship heeled further and then, in front of the horrified eyes of the monarch, quickly sank.

"All my gallant men," said the king. The loss was truly terrible. So swiftly did the ship founder that less than 40 of the 700 men on board managed to get clear. Many were trapped below and those on the upper deck were hampered from escape by the anti-boarding nets strung across the ship's waist. Down with the vessel went men, guns, ammunition and the ship's stores, including tools used by the tradesmen who made or mended the many items aboard a fighting ship of the period.

Several attempts were made to raise the Mary Rose—she lay in water so shal-

low that for a while the tip of her mast showed—but they all failed. Memories gradually faded, the wreck silted over and its exact location was lost. It wasn't until 1965 that a serious effort was made to find, record and finally recover what was left of the ship.

During the 1970s divers brought thousands of artifacts to the surface, making it apparent that the tragedy of 1545 had become an archaeologist's treasure trove. Here was a time capsule of lives of the sailors, soldiers and tradesmen on board a Tudor warship.

Chief among the tradesmen were the carpenters. They had their own cabin, toward the stern of the vessel, fitted out with work benches. In this workroom divers found a large number of early woodworking tools (see photo, following page), most of them in open wicker baskets ready for use. Braces, saws, rules, measuring instruments, gouges, many remarkably well preserved after their long immersion.

These tools were conserved and taken ashore as the ship was gradually emptied of everything movable in prepara-



Most of these tools that divers recovered from the ship's carpenter's cabin will look familiar to present day woodworkers. The author held a modern rule alongside one recovered and found a discrepancy of only $\frac{1}{4}$ in.



The massive oak skeleton of the 16th-century Mary Rose rests in a climate-controlled building to keep it from disintegrating.

ice-cold fresh water for 20 hours a day. This not only arrests decay but prevents the wood from drying out. The drying process—especially rapid drying—is extremely destructive to water-soaked timber. Wood that has remained intact under the water for hundreds of years simply disintegrates on exposure to air.

Eventually, the ship may be immersed in polyethylene glycol (PEG), which replaces the free water and prevents the cell walls from collapsing when exposed to air. But research continues on this crucial decision.

From a viewing gallery, high up in the building, visitors can look down into the remains of the great oak skeleton of the Mary Rose. It is chilly inside the building and the wreck is often shrouded in fog. It is easy to let one's imagination slip back centuries to see craftsmen laboring in the dim light of a lower deck, producing all the working accoutrements of a working man-of-war.

The Mary Rose and an associated museum can be seen at the Royal Navy Base, Portsmouth, England. ▲



RICHARD WOOD

makes woodworking tools and manages a 150-year-old family business dealing with musical instruments.

MAKING REPLICAS OF 450-YEAR-OLD TOOLS

The wooden tools found in the wreck of the Mary Rose were too precious and vulnerable to be handled without the most stringent safeguards. But without the chance to examine and handle the tools freely, researchers couldn't learn how the timber was worked. What was needed were very accurate copies.

Since I have some experience in this field I wrote to the Mary Rose Trust, offering my help. I was invited to the Royal Navy Base in Portsmouth, where the Mary Rose and some of the artifacts are on public display. The trust's director of research, archaeologist Margaret Rule, showed me two trays filled with 40 or 50 tools recovered from the wreck, many of them in excellent condition.

I first thought of making accurate copies in timber—a scheme I soon abandoned because of the cost and time involved. Dr. Rule suggested making a mold directly from an original and using it to cast replicas. I recalled a firm, Oakleaf Reproductions, near my home in Yorkshire, that makes imitation oak beams, using an actual beam to make the mold and then filling the mold with polyurethane foam at high pressure. The foam picks up every surface detail and the results, when properly colored, are very convincing.

Oakleaf Reproductions agreed to see what they could do, and because we needed accuracy in all six elevations, we decided to make a two-part mold in silicone rubber. I volunteered a Victorian plane of small value in my tool collection as a guinea pig.

After a couple of attempts we produced a very accurate copy which I took back to Portsmouth. Dr. Rule and the Mary Rose Trust were pleased with this initial result and I managed to convince them the process could safely be used on the priceless Mary Rose tools. The trust was understandably nervous about this whole affair. They insisted on secrecy since they had been inundated with inquiries from overzealous tool enthusiasts eager to examine the originals.

So with a member of the Mary Rose Trust team to supervise, we decided to duplicate six tools—five planes and a brace. Although all had been carefully conserved, we still stored them in cotton wool and handled them only with rubber gloves. We stashed five of the tools in the strong room of the local bank (where they were insured for a quarter of a million pounds) and went to work on the sixth.

With extreme caution we first applied a small patch of silicone rubber to the side of the plane. A few hours later, when the silicone had cured, we peeled it off and examined the surface. We were greatly relieved to find that it left no trace. Thus encouraged, we set about making a cast of the entire tool. Since the wood in the original was deeply fissured, we first had to carefully fill these cracks with cotton wool followed by plasticene.

The two-part hinged molding boxes had already been made and filled with enough silicone rubber to form the mold. Then with considerable trepidation we inserted the



This "boltel," or hollow molding plane, would have produced a 1½-in. bolt or rod. Made in a shape that suggests a whale, it is about 12 in. long and was cleft from an oak board.

plane, closed the box and left it overnight. Mercifully, the process was successful and in the morning we found that we had produced our first mold. (See photo, below left.)

Since it was made of expanded polyurethane foam, our first replica molding (see photo, below right) was ridiculously lightweight. We ballasted subsequent moldings with short pieces of iron rod so they came out the same weight as the original tool. Our final step was to hand-finish each molding with oil and water stains so they were a very close match to the originals in both shade and color.

The whole process had taken us six weeks, but finally we had our moment of triumph. I shall never forget laying out the tools (six copies and one original) in front of Dr. Rule and several members of the Trust. From a distance of two or



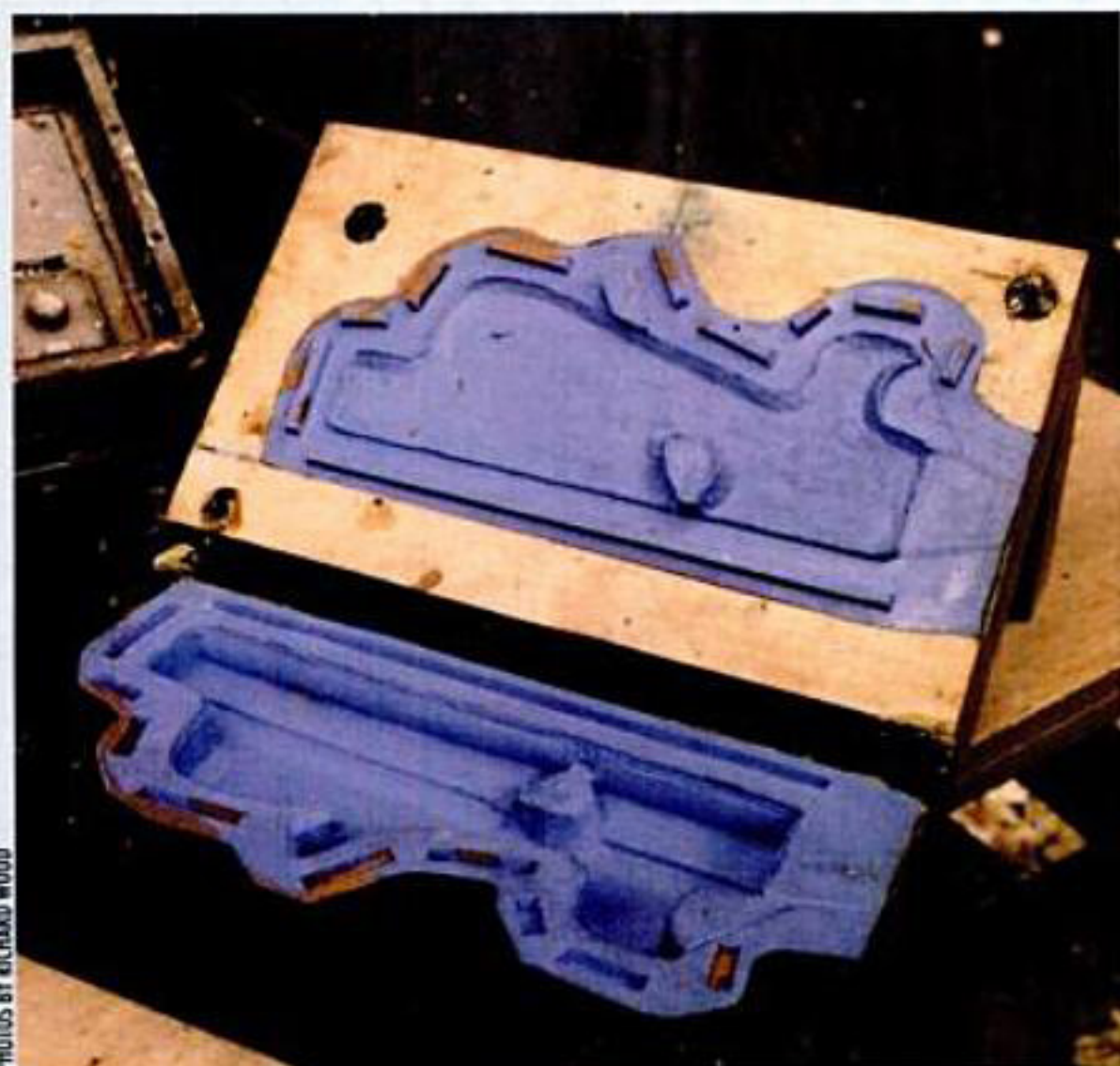
This all-wooden brace was cleft from an oak board and probably was used to drill only holes of small diameter. The angle of the return guarantees the brace will clear the forearm with each revolution.

three feet, not one of them was able to tell the difference between the original plane and the replicas. I felt that our mission had been accomplished.

I still feel very privileged to have actually handled these priceless tools. What continues to fascinate me is their very lack of perfection. They were made by humble craftsmen and used to create the everyday wooden items needed by the ordinary folk of the 16th century.—R.W.

Reproduction tools are available from R.H. Wood Historical Woodworking Tools, The Dower House, Upper Denby, Grange Moor, Wakefield, WF4 4BJ, United Kingdom. Prices shown include packaging and postage: Large plane \$39.50; small plane \$36.40; brace (in two pieces) \$54.20.

Using Rubber Molds, Workers Have Produced Replicas That are Nearly Indistinguishable From the Original Tools



To exactly replicate the Mary Rose tools, the author made a mold using one of the tools as a pattern, then sealed the mold and injected polyurethane foam at high pressure. A replica plane as it comes from the mold (above right). Much too light in color, it was later stained to match the original.

WOOD FACTS



PHOTOS BY ELLIS WALENTINE

Plain bubinga (left) vs. the rarer mottled or variegated-figure bubinga (right).

BUBINGA

BY DICK BOAK

SPECIES NAMES

Primary species:

Guibourtia tessmannii

Guibourtia demeusei

Guibourtia pellegriniana (West Africa, Nigeria, Cameroon, Gaboon, Lower Congo)

TRADE NAMES

Common trade names are bubinga, African rosewood, buvenga, and essingang. Highly figured rotary-cut veneer is marketed as kevasingo.

APPEARANCE

Bubinga ranges in color from medium reddish brown to vibrant salmon or rosy crimson with darker veins of red or purple. The outer layer of sapwood is creamy vanilla in color. With a general appearance that mildly resembles Honduras rosewood, bubinga is commonly and incorrectly marketed as "African rosewood" (true rosewoods belong to the genus *Dalbergia*). The wood has very fine pores that are barely visible. Grain lines are typically straight, with occasional rippled, mottled, marbled or variegated figuring that is highly prized.

WORKABILITY

Bubinga is extremely hard, having a density exceeding that of rock maple, making it difficult to work and hard on tools and blades. Bubinga's natural color is beautiful and needs no stain.

The sanded surface requires little or no filler and accepts most types of finishes reasonably well, although pitting may result when high-solvent finishes contact the resin trapped in the pore structure.

TECHNICAL PROPERTIES

With a specific gravity of .88 (55 lbs. per cu. ft.), bubinga is extremely dense and hence suited for applications that require strength. Wind breaks (internal cracks) are common near the heart of the tree. The sapwood is considerably softer than the heartwood and susceptible to attack from boring insects and decay. Felled logs allowed to lie in the forest often develop an attractive sapwood patterning similar to that of spalted maple.

USES

Bubinga is commonly substituted for rosewood in many varieties of exotic furniture, joinery and cabinetry. Sliced and rotary-cut veneers are used for decorative wall paneling. Because of its strength, bubinga is often used for knife and tool handles, billiard cue butts and police batons or "billy-clubs." Bubinga is not naturally water-resistant and it is inappropriate for outdoor use.

SIZES

Bubinga trees occasionally achieve a 2- to 3-ft. diameter, but the heartwood is

subject to severe checking. In general, planks are available in widths of 6 in. to 10 in. and lengths from 8 ft. to 12 ft. Primary thicknesses are 4/4 and 8/4—thicker stock is unstable. Logs yield a moderate to high percentage of lower grade, #1- and #2-common lumber.

TOXICITY

Aside from a sweet, fairly pungent odor during cutting, bubinga displays no toxic qualities, though as with any species, a dust mask should be worn during sanding and machining operations.

SUSTAINABILITY

Bubinga is a widely harvested African tropical hardwood and popular on the world market. Although estimates of remaining supply vary, several countries have enacted regulations to limit the cutting of bubinga.

AVAILABILITY

Bubinga is considered an exotic hardwood, but it is readily available through specialty wood dealers.

COST

Wholesale costs of bubinga (for 100 bd. ft. or more) range from \$4.50 to \$6 per bd. ft. Retail prices run from \$6 to \$10 per bd. ft. depending upon quality, plank widths and the presence of figure. ▲



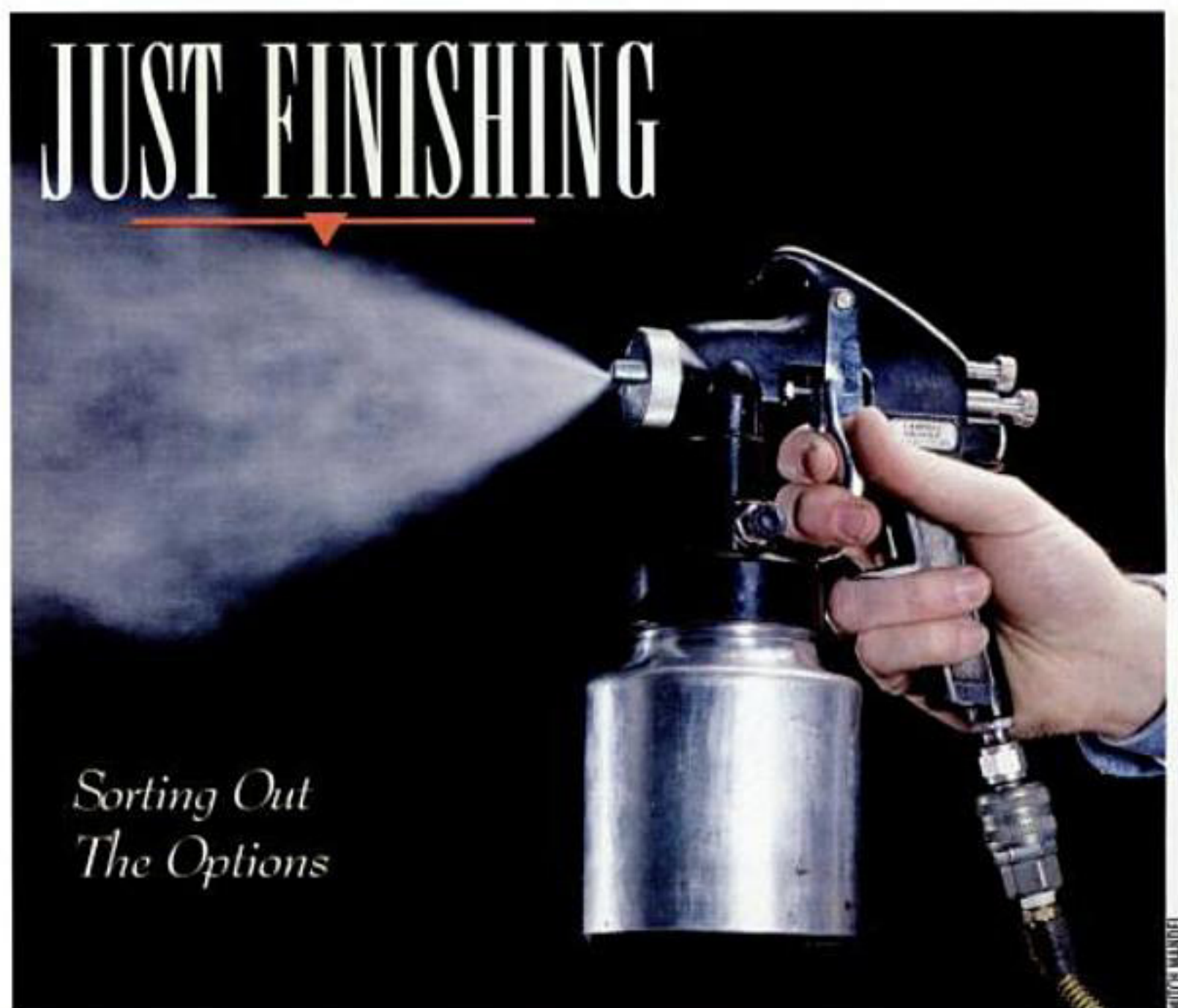
BY MICHAEL DRESDNER

Selecting spray equipment can be intimidating, especially for newcomers. There are three major types of systems on the market, each with its own advantages and a wide variety of guns and options. In this column, I'll try to sort out the differences to help make your choices less bewildering. But first, let's consider whether spray finishing makes sense for you.

Should You Spray?

The primary advantage of spraying over other methods of applying finishes is *speed*. Brushed finishes must stay wet long enough to let you smooth out the entire surface. Spray systems allow you to quickly and evenly coat large areas; and, consequently, you can use faster-drying finishes. You spend less time applying the finish and less time waiting for it to dry.

But, ounce for ounce, spraying is the most expensive and wasteful application method. Spray guns "atomize" finish material by breaking the liquid up into tiny droplets and mixing them with air. With a standard compressed-air spray system generally only 25 percent to 35 percent of the finish lands on the wood; the rest ends up in the surrounding air. (This percentage is described as "transfer efficiency" or TE.) HVLP (high-volume, low-pressure) systems are more efficient, averaging 65 percent TE, with some claiming as high as 85 percent. By comparison, rags, rollers and brushes achieve almost 100 percent TE (you lose only the small amount left on the brush when you wash it out).



SPRAY SYSTEMS

Spraying flammable finishes is also potentially more dangerous than brushing or wiping them on because you are atomizing the finish and filling the air with a potentially explosive mist. This means for safety's sake, you should spray all but water-based products in an explosion-proof spray booth or room that filters the outgoing air and provides adequate ventilation. (For more on setting up a spray booth, see *Wood Finishing*, Time-Life Books, 1992; St. Remy Press, page 102-103.)

So if you finish only occasionally, or the bulk of your projects are small, one-off pieces, spray finishing is probably a luxury. But when you have lots of large surfaces to spray, or you're doing production work, spraying is the way to go.

Spray Options

If you decide to take the plunge into spray finishing, you can choose from several types of systems. Furniture finishers generally stick to three: Compressed air, HVLP, and "CAS" systems. (Depending on whom you ask, CAS stands for either conversion or

compressed-air system and is sometimes called a CAS-HVLP system.)

Each system uses a spray gun matched to its air delivery source. The guns all take some getting used to, but I find them about equally easy to learn to use. Whichever system you choose, look for a gun that feels comfortable in your hand with smoothly operating, easily accessible controls for both fluid feed rate and spray pattern size. Also, make sure the manufacturer offers an ample number of fluid nozzle/needle/air tip combinations to allow you to spray various types of coatings. Choosing the right combination for each finish can mean the difference between a smooth surface and a disaster.

The **compressed-air system** is the most common. It uses small amounts (5-10 cfm) of high-pressure air (35-65 psi) to atomize the finish. A good quality gun costs about \$150 and can be fed by even a small (1½ HP) compressor (at least a \$200 expense). Although their TE is low, you can spray both thick and thin finishes by changing the air pressure to the gun.

JUST FINISHING

HVLP systems are much more efficient. They use large volumes of air (80 cfm and above) at low pressures (below 10 psi) to deliver atomized finish with very little "bounceback" or overspray (excess mist that does not land on the wood). In fact, it's not at all unusual to cut your material usage by at least one-third over a standard compressed-air system. HVLP air is supplied by a turbine and delivered through a large diameter (1-in.) hose. The gun and turbine are generally sold as a set. Light-duty units start at less than \$200 and a good heavy-duty unit costs from \$500 to \$1,000 or more. The biggest drawback is that you cannot "turn up the pressure" on a turbine; it puts out a set volume and pressure of air. Therefore, you must either thin very thick finishes or buy a larger turbine. One-stage turbines are somewhat small for most finishing applications, and, if you're considering spraying

water-based finishes, I'd recommend a three-stage machine. (For more on HVLP systems, see AW #28.)

The **CAS system** is a hybrid of the other two systems. It consists of a special gun that converts high-pressure compressed air to HVLP air. One advantage of a CAS system is flexibility: Like a standard compressed-air system, the air pressure can be turned up or down to accommodate different finish viscosities (thicknesses). But, CAS guns require lots of air (15-20 cfm), so they need a large (3 HP to 7½ HP) compressor to supply them adequately. With prices starting at around \$300, CAS guns are costlier than standard compressed-air guns, and a large compressor can add \$350-\$1,000 to the cost of getting started.

Which To Buy?

Assuming you have enough compressed or turbine air, all three system

types will spray almost all finishes—if you follow the manufacturers' recommendations for matching the fluid nozzle and air tip to the finish you are spraying. HVLP systems have the advantage of complying with recent air-quality regulations. And, if you're starting from scratch, an HVLP outfit is the most cost-effective. The initial price difference will be offset by material savings in the long run. But, if you already own a compressor, a conventional gun will start you spraying for the least amount of money. If you own a *large* compressor, a CAS gun is a prudent investment. It provides the economy of HVLP with the flexibility of compressed air, at a price between the two.

As far as which brand to buy, the greatest factor here is quality, and, not surprisingly, quality and price tend to rise together regardless of which system you choose. ▲

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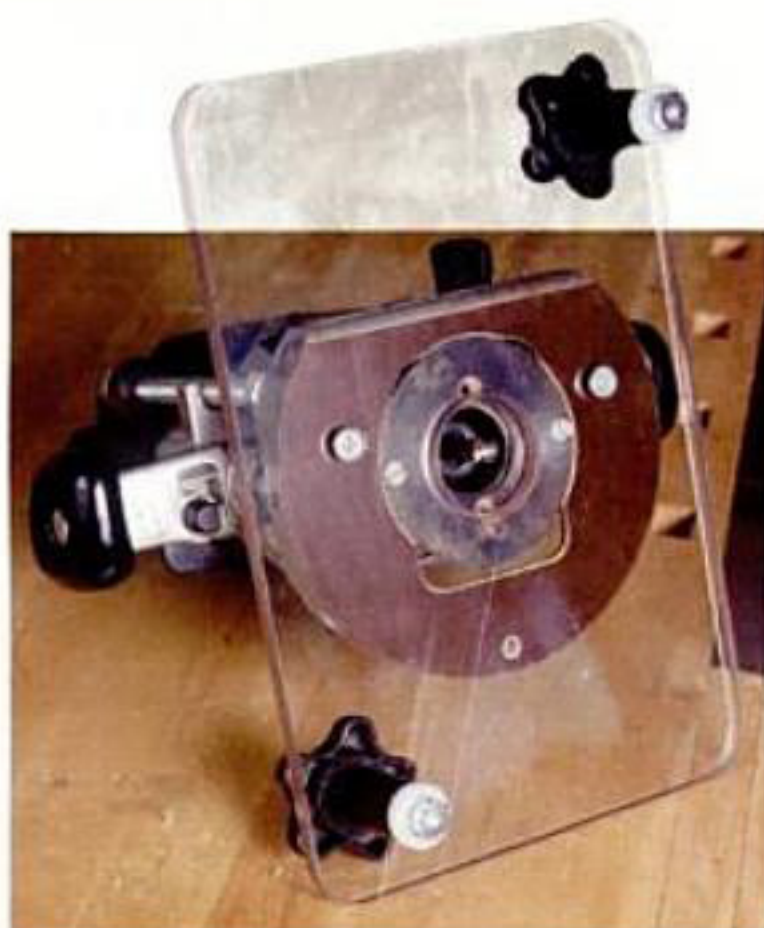


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TOOL BOX



Mortise Centering Jig ▲

This accessory kit converts your auxiliary router baseplate into a jig that will quickly center mortises on stock of any thickness. The kit consists of two non-marking posts, bolts and knobs. To install it, you drill two 3/8-in.-dia. holes in your aux-

iliary baseplate. To use the jig, place a post on each side of the stock and the bit is automatically centered. (Price: \$19.95) *Eagle America, Box 1099, Chardon, OH 44024, (800) 872-2511.*

CIRCLE NO. 623 ON PRODUCT INFORMATION FORM

Diamond Hone for Carbide Bits ▶

With Furnima's Diamond Hone you can sharpen carbide router bits right in the shop. The diamond-impregnated hone fits into a 1/2-in. variable-speed router and runs at the low-speed setting. You sharpen the bit freehand, honing the carbide's flat face. The hone cuts fast and clean.

The Furnima Diamond Hone comes in two models: An electroplated hone



for \$59.99 (U.S.) and a resin-bonded hone for \$99.99.

Furnima Industrial Carbide, Box 308, Barrys Bay, Ontario, Canada K0J 1B0, (800) 267-0744.

CIRCLE NO. 628 ON PRODUCT INFORMATION FORM



Woodrat

There are plenty of router dovetail fixtures on the market, from simple template jigs to sophisticated gadgets that let you move your router or workpiece in three dimensions. Some allow you to customize the pin and tail spacing, but they take a long time to set up, and you're limited to that spacing until you change the settings again. With the Woodrat, you can cut not only through or half-blind dovetails of virtually any size and spacing, but also box joints, mortise-and-tenon joints and sliding dovetails—just to name a few—all with just a few minutes setup. In many cases, you can cut several pieces at a time (up to 40, in some cases), which makes it useful for small production runs.

Made in England, the Woodrat offers several modes of operation. First, for cutting dovetails or box joints on boards up to 12 in. wide, it works like a duplicating machine. You use a sample ("marker") board mounted parallel to your workpiece to determine cut placement, then

pull the router through the workpiece. You also can lock your router in a fixed position and feed pieces of any length by hand or pieces up to 30 in. long by means of a sliding carriage. For sliding dovetail grooves in boards up to 9 in. wide, you clamp the board to the underside of the fixed router plate and pull the router through the work.

The Woodrat is compact, measuring only 5 in. by 16 3/4 in. by 35 in. and weighing less than 20 lbs. Its backbone



TESTED BY BILL MCCARTHY

is a 5-in.-square extruded aluminum bar that you mount on a wall or clamp on top of a workbench. You attach your router to an assembly that's bolted to the top of the bar, while the workpiece rides on a carriage, which slides along the front face of the bar. There are two movable cam clamps on

the carriage to hold your workpiece and marker board perpendicular to the router base, and you turn a handwheel to move the carriage back and forth.

Although the instruction manual is very difficult to follow, I assembled the Woodrat in less than an hour. I'd recommend watching the video first to get a better idea of how the parts interact. The router mounting plate is predrilled for an Elu router but you can mount any router you choose—a plunge router works best.

Problems with the Woodrat are few. There is a bit too much slop in the sliding carriage, but not enough to greatly affect accuracy. A new and, hopefully, improved instruction manual is also in the works.

All-in-all, I thought the Woodrat's design and performance were exceptional. It would be especially valuable for anyone making reproductions, where asymmetrical dovetail layouts are necessary for that authentic look. (Price: Woodrat \$849.)

Garrett Wade, 161 Avenue of the Americas, New York, NY 10013-1299, (800) 221-2942.

CIRCLE NO. 624 ON PRODUCT INFORMATION FORM



Adjustable Miter Gauge Track ▲

The True-Fit Adjustable Miter Track provides a clever and inexpensive means for getting a perfect sliding fit between a miter-gauge bar and the slot.

The Track is an aluminum channel that lines a routed slot. The bar slides in the channel and you adjust the Track's "grip" by tightening screws in the bottom of the Track. As the screws pull the channel bottom downward, the sides of the Track pull inward, eliminating any play. The Track works with any miter gauge and costs \$19.95 for a 42-in. length. It can be cut to length with a hacksaw.

Garrett Wade Co. Inc., 161 Avenue of the Americas, New York, NY 10013, (800) 221-2942.

CIRCLE NO. 625 ON PRODUCT INFORMATION FORM

TOOL BOX

Circle Jig Does Double Duty ▼

The Circle Mark-N-Cut allows you to draw or rout circles without making a hole in your workpiece. The secret is the Mark-N-Cut's tape-on pivot point.

The Mark-N-Cut comes with centering inserts for pens or pencils and a



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Mark-N-Cut Distributors Inc., 115 Hubert Siler Rd., Williamsburg, KY 40769, (606) 549-0524.

CIRCLE NO. 626 ON PRODUCT INFORMATION FORM



Router-Table Vacuum Outlet ▲

This vacuum outlet attaches to a router-table fence to provide a convenient dust-collection hookup. The plastic outlet has a tapered press-fit flange for a 2½-in.-dia. shop-vac hose. Screw-in adapters are also available for 3-in. and 4-in.-dia. hoses (\$9.99). The outlet comes mounted on a 4-in. by 6-in. plate with wooden corner blocks and mounting tape. (Price: \$9.99)

Woodhaven, 5323 W. Kimberly Rd., Davenport, IA 52806, (800) 344-6657.

CIRCLE NO. 627 ON PRODUCT INFORMATION FORM

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DW 318K Orbital Jig Saw Kit	\$139.95
DW 361 7¼" Saw w/Brake	\$129.95
*DW 430 3x21 Belt Sander	\$166.95
*DW 431 3x21 VS Belt Sander	\$183.95
*DW 614 1¼" H.P. Plunge Router	\$142.95
*DW 615 1¼" H.P. VS Plunge Router	\$165.95
*DW 624 3 H.P. Plunge Router	\$249.95
*DW 625 3 H.P. VS Plunge Router	\$279.95
*DW 675K 3¼" Planer with Case	\$159.95
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CIRCLE NO. 28 ON PRODUCT INFORMATION FORM

WEAVING

GALLERY

Woodturner Lincoln Seitzman manages to blur the line between what is woven and what is . . . wood. In fact, all of his turnings begin as individual segments that he glues into rings then stack-laminates to form a rough shape. After turning each vessel inside and out to refine the form, the artist uses inks to depict patterns based on Native American basketry. While his "Illusion" series uses colorful inks to affect the design, his "Petrified" series employs contrasting woods to convey the basket theme, with dark ink added only to accent the effect.

PHOTOS BY JEFF MARTIN

▼ Petrified Hopi Basket. Marupa, purpleheart, poplar, black-dyed birch. Dimensions: H: 12 in., Dia: 14 in.

► Petrified Sewing Basket. Cherry, wenge. Dimensions: H: 7 in., Dia: 13 in.

▼ Chumash Snake Basket Illusion. Oak, ink. Dimensions: H: 12 in., Dia: 14½ in.

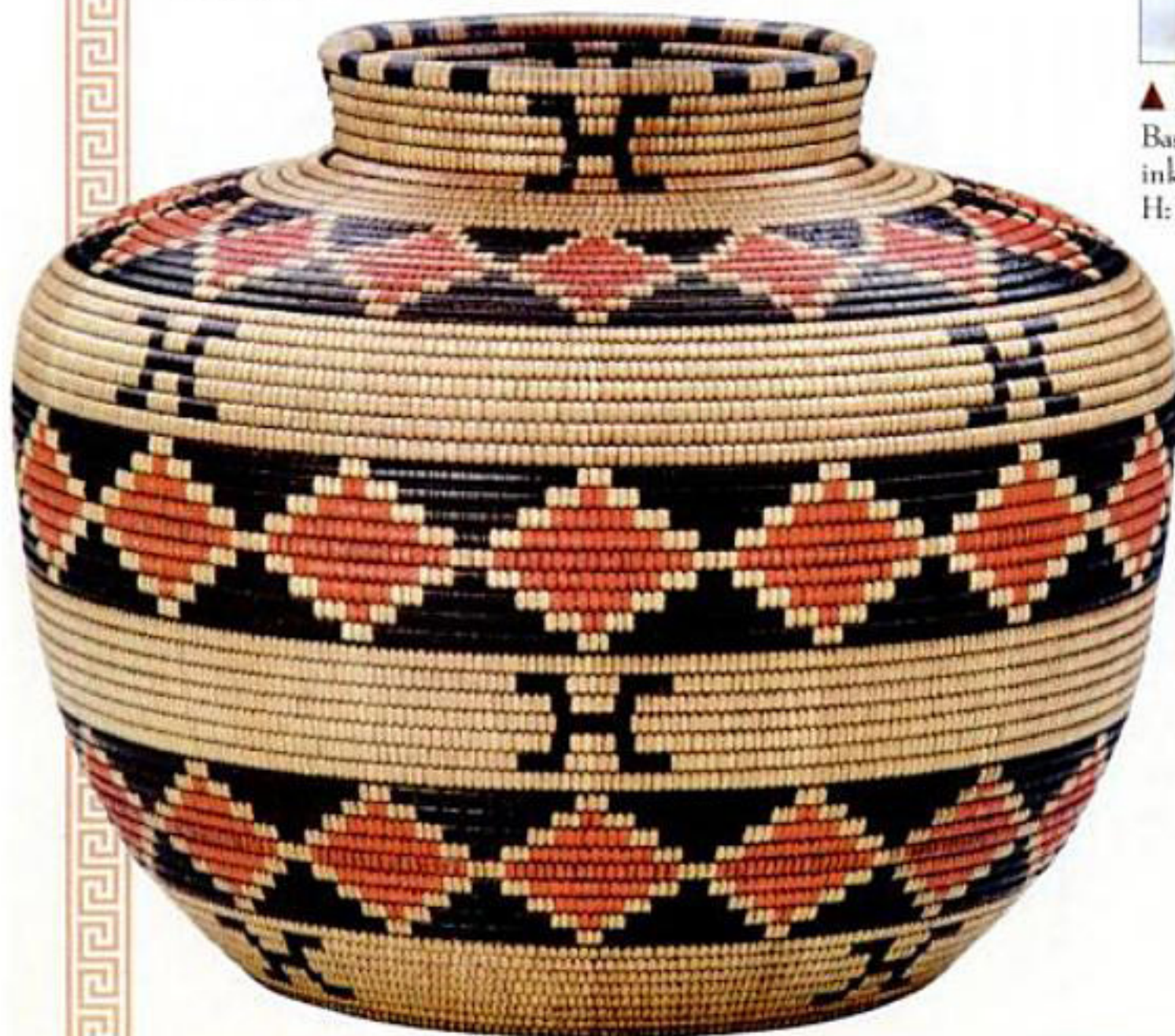


▼ Petrified Basket V. Oak, leopard wood, shedua. Dimensions: H: 13 in., Dia: 12 in.

▲ Mescalero Apache Basket Illusion. Oak, ink. Dimensions: H: 7 in., Dia: 7 in.



▲ Petrified Cherokee Basket. Maple, ipe, bloodwood, amapa. Dimensions: H: 8½ in., Dia: 8 in.



ON THE LATHE



▲ Navajo Basket Illusion. Oak, ink. Dimensions: H: 12 in., Dia: 9 in.

► Petrified Shopping Basket. Ipe, cherry. Dimensions: H: 18 in., W: 15 in., Dia: 9 in.



► Apache Water Basket Illusion. Oak, horse-hair handles, ink. Dimensions: H: 10 in., Dia: 8 in.



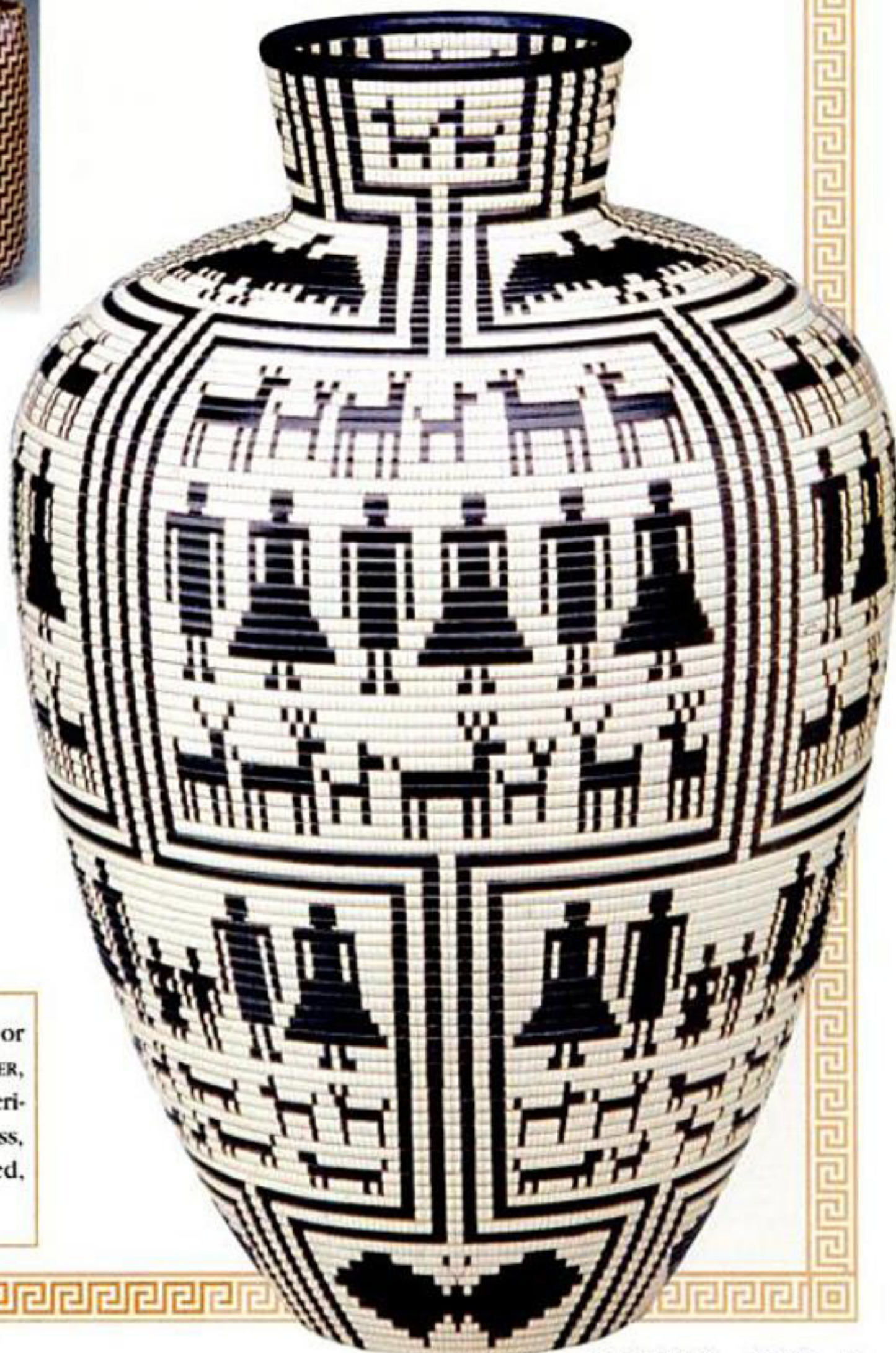
► Petrified Basket III. Ash, ipe, afrormosia. Dimensions: H: 17 in., Dia: 13 in.



► Shoshonean Basket Illusion. Oak, ink. Dimensions: H: 7 in., Dia: 10 in.



▼ White Mountain Apache Olla Basket Illusion. Guatambu, ink. Dimensions: H: 21 in., Dia: 14 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. If you want your photos returned, enclose a self-addressed stamped envelope.

FINAL PASS

SHARPENING-SERVICE COMPLAINTS

We've had several complaints about Superior Sharpening Services, a hand-sharpening business in Palos Hills, Illinois, which we mentioned in Final Pass (AW #30). Because woodworkers who have shipped tools to Superior are having a hard time getting them back, we advise readers not to deal with Superior Sharpening Services until further notice.

NiCad Collection Programs Start

Many states are passing laws making it illegal to toss out spent batteries from rechargeable tools. In response to this trend, both Skil Corp. and Black & Decker have started collection programs to recover and recycle NiCad batteries from their tools.

To locate the nearest Skil battery collection center, call 312-286-7330. Call 800-762-6672 for information on Black & Decker's collection spots.



Stuart King of High Wycombe, England, shows a future turner how a pole lathe works at the World Turning Conference.

Turners Hold Global Gathering

Woodturners from around the globe flocked to Wilmington's Hagley Museum last April for the first World Turning Conference. Sponsored by the



"Study in Flower Forms" by David Pye. Dimensions: H: 6³/₈ in., W: 7 in., D: 3 in.

"Kidney Bowl" by David Pye. Dimensions: H: 2¹/₂ in., D: 8³/₄ in., W: 15 in.



PHOTOS BY JOHN CARLAND, WORLD TURNING CENTER COLLECTION

David Pye Dies at 79

David Pye, the British woodworker and designer whose talents and teachings drew attention worldwide, has died at the age of 79.

As a carver, turner, author and designer, Pye instilled a generation with his passion for design. He taught at London's prestigious Royal College of Art for more than 30 years, and while there wrote two of his three influential books on woodworking, *The Nature of Design*, and *The Nature and Art of Workmanship*. This last work argued strongly against the idea that handcrafted furniture is superior to mass-produced. The two are simply different, Pye believed, and can

complement each other as spice enlivens a bland dish.

Pye carried this theory of complementary roles into his woodworking. He was just as likely to carve a bowl with an 18th century tool as he was to invent a new machine or jig for his lathe. The results in both cases were stunning, as the photos above show.

After retiring from teaching in 1974, Pye created and exhibited his work extensively. In 1985, Queen Elizabeth II honored his accomplishments by presenting him with an OBE (Order of the British Empire). He died on New Year's Day after suffering for several years from Parkinson's disease.

Wood Turning Center and coordinated by brothers Albert and Alan Lecoff, the three-day event featured seminars, demonstrations and panel discussions on matters of technique, philosophy and art and a gallery exhibition entitled, "Art From the Lathe." For more information contact the Wood Turning Center at 215-844-2188.

COMING NEXT ISSUE

- Buyer's Guide to Biscuit Joiners
- Designing for Wood Movement
- Colonial-Style Storage Bench
- Glues Reviewed