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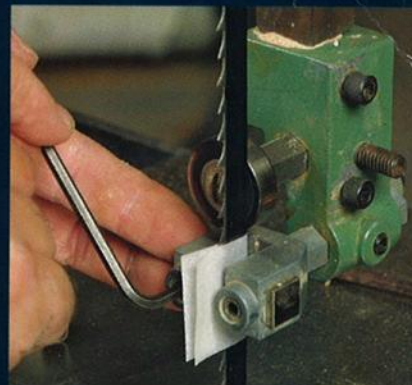
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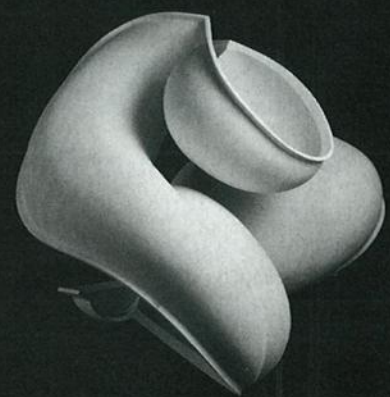
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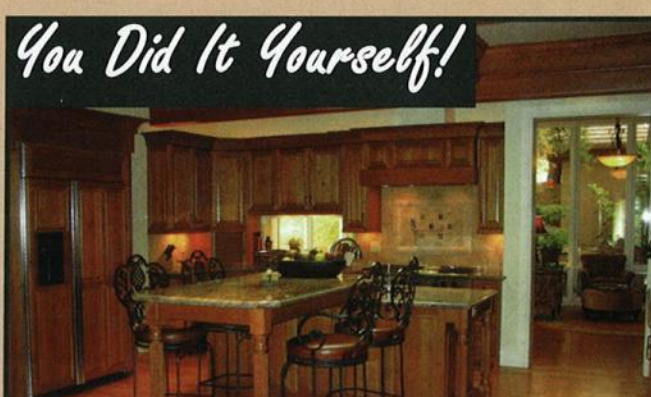
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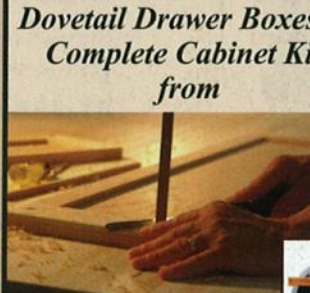
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Tune up your tools



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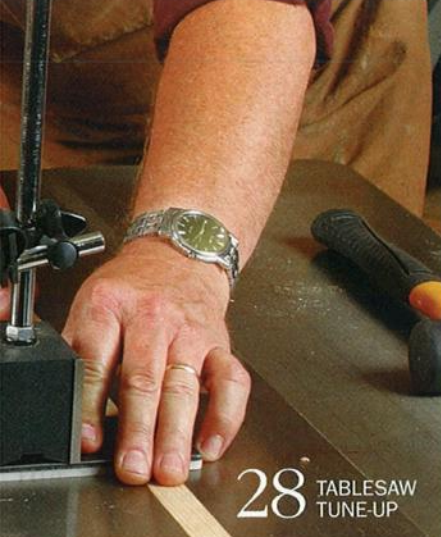
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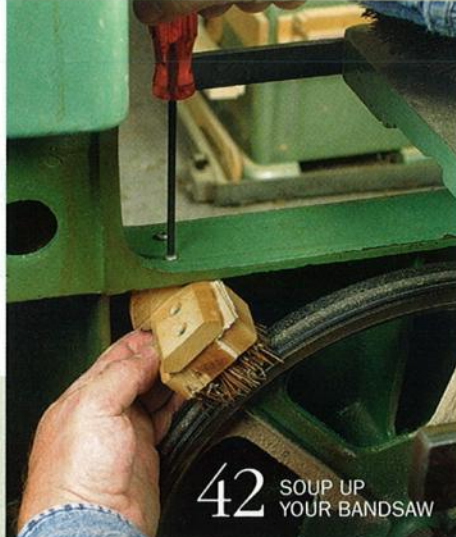


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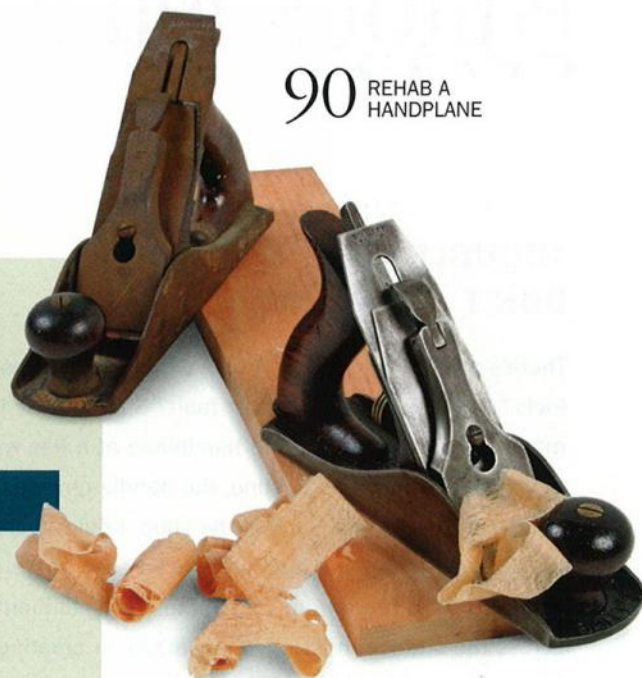




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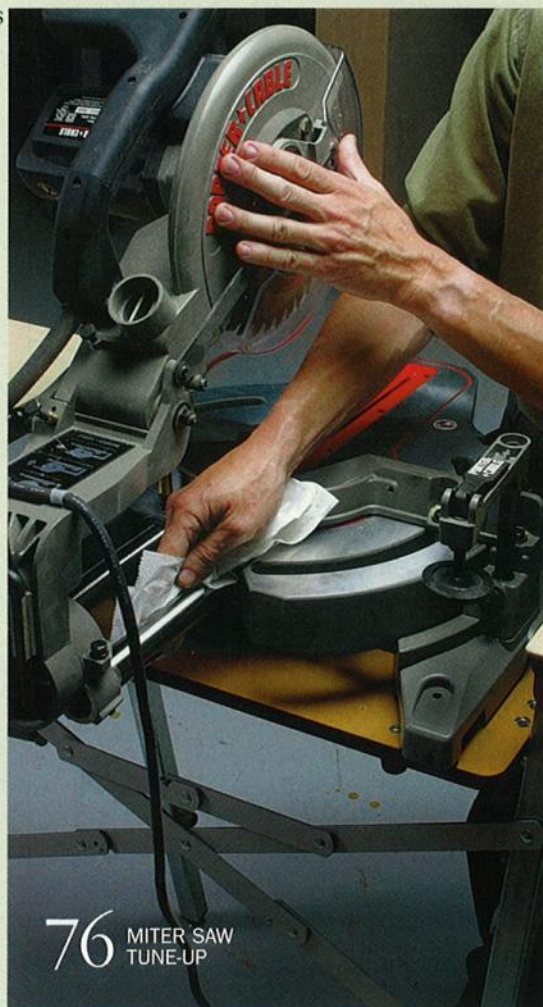
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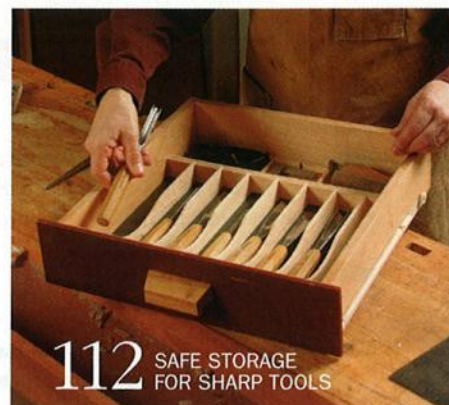
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editor's letter



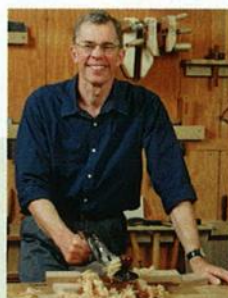
TROUBLE WITH TOOLS? DON'T BLAME YOURSELF

There's an old saying that "A poor workman blames his tools." But what if the tool *is* at fault? Shortly after joining *Fine Woodworking* magazine, I picked up an old handplane at a flea market. It looked like a real bargain: The paint was pristine, the handle unworn, and the steel still shiny. In fact, it looked barely used. Back in the shop, I quickly clamped a board to my bench and began to try and plane it smooth as I'd seen some of my fellow editors demonstrate so effortlessly. The harder I tried, the more stubbornly the plane behaved, jumping across the surface, missing whole areas, or creating great gouges. After 30 minutes I gave up, put the plane on a high shelf, and concluded that I clearly didn't have the skill to be a "fine woodworker."

I carried this guilt for a couple of years until I was asked to edit an article on how to tune up a handplane. One of the first tasks was to see how flat the sole or bottom of the plane was. Apparently if it was dished in the middle, then no amount of skill would get the plane to cut properly. Curious, I checked my plane and found it to be concave by almost $\frac{1}{16}$ in. I followed the author's directions on how to correct this problem, along with his other suggestions on how to tune up a plane. This time when I tried the plane, long wispy shavings flowed from it, leaving the board with a beautiful, flat, shimmery surface.

If you're not happy with the way your tools are working, don't blame yourself. Instead, see if there is way to tune them up. From bandsaw to block plane, almost every tool occasionally needs some TLC. In return, they'll reward you with much better performance.

—Mark Schofield
Tune Up Your Tools editor



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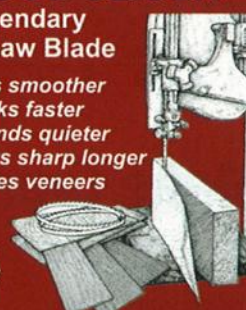
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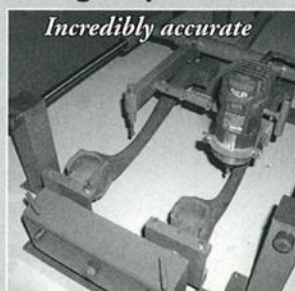
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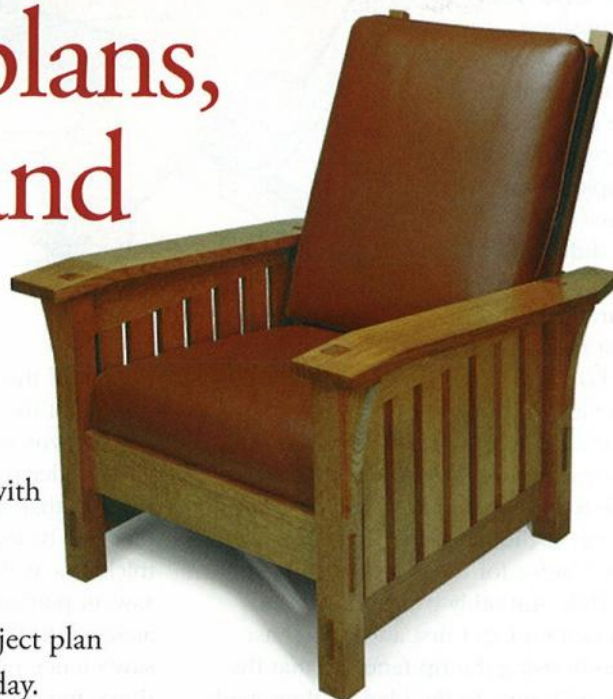


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Make tapered cuts on the tablesaw

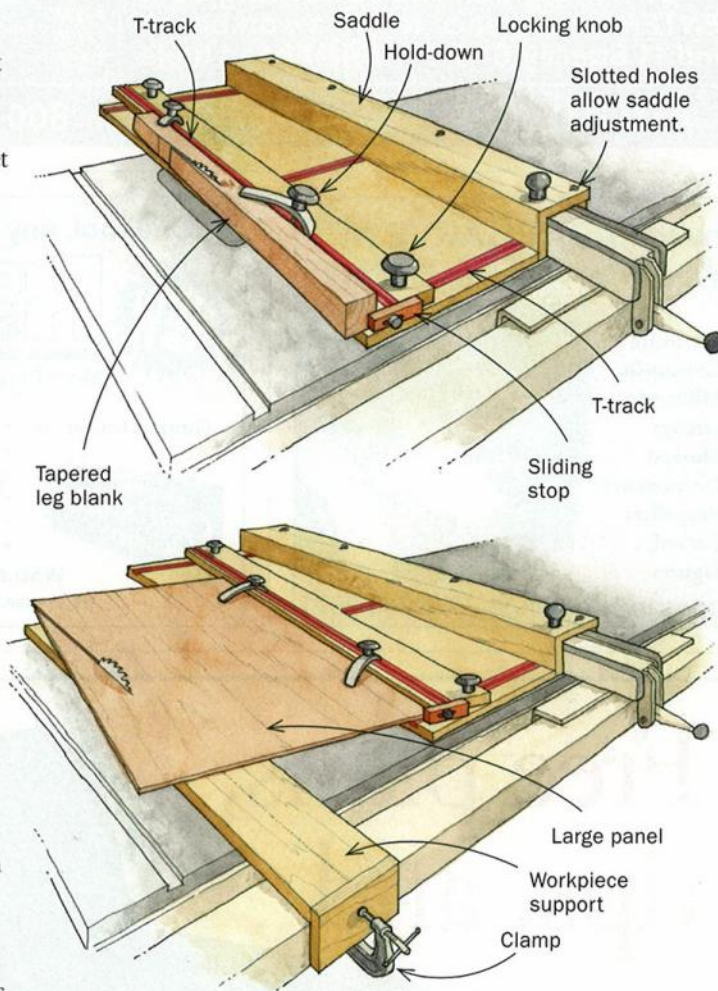
This versatile jig not only makes tapered legs, it also makes angled cuts on sheet goods as wide as the tablesaw will allow. It consists of a sliding base, fences, and a workpiece support for sheet goods.

The long fence can be used to cut tapers up to 15° on pieces up to 40 in. long. I also have a shorter fence for cutting steeper tapers on shorter pieces.

The fence locks into position with knobs and T-slot bolts that slide in T-tracks. The two hold-down clamps ride in a T-track as well. The sliding stop registers workpieces accurately. (Knobs, T-slot bolts, T-track, and hold-down clamps are available from hartvilletool.com.)

The right side of the sliding base features a channel that rides the saw's rip fence for maximum accuracy. The far side of the saddle is adjustable with slotted holes for the screws, so the jig will slide smoothly over the fence.

To taper a leg, I first adjust the base position using the rip fence so that the jig is right next to the blade. I then mark each end of the workpiece to get the taper I want and line up the marks with the edge of the jig, which is also the cut line of the blade. After that, I move the fence up to the leg blank, butting the



bottom of the leg against the stop at the bottom of the fence. Finally, I tighten the hold-downs and make the cut.

For wider pieces, I use a workpiece support that straddles the blade. It is a piece of Baltic-birch plywood the same thickness as the base of the jig, with a sawcut partway through it and a fence attached to the front that I clamp to the saw's fence rail. I have drawn a line down the center of the support in line with the blade to assist in lining up the workpiece for the cut. With this support I can move the jig as far from the blade as necessary to cut wide panels.

—ALAN CARTER, Lisle, Ill.

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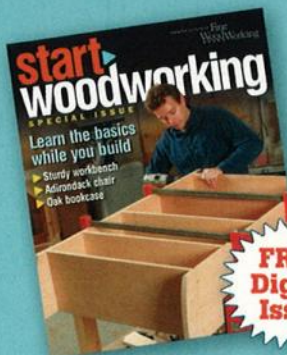
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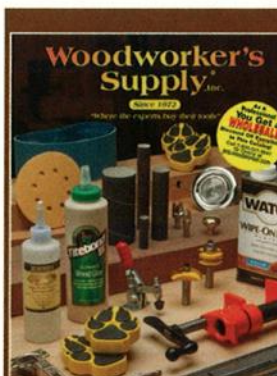
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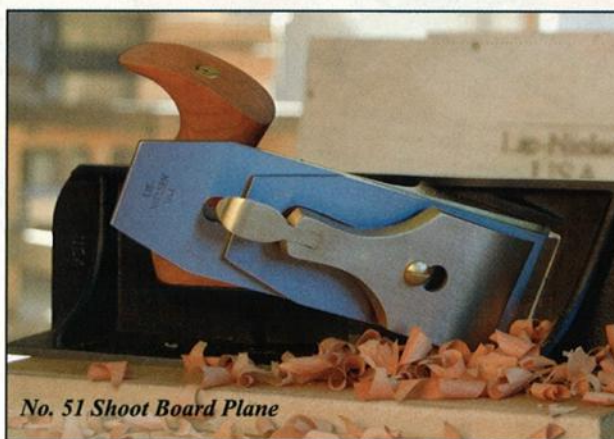
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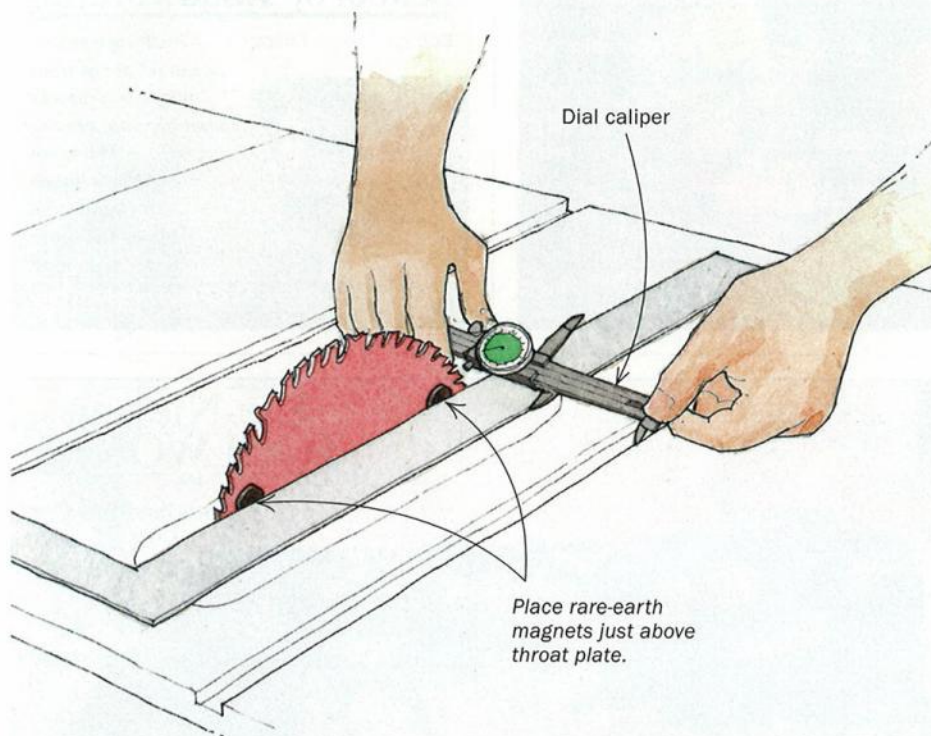
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Dial in your tablesaw with magnets and a framing square

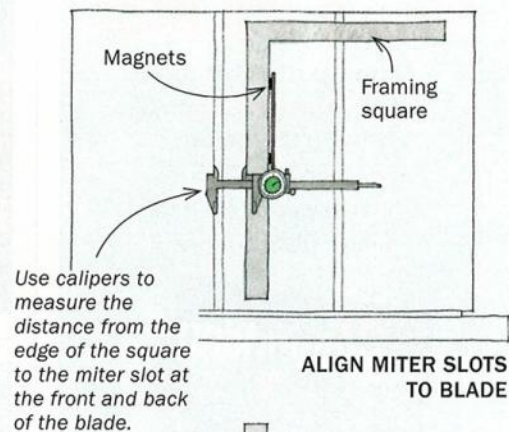
Rare-earth magnets and a framing square offer a wonderful way to set up your entire tablesaw, from the table to the rip fence and the miter gauge. The magnets prevent the blade teeth from interfering with the square, which ensures accurate measurements.

To align the tablesaw's miter-gauge slots (table) parallel with the blade, first disconnect the power. Raise the blade to its full height and place two identical rare-earth magnets on the left side of the blade just inside the teeth—one in front and one in the rear. Both magnets should be low, about level with the throat plate.

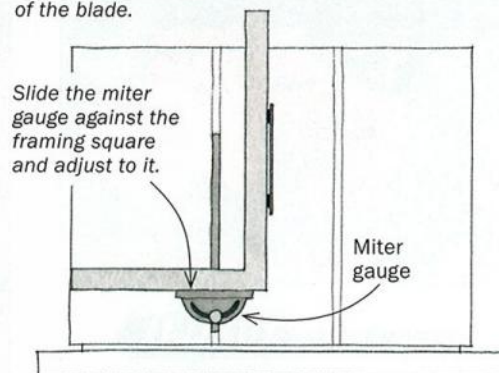
Now place an accurate framing square flat on the saw's top and move the square to the magnets as shown. With a dial caliper, measure the distance from the miter-gauge slot to the framing square at both the front and rear of the blade. Both measurements should be equal. If not, rotate the top left or right until the readings are the same.

Once you have the table adjusted so the miter slots are parallel to the blade, you can also use the magnets and framing square to quickly adjust your miter gauge and fence as shown.

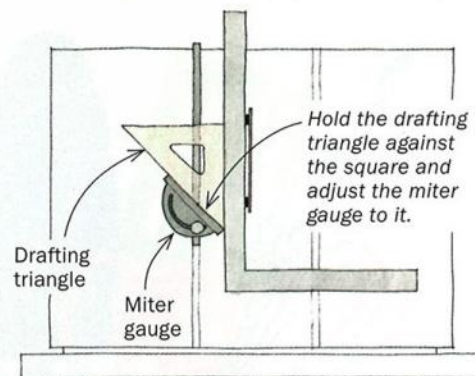
—RICHARD BABBITT, Friday Harbor, Wash.



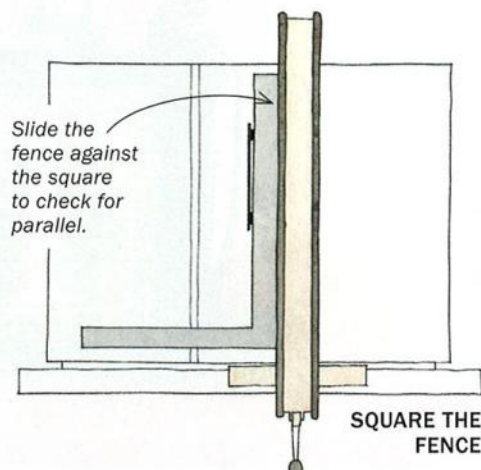
ALIGN MITER SLOTS TO BLADE



SET THE MITER GAUGE AT 90°



SET THE MITER GAUGE AT 45°



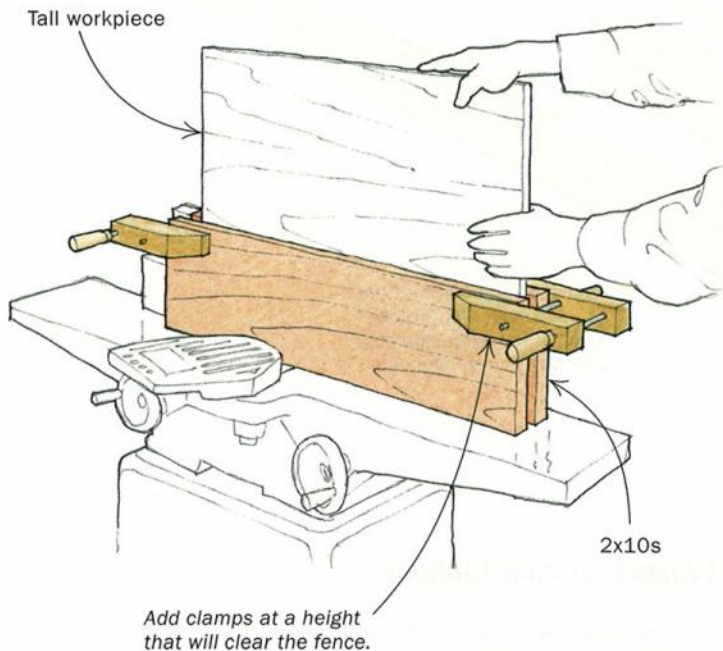
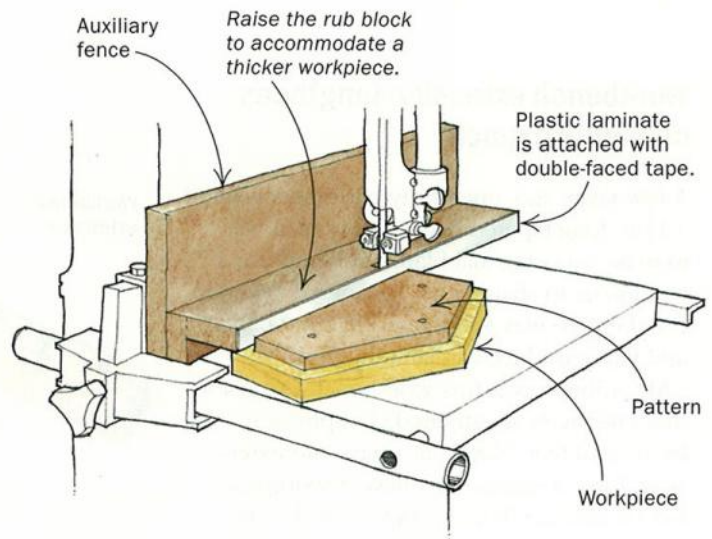
SQUARE THE FENCE

Add a pattern-cutting jig to your bandsaw

For years I've used my tablesaw for pattern sawing. Recently, however, I became nervous about using the tablesaw technique when I had a workpiece that was only 2 in. on one side. It just didn't feel safe. So I modified the pattern-cutting fixture for use on my bandsaw. The fixture is quite simple to build.

It is a good idea to construct the fixture so that the inside cutting edge of the blade is a standard distance from the outer edge of the fixture— $\frac{1}{2}$ in. in my case. This allows you to cut the hardboard pattern pieces $\frac{1}{2}$ in. smaller than the desired final dimensions. One important part of the fixture is a strip of plastic laminate held in place with double-faced tape. This provides a continuous surface against which the pattern can be run, avoiding any snags at the cut-out around the sawblade.

—BARNETT C. HOWARD, Sisters, Ore.



Help your jointer handle large panels

When I needed to square up the edges of a 20-in.-square tabletop, I knew from experience that I would have trouble running it through my jointer. Without going to all the effort of adding a tall fence to the jointer, it is difficult to keep a tall workpiece from tipping and ruining the cut on the edge. Here is the solution I came up with, and it worked perfectly.

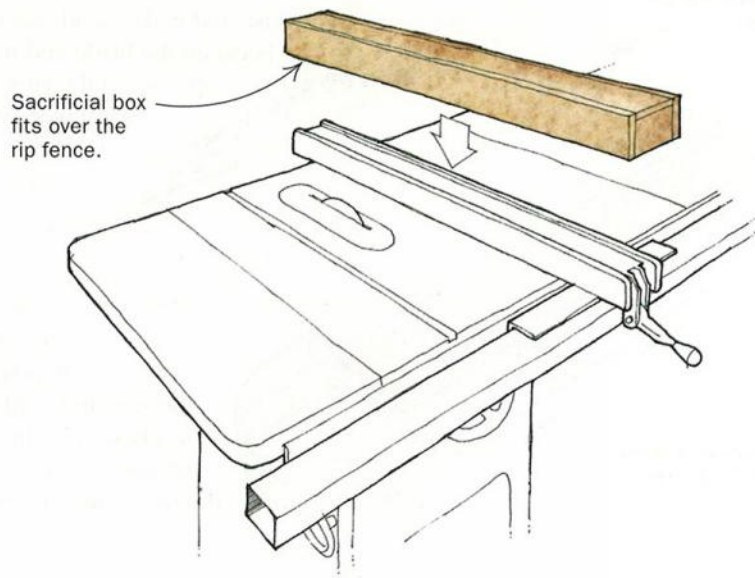
I cut two 2x10s a few inches longer than my workpiece and sandwiched the workpiece between the two boards with clamps. I kept the clamps high enough to avoid interference with the jointer fence, and then ran the sandwiched edge through the jointer. The extra width added stability to the tall workpiece. I was able to joint perfectly smooth edges without tipping or wavering.

—JAMES A. JOHNSON, Brunswick, Ohio

Make a sacrificial rip-fence cover

Make a box to fit over your tablesaw's rip fence. It must be a snug slip-fit in both width and length. Use melamine pieces on the outside, and you'll have an almost friction-free fence you can saw or dado into without damaging your regular rip fence. The cover is very easy to take on and off, and mine has lasted longer than I thought it would.

—BLAISE GASTON, Earlysville, Va.

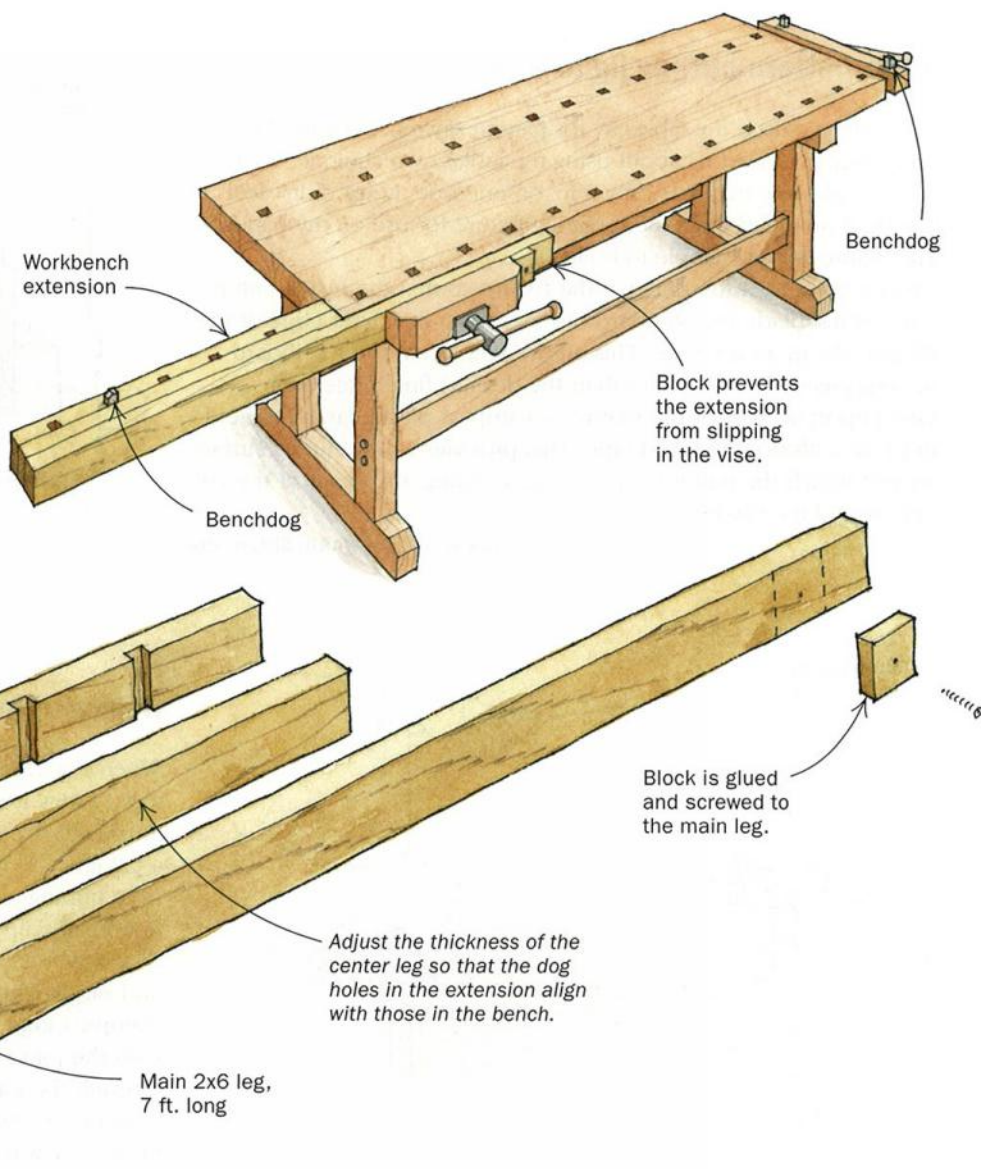


Workbench extension lengthens clamping capacity

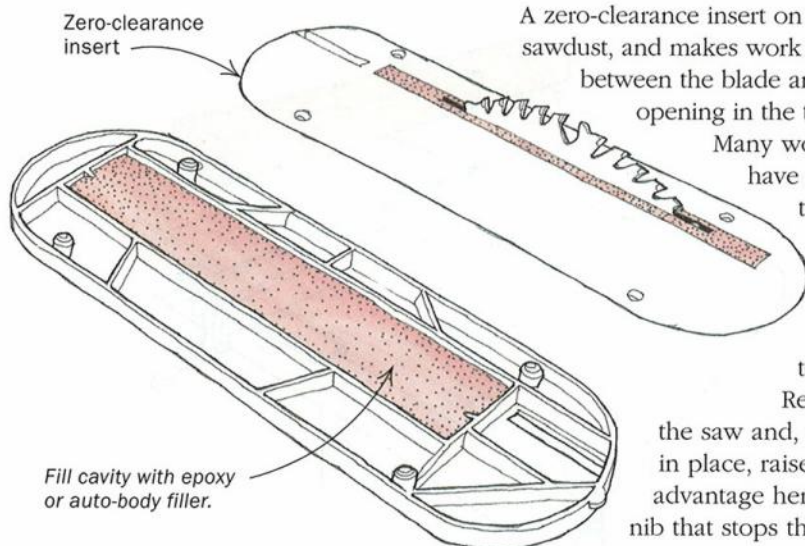
A few years ago, one of my customers wanted a 12-ft.-long tapered flagpole. My plan was to make an octagonal blank and then use a handplane to shape it into a tapered cylinder. But the pole was 5 ft. longer than my bench, and that introduced a clamping problem.

My solution was this workbench extension that effectively lengthened clamping capacity by several feet. Now that I have the extension, I use it whenever I have a workpiece longer than my bench, such as bedposts, tabletops, and countertops.

—AURELIO BOLOGNESI, Hardwick, Mass.



Make a no-tearout insert for your tablesaw

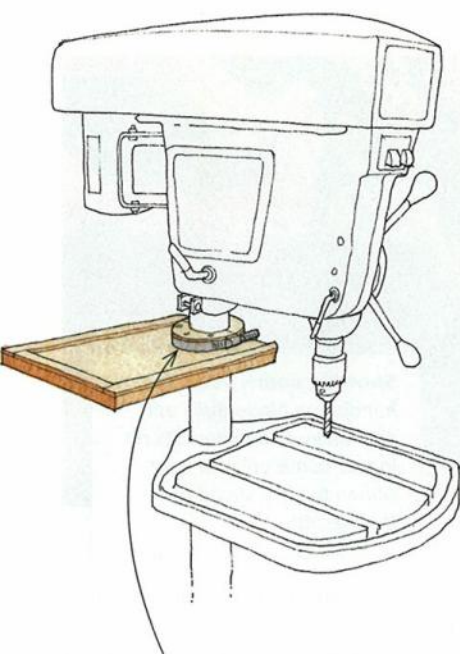


A zero-clearance insert on a tablesaw helps prevent tearout, confines some of the sawdust, and makes work safer by preventing small cutoffs from becoming jammed between the blade and the insert. The problem is that most factory inserts fit the opening in the table pretty well, but have a sloppy blade opening.

Many woodworkers make or buy zero-clearance insert blanks, but I have devised an easier method. I fix a piece of common packing tape over the top of the blade opening in the stock cast insert. Put the tape on smoothly and make sure the insert is clean and in good shape. Turn the insert over and pour some epoxy or Bondo in the webbing of the cast insert. Set it aside on a dead-flat surface, and wait for the epoxy to set before you peel off the tape.

Replace the insert in the saw with the blade lowered, start the saw and, with a block of wood clamped over the insert to hold it in place, raise the blade to cut your new zero-clearance slot. The major advantage here is that you get to keep the leveling screws and the little nib that stops the back of the insert from flipping up.

—KEITH PRICE, Campbell River, B.C., Canada



Tray clamps around drill-press column.

Easy-access shelf for drill-press accessories

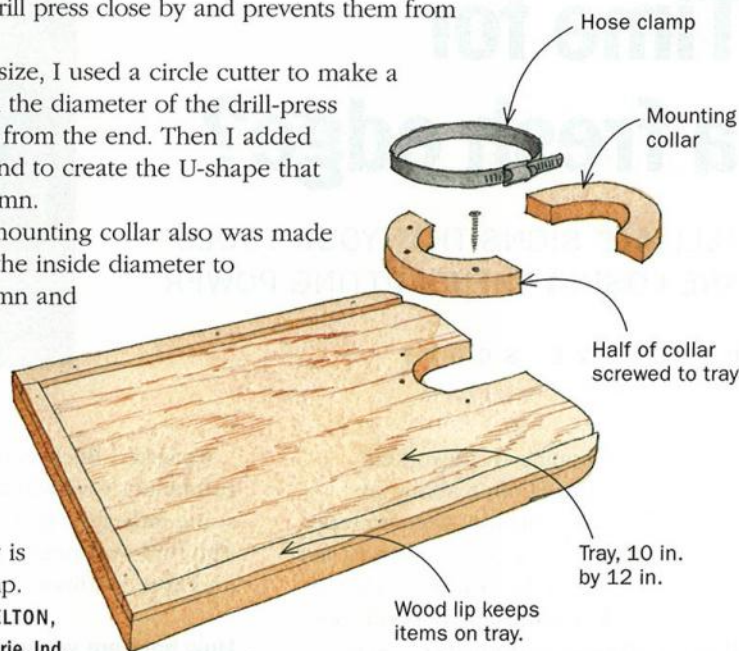
This shelf, made from $\frac{3}{4}$ -in.-thick Baltic-birch plywood, keeps bits and other accessories for my drill press close by and prevents them from rolling off onto the floor.

After cutting the tray to size, I used a circle cutter to make a 3-in.-dia. cutout (to match the diameter of the drill-press column), centered $1\frac{1}{2}$ in. from the end. Then I added the lip and trimmed the end to create the U-shape that slides easily over the column.

The two-part plywood mounting collar also was made using a circle cutter. Size the inside diameter to match the drill-press column and make the outside radius $\frac{3}{4}$ in. or 1 in. larger.

One half of the collar is screwed to the tray, aligned with the inside edge of the cutout, and the other half fits around the column. The assembly is held fast with a hose clamp.

—BRUCE MELTON,
Rolling Prairie, Ind.



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understanding your tools

Time for a fresh edge?

TELLTALE SIGNS THAT YOUR TOOLS ARE LOSING THEIR CUTTING POWER

BY STEVE SCOTT

Beginning woodworkers are told often about the importance of keeping tools sharp. Deciding when to stop and sharpen or replace a tool ultimately depends on how much poor performance you're willing to accept. Applying that lesson, however, takes practice. For starters, how can you tell when a tool is losing its edge?

Christian Becksvoort calls the descent from sharp to dull "a gentle, downward curve, with steadily declining results and ever more effort required."

We asked Becksvoort and other prominent woodworkers to describe some indicators that it is time to sharpen. The three warning signs: effort, results, and tool condition.

How hard are you working?

When deciding whether a tool is losing its edge, "my first clue is an increase in cutting resistance," says Garrett Hack.

Simply put, a dull cutting edge on a hand or power tool requires more force to cut the wood. On router tables, for instance, a dull bit means you'll have to

exert more pressure to keep the wood against the fence.

"A dull bit will tend to push the material away," Roland Johnson says. "A sharp bit just cuts." Similarly, a dull jointer knife wants to lift a board off the table.

You'll have to push harder to move stock through a cut if a bandsaw or tablesaw blade is dull. A dull tablesaw blade requires extra effort even if cleaned of gum and pitch, Becksvoort says.

On the bandsaw, you'll find yourself pushing the blade against the rear thrust bearing as you force stock through a



Showing some wear. As a handplane blade dulls and gets nicked, the shavings no longer come off as a wide ribbon but are sliced down their length.

Power tools

The brute force provided by an electric motor can't overcome the effects of a dull blade or bit. You'll work harder to feed the stock or guide the tool, and the finished cut will not be clean.



More push needed. The extra force required to feed stock into a dull bandsaw blade can cause the blade to wander. A rough, wavy cut is the result.



Slow going. A dull tablesaw blade requires more effort to feed stock into the cut, and the difference shows in the work. Although a dull blade won't look markedly different from a sharp one, it can leave stock looking burned and scarred.

Hand tools

As it dulls, a chisel or plane iron will gradually offer more resistance to the force you apply.

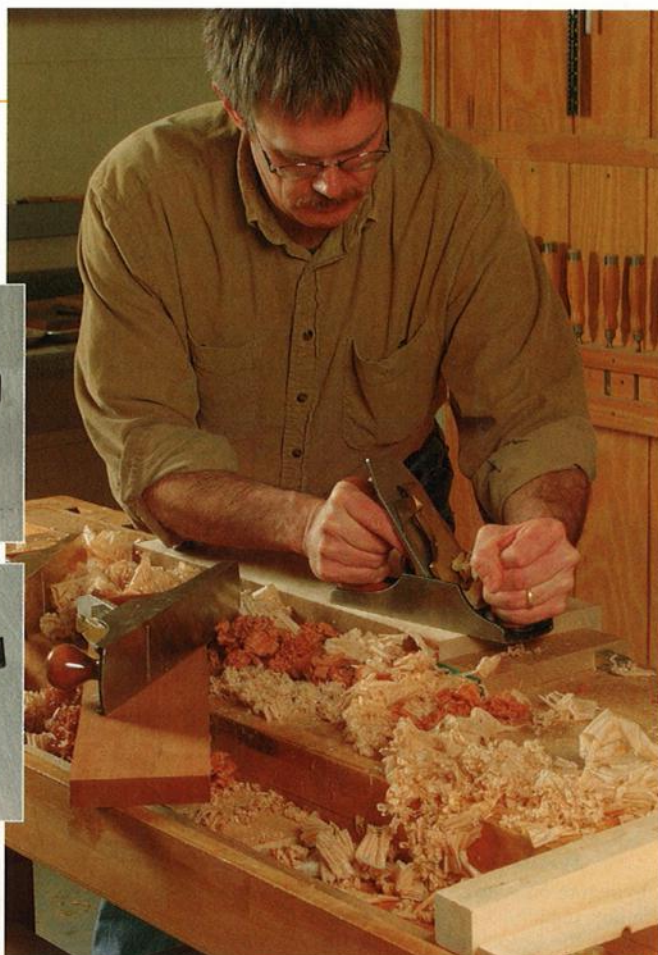
DULL



SHARP

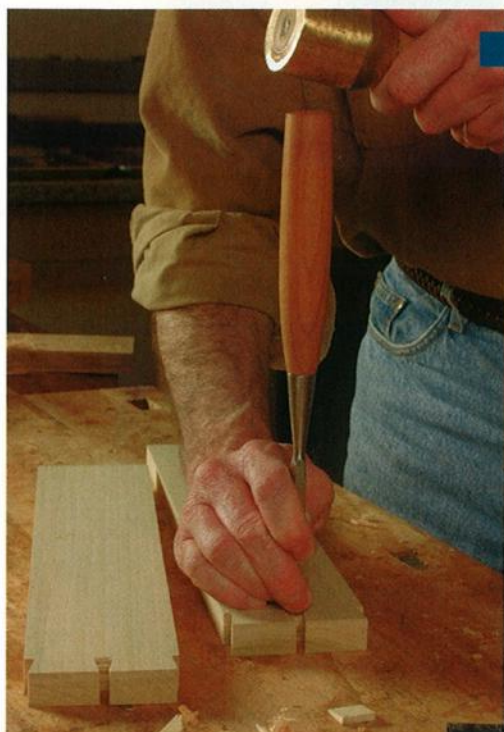


A sign of wear. A dull plane iron will show a telltale line of light near the cutting edge. A sharp blade won't.



DOVETAILS ARE A GOOD TEST

Torn-out end grain between the tails indicates a dull chisel. Soft woods like white pine show tearout sooner.



DULL



SHARP



cut, according to Gary Rogowski. This is more apparent with thicker stock.

With handplanes, Hack says, a dull edge is most noticeable on end grain. And dull chisels are harder to handle.

"On long grain I have to push harder," says Hack, "and I sometimes lose control because the dull edge wants to dive into the fibers rather than sever them."

Becksvoort sharpens chisels after one large dovetailed case or two or three smaller pieces.

What do the results look like?

If increased effort is the first sign of a dulled edge, poor results are the surest.

Jointers and planers will leave tearout when blades are dull. Becksvoort changes them after two to four months of frequent use. The dulled blades give the wood a polished appearance that is "very shiny, but not particularly smooth."

A router with a dull bit can burn the stock, but that also can happen with a slow feed rate. A surer sign, Hack notes, is a cut with feathery or splintered edges.

On the bandsaw, Rogowski says, a dull blade will wander and yield a wavy cut, or begin to drift increasingly to one side.

With chisels, Becksvoort finds that when chopping dovetail slots, "I begin to get an unacceptable amount of tearing as I chop down across the grain."

Hack gauges the sharpness of a handplane edge "by looking at the shaving and by feeling the surface." On long grain, he looks for tearout and a dull or slightly rough surface. "The shavings no longer come off as a continuous thin ribbon but are getting sliced down their length at each nick, or they have holes where tearouts occur."

How does the tool look?

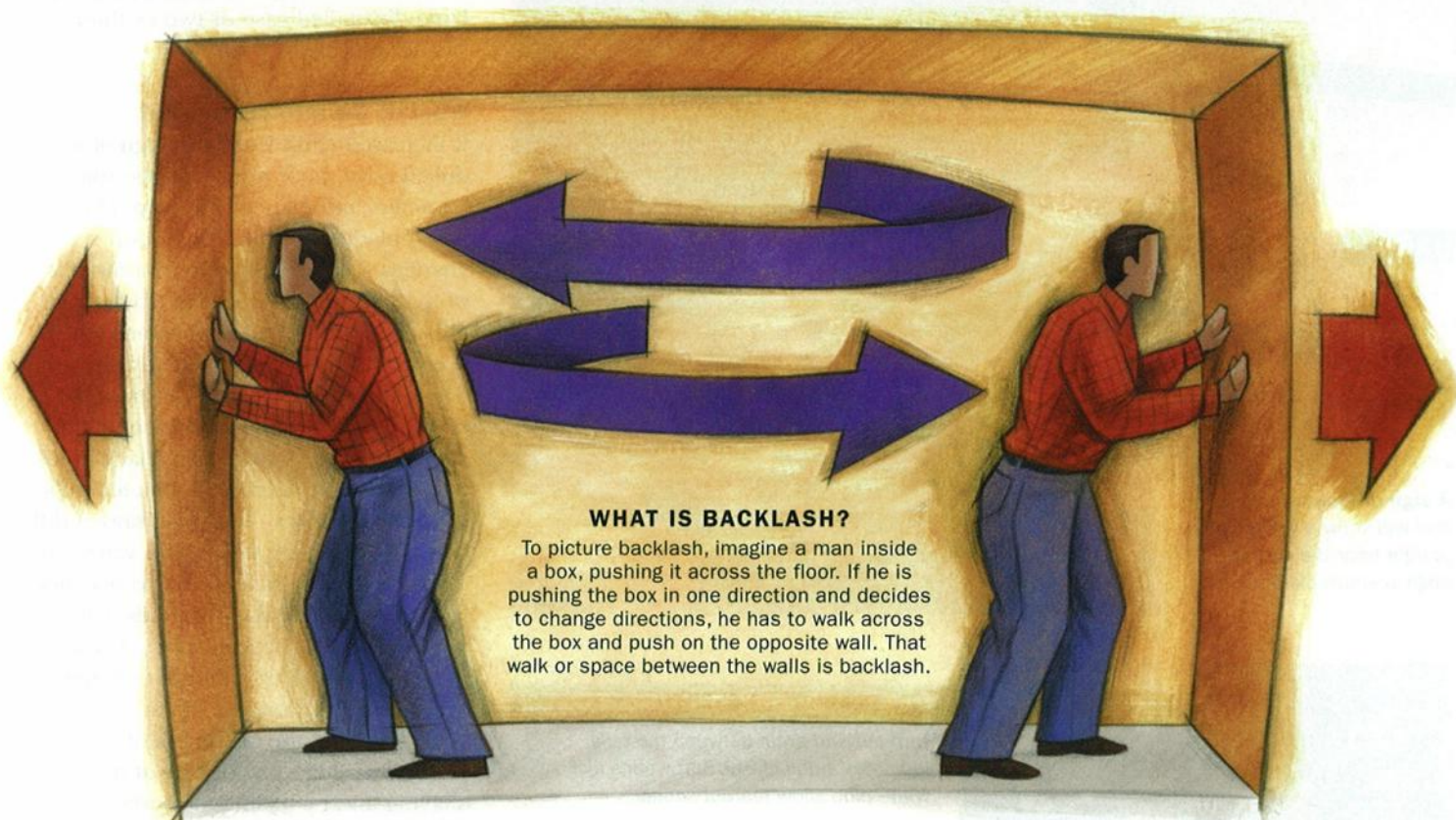
If you are still unsure, look at the edge itself. On plane irons and chisels, a dull blade will reflect a line of light at the cutting edge. Dull sawteeth are much harder to see. They won't look or feel blunter than sharp ones. But if a good cleaning doesn't improve their cutting ability, the edge is suffering. □

Steve Scott is an associate editor for Fine Woodworking.

Making sense of backlash

FOR MORE ACCURATE WORK, TAKE THE SLOP OUT OF ADJUSTERS

BY GEORGE WALKER



WHAT IS BACKLASH?

To picture backlash, imagine a man inside a box, pushing it across the floor. If he is pushing the box in one direction and decides to change directions, he has to walk across the box and push on the opposite wall. That walk or space between the walls is backlash.

Tracking down loose adjusters



WORN GEAR TEETH

Rotation of the worn gear pushes against the gear segment, causing the two parts to wear over time, creating more dead space and backlash.



LOOSE COLLARS

The vibration caused by normal wear and tear on machines can cause setscrews to rattle loose.



WORN PINS

The pin that holds the adjusting arm on any machine can wear away, causing the adjusting arm to slide around. The easy fix is a new pin.

When I served a machinist apprenticeship nearly 30 years ago, apprentices were expected to pay their dues, which meant running old, worn-out machines and completing jobs the more experienced journeymen didn't want to fiddle with.

I manned an ancient, dilapidated lathe that had spent its better years in Brazil. One journeyman, the cigar-puffing Dom, taught me how to overcome backlash, a common problem that occurs in machine and woodworking shops alike. You may have a jointer, a tablesaw, a planer, or a handplane that has a temperamental streak, that occasionally requires a little voodoo or that is just plain evil. Backlash may be the root of the problem.

Backlash is a necessary evil

Backlash is defined simply as the play between moving parts, such as gears or threads, and is most noticeable when changing directions. Although backlash is usually associated with old or worn machines, it's actually a necessary part of any machine design. Without the play, or clearance, between moving parts, mechanisms would seize up, shafts wouldn't turn, tables would not tilt or adjust. Backlash becomes a problem when that play is excessive—typically resulting from loose-fitting threads, gears, or other mechanical connections—and often shows up as slop in adjustment mechanisms like the crank handles on a tablesaw.

Backlash also can cause false readings on an adjustment scale, such as planer blade height. The scale may indicate that you moved the blade $\frac{1}{32}$ in., yet the blade cuts nothing, or, worse yet, it suddenly bites off $\frac{1}{8}$ in. It can plague the tilting table on a bandsaw or drill press, causing the table to shift or drop unexpectedly. The pattern here is loss of accuracy or pesky

shifting of cutting tools, tables, or fences. If a machine has adjustments driven with a screw or a linkage with moving parts, backlash may occur. Almost any machine in the woodshop can be affected. You might not see symptoms as drastic as these, but backlash can make it increasingly difficult to make fine adjustments on a machine or require you to make more trial cuts.

But there are ways to overcome the effects of backlash once you understand what causes it.

What causes backlash?

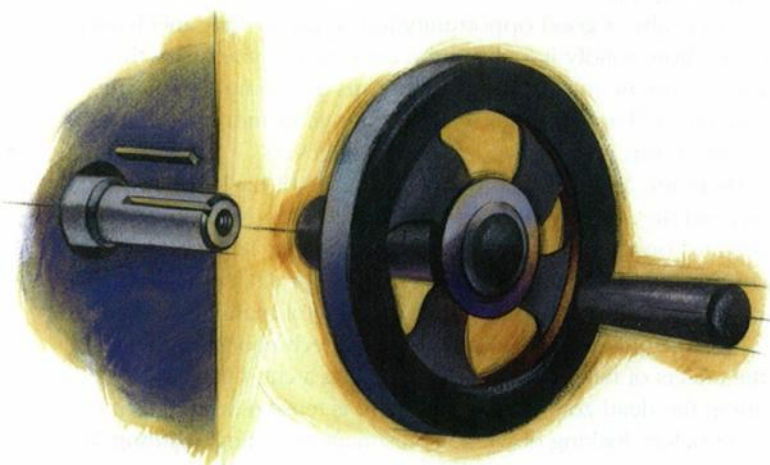
The most common cause of backlash is normal wear and tear. In a woodworking shop, sawdust is inevitable, and it works its way into the threads or moving parts of a machine. Most wear is caused by contamination and a lack of lubrication. Sawdust is pesky on both counts because it is a contaminant that soaks up lubricants. As the shaft and nut wear, the amount

of dead space that must be traversed increases. You find that you have to turn the shaft farther before you feel the threads reengage.

To transfer motion from a crank handle to a cutting tool, there may be a series of shafts, bearings, connecting links, gears, and slides. Any of these can vibrate loose or wear out and add play. Loose connections create excessive backlash in a slightly different manner. Think of an adjustment mechanism as a metal chain. For that chain to transfer motion, the links must be in tension. Motion applied to a crank transfers power when all mechanical links are pulled tight; until then you are just taking up slack.

Backlash also can be inherent to the design of a tool. Loose tolerances and sloppily fitting machine parts are typical indicators of poor quality control in manufacturing. Wood-

Although backlash is usually associated with old or worn machines, it's actually a necessary part of any machine design.



WORN KEYS

Over time, keys may become round or misshapen, creating a rattle and looseness in the adjustments.



PLAY IN ADJUSTER

The adjuster on this handplane has slop in the adjustment because the link fits loosely in the adjustment knob's groove.

TROUBLESHOOT A TABLESAW

REPLACE WORN KEYS

On this table-saw, the handle itself has slop. Begin inspection by loosening the setscrew on the adjusting wheel and remounting it.



Pull things apart. With the handle removed, you see that the key that locks the handle to the adjusting rod has worn out.



Out with the old. Clean and lubricate all of the parts, then slide a new key into place, which should eliminate slop in the adjustment.

TIGHTEN A LOOSE COLLAR



Inside this table-saw, a setscrew has worked itself loose. This allowed the collar to loosen (above), which creates slop in the height adjustment.



working machines are not all born equal; some, unfortunately, start life with excessive backlash. A good, solid machine with minimal play will more than make up for differences in price over the life of a tool. The old phrase, "You get what you pay for," often is true where backlash is concerned.

It also is important to understand that adjustment mechanisms are designed with a twin role. The primary purpose is to make fine adjustments. But they also act as support when all of the parts are engaged and in tension. Adjustment cranks often are equipped with a lock or brake. If you use a lock but ignore whether the mechanism is in tension, it is like stopping a car with a hand brake only. You compromise much of the stability built into the machine.

Preventing and handling backlash

What can be done to remedy the situation? Short of going out and buying a new machine, you should be able to make some minor corrections to reduce backlash. You also can develop work habits that minimize the effects of backlash.

Small adjustments can have a major effect—Excessive backlash usually is caused by several loose or worn parts, so correcting even one or two can give you good results. Give the machine a thorough once-over, which will help you find problems and give you a clear understanding of how motion is transferred.

Always begin by disconnecting the power source and removing cutting tools. Remove inspection plates and guards, then vacuum out debris. Put the adjuster through the entire range of motion; reverse directions back and forth at intervals all along the range. Feel each part of the mechanism separately with your hands—push up, push down, and push side to side—and look for any play or looseness. Carefully check all mounting bolts, setscrews, keys, or pins, making sure they are solid and tight. Before tightening loose bolts, disassemble them and remove any sawdust and make sure contact surfaces are free of burrs. When possible, I like to replace standard screws with Allen screws because they are easier to adjust. Be sure to check for missing bolts, broken springs, or worn connecting pins.

This is also a good opportunity to test the locking mechanism to see how solidly it locks in the zone where you make the most frequent cuts. Once minor repairs are complete, put the mechanism back through the entire range of motion, and be sure to lubricate parts before replacing covers.

There are a number of potential sources of backlash that are beyond the scope of this article. I would suggest only moving forward on these repairs—the replacement of feed screws, bearings, and gib adjustments on slides, for example—based on your confidence level and the availability of manuals and parts.

Working around backlash—Several techniques can negate the effects of backlash. First, avoid taking a cut while adjusters are in the dead zone. Make sure there is tension in the mechanism before locking down an adjustment or cutting anything. In practice, this means simply being aware of the feel of the mechanism when it is solidly in tension. If you want to reverse just a small amount, crank the handle back anywhere from half to a

CORRECT BACKLASH IN A BLOCK PLANE

Feel the dead space. The depth adjustment on this handplane experiences severe backlash because the knurled knob is narrower than the adjuster it keys into.



Reduce the gap. Close up the slot on the adjuster with a pair of pliers or vise grips.

full turn or until the threads fully reengage. Then creep back up to the setting you want, making sure it feels solid.

Make a habit of using the machine's normal forces to keep adjusters in tension. Think back to when you inspected the mechanism. You should have a clear idea of how it works and how forces act upon it. Usually you have the force of the wood resisting the blade, plus gravity itself. On a tablesaw these forces tend to push down; on a planer, whose cutterhead is above the work, the forces push up. This affects how you should make adjustments. Even if the mechanism is in tension, it is in tension in only one direction. If those normal forces push from the opposite direction, they can push the mechanism into the dead zone. Think of towing a car with a chain: If you tow down a hill, gravity may take over, and the car you are towing can drift forward. On a tablesaw, adjustments always

should be made uphill. If you take the blade too high, back off a turn or two and approach back up. This keeps the mechanism in tension and avoids the dead zone. The blade responds to the smallest adjustment of the crank handle, and the forces from cutting and gravity cannot cause the blade to shift.

It's good practice to take a look at sloppy machines, because more often than not, excessive backlash can be corrected. But also remember that some backlash is inherent in adjustable machines, so you need to develop habits that use backlash to your advantage. The methods become second nature with only a little practice. Once the techniques have been mastered, backlash should cease to be a frustration, and both you and your tools will work better. □

George Walker builds furniture in Canton, Ohio.

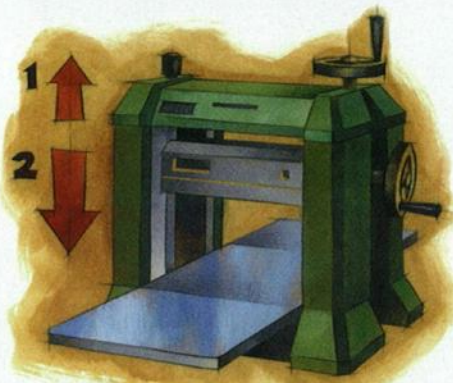
Living with backlash

No matter what you do, some backlash is inevitable. Understanding how backlash works and adjusting your habits to work around it will keep you cutting square and smooth.



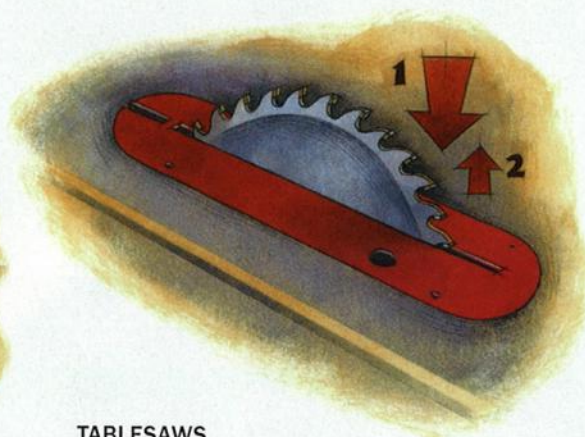
HANDPLANES

To deal with backlash in a handplane, back off the blade more than necessary, then turn it forward a bit to get your final setting.



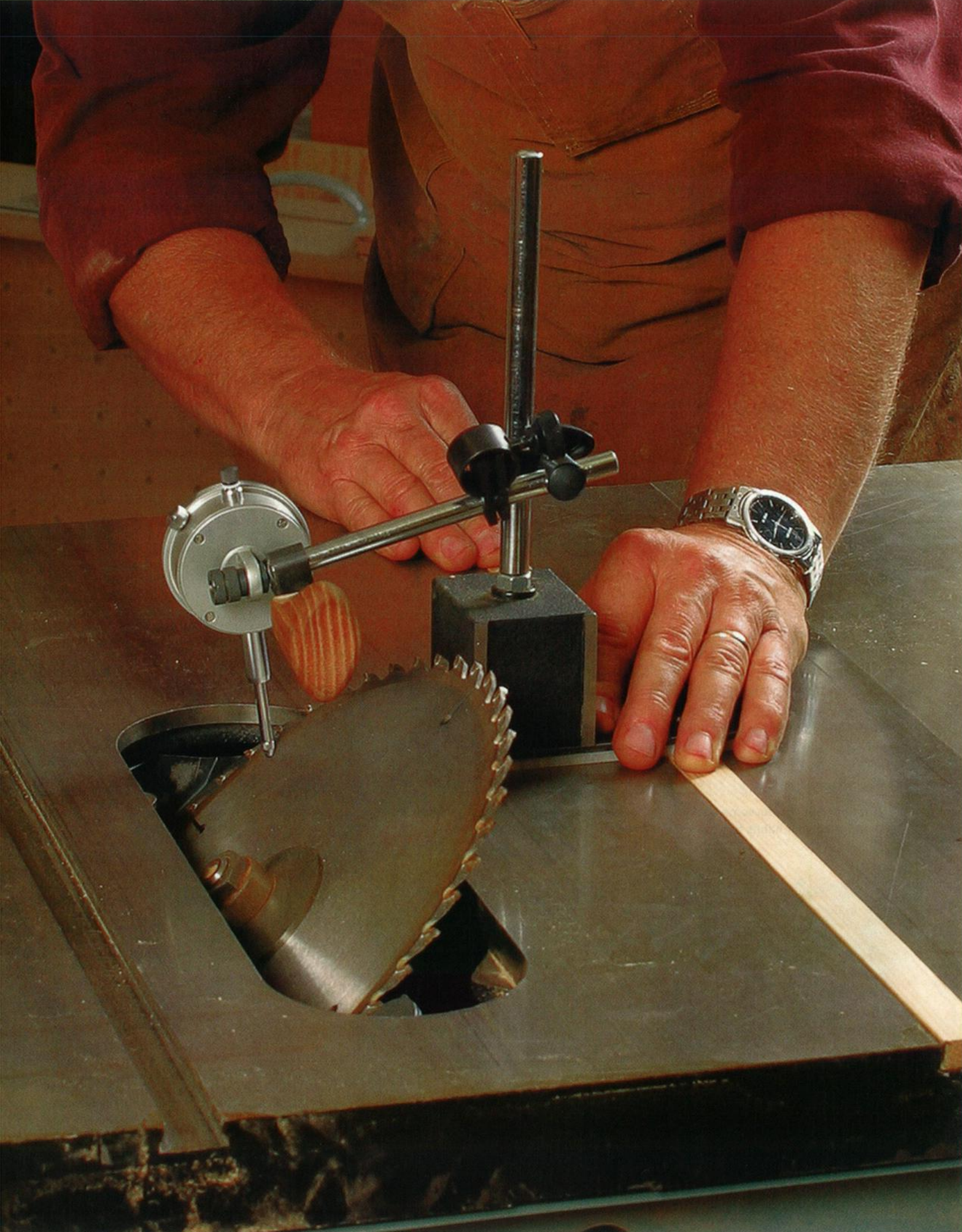
BENCHTOP PLANERS

The carriage should be lowered into the cut so that the pressure is against the thread on the adjuster.



TABLESAWS

When working at a tablesaw, adjust the blade by raising the arbor assembly to the desired height instead of lowering it. If you need to lower the blade, lower it more than necessary, then raise it to final height.



MACHINES



The tablesaw, bandsaw, jointer, planer, and drill press are the workhorses of your shop. They do the heavy lifting and transform rough boards into finished parts ready for assembly. Learn how to keep these tools running sweetly and your shop will be happier and more productive.

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Tool Kit for Tune-Ups

Three basic tools will keep your machines cutting straight, square, and smooth

BY GARY ROGOWSKI

If your woodworking machinery arrives needing only to be unpacked and plugged in, I suggest you buy lottery tickets that day. It's a lucky one.

Woodworking machines always need tuning or tweaking before they really purr. Which tools do you need to set them up properly and to check them periodically so they keep running smoothly? Fortunately, the list is short. Some might be in your shop already: a good straightedge, a combination square, and a plunge-style dial indicator. With these basic tools, you can go a long way toward making your machines run true and your woodworking accurate.

A straightedge is the foundation

In the woodshop, flat surfaces are priceless. On them, you can mill lumber true, joint an edge square, and check pieces for twist after assembly. But how flat is flat? And how do you check?

You can't use a piece of wood to check for flatness unless you are sure it's flat. Instead, buy a good straightedge with a guaranteed tolerance of 0.002 in. over 24 in. This is more than adequate for setting up tablesaw tables and checking the flatness of jointer tables and other cast-iron or steel surfaces. A 24-in. straightedge will meet most needs, but for longer jointer tables or other especially large surfaces, you'll be better served if you can invest in a 36-in. edge.



Check for flatness with a straightedge

STRAIGHT

Jointer tables should be dead flat. Measure any gaps with a feeler gauge. A variation of more than 0.002 in. on a new machine is reason to ask the seller for a replacement. Tables on older machines can be reground if necessary.



Level the table and wings. A tablesaw's bolt-on extension wing may need adjustment or shimming to bring its surface level with the rest of the table. Lay a straightedge across the junction of the table and wing and look for telltale gaps underneath.

SQUARE

Keep machines in line with a combo square



Check the fence. Use the combination square to ensure that a jointer's fence is set at 90° to the tables. Make similar checks on the tablesaw and bandsaw.

Use the straightedge on the tablesaw to see that your extension tables and the main table form a continuously flat surface. Edges that appear flush where they meet are not enough. Stand the straightedge on its narrow edge and look for gaps between the edge and the surface you're checking. Check across the table's width and length, then check the diagonals. Measure any gaps underneath the straightedge with a set of feeler gauges. Acceptable tolerance for a tablesaw measuring 28 in. by 36 in. is 0.008 in. to 0.009 in. You might need to insert shims between the wing and the table to ensure a completely flat top.

Also check your tablesaw fence. The piece of composite material bolted onto the fence is not always perfect, but you can shim it to make it flat.

The jointer has three major cast-iron surfaces: the infeed and outfeed tables and the fence. A jointer table should be dead flat within 0.001 in. to 0.002 in. over any of its lengths. You can return a new machine to the seller if the surfaces are seriously out of flat or misaligned. On an older machine, a machine shop might regrind the surfaces for you.

On a belt-driven machine, the pulleys attached to the motor and the arbor should line up with one another in a flat plane to minimize bearing and belt wear. Use a straightedge to check by laying the narrow edge across both pulleys.

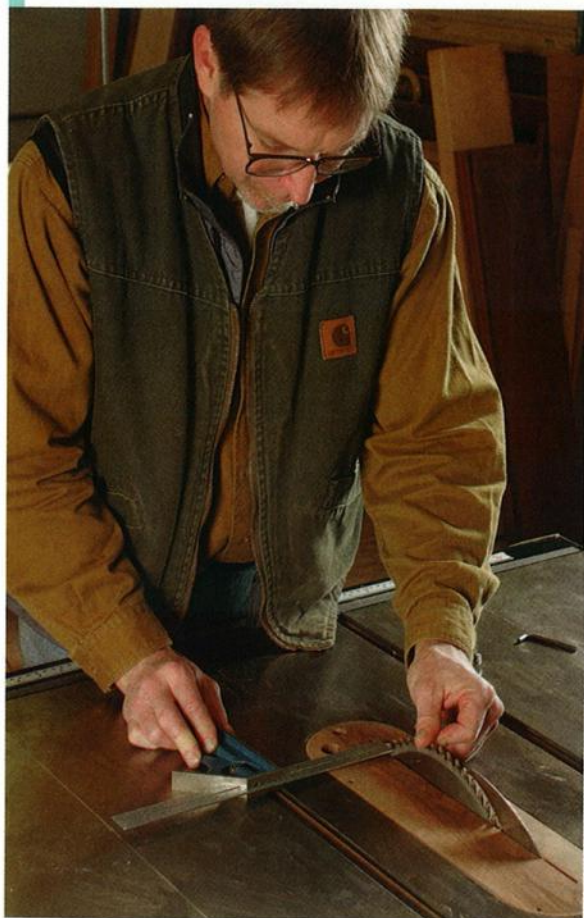
Combination square is a versatile setup tool

Just as important as checking flat surfaces is making sure that two machine surfaces meet up squarely.

You don't need a specialized machinist's square. If you use a combination square for joinery layout, it will work if it is truly square. Here's a simple test:

Hold the square up to a flat edge and mark a line. Then flip the square over and see if your mark again lines up perfectly with the blade of your square. Any variation means it's out of square.

Use the square to check the jointer fence. It can be adjusted and then locked into place. A tablesaw fence will need adjusting or shimming if it's not square to the table. A word of warning: Simply checking with the square isn't always enough. Squaring a blade to a table on a



Adjust the miter slot. The combination square also can help check whether a table-saw's miter slot is parallel to the blade. Mark a tooth at the front of the blade and measure the distance from the blade to the slot. Next, rotate the marked tooth to the back of the blade opening and measure again. If the readings are different, you need to adjust your saw's tabletop or trunnions to bring the slot parallel with the blade.

bandsaw, chopsaw, or tablesaw will mean making practice cuts and checking those (see “Test Cuts Never Lie” by David Hyatt, pp. 25-27).

A combination square also is handy for aligning a tablesaw's miter-gauge slot parallel with its blade. This is crucial for safe operation and square crosscuts. With the machine unplugged, hold the head of your combination square against the gauge slot and check the distance to the blade at a single marked tooth, rotated to the front and then to the rear of the throat plate. You can adjust all cabinet and contractor-style saws to move the table into parallel with the blade.

A dial indicator measures runout

Runout is a measure of how true a rotating surface spins. If a surface wobbles or oscillates, then this runout will be magnified as you move away from the center of rotation. On a tablesaw, if the arbor is wobbling, then the end of its 10-in. blade will be rocking and rolling. This translates into rough, inaccurate, or dangerous cuts. The movement also wears on the bearings, cutting short their life.

Sources of Supply

VERITAS STEEL
24-IN. STRAIGHTEDGE
 \$37; leevalley.com

MAGNETIC BASE DIAL INDICATOR
 \$35; tools-for-woodworking.com

STARRETT 12-IN.
COMBINATION SQUARE
 \$80; garrettwade.com

A dial indicator measures movement such as runout with an arm mounted into a dial that usually reads 0.001-in. increments. The indicator itself must be held in place; the best way is to use a magnetic base to lock it into position. Then, on the tablesaw with the blade and throat plate removed, you can check the pressed-on arbor flange for runout. Set the magnetic base on the table-top near the throat opening and tilt the arbor to 45°. Angle the dial's plunger to meet the surface of the arbor flange. Turn the arbor by hand to see whether the gauge registers any variation in the flange surface.

A tablesaw arbor should have zero runout, but 0.001 in. of runout won't mean you have to trash your saw. Any more, though, and I'd send a new saw back to the factory or get a replacement arbor. On a used saw, I would remove the arbor and have it machined true.

A drill-press chuck also should have nearly zero runout. Set the magnetic base on your drill-press table and align the dial plunger to touch a bit or a piece of straight unthreaded rod mounted in the chuck. Turn the chuck by rotating the drive-belt pulleys and watch for variations registered by the dial. Acceptable tolerance is 0.001 in. or less. Drill-press chucks can be replaced.

You also can use a dial indicator to check whether your jointer knives are all set to the same height. Set the base on the jointer table with the plunger riding the tops of the knives as you rotate the cutterhead by hand. Note and adjust for any variations in the maximum height of the blades. □

Gary Rogowski owns the Northwest Woodworking Studio in Portland, Ore.

SMOOTH

Check runout and blade height with a dial indicator



Check for runout. Use a dial indicator to check the tablesaw's arbor flange. Any variations in the flatness of the piece can cause blade wobble, which leads to rougher cuts.



Blades should be uniform. The dial indicator also helps check whether jointer knives are set to the same height and are even with the outfeed table.

Test Cuts Never Lie

Fine-tune your machine setups
with test cuts

BY DAVID HYATT



Building furniture or other projects with strong, square-fitting joints requires machines that are set up to make accurate 90° cuts. Checking with an accurate square might seem like all that's needed, but it's really just a starting place.

A square won't register some factors such as variations in the flatness of a tabletop. Some squares aren't as square as they should be. And, using a square alone, very small errors can be hard to see. The following test cuts will finish the job that the square started, making errors more visible by multiplying them.

David Hyatt is a woodworker near Vancouver, B.C., Canada.

■ Tablesaw: Square the blade and miter gauge



1 Start with a square. An accurate square can help set the sawblade at a 90° angle, but this is only the start of a precise setup. Very small errors can be hard to see with a square alone.



2 A test cut is more revealing. Use two pieces of lumber or medium-density fiberboard (MDF). Stand the pieces on edge and cut them in the same pass.



3 The moment of truth. Butt the two cut ends together. Any error will reveal itself as a tapered gap between the two ends.

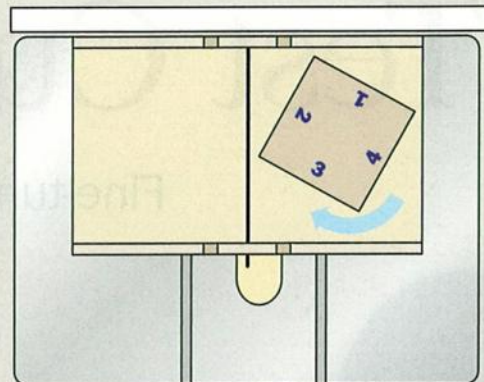


4 A similar test for crosscuts. Lay the boards flat to check the 90° stop on the miter gauge.

A very reliable way to check a tablesaw blade for an accurate 90° angle is to cut two test strips and then check the squareness of the cut by placing them end to end.

Raise the blade to maximum height. Use two strips of sheet goods (I prefer ½-in.-thick melamine) that are slightly narrower than the height of the blade and 18 in. to 20 in. long. Hold the two strips together on edge and trim one end of them using a miter gauge. Open the two strips in a book-match (like opening a book) and place them on a known flat surface. Any deviation from 90° will show up as a tapered gap between the ends as they touch. Once the blade has been adjusted to 90°, the 90° stop can be set and locked in place. Lay the same two strips flat, trim, and mate the ends again to check the 90° stop on the miter gauge. If the miter gauge is set at exactly 90°, there will be no gap between the ends of the test strips as they meet.

Tablesaw: Square your crosscut sled



1 Make a test piece. Number the edges on a square of MDF. With edge 1 against the sled fence, trim each side in turn, rotating the piece clockwise between cuts.

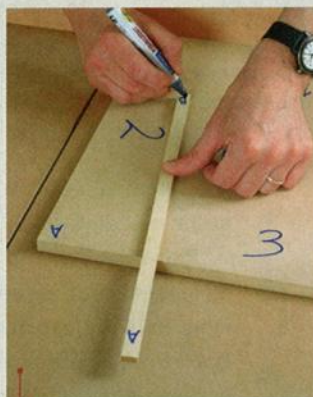


2 Make five cuts in all. Finish the sequence by taking a second, wider strip from edge 2.

Larger pieces such as panels are usually crosscut on the table saw with a shopmade crosscut sled. The accuracy of these cuts can be checked with a large square, but a better and more accurate method is to use the “five-sided” test cut.

Begin with a piece of sheet goods that is roughly 18 in. to 24 in. square. Number the edges 1 to 4, going counterclockwise. Place edge 1 against the fence of the sled and trim edge 2. Then place edge 2 against the fence and trim edge 3. Continue around until you have trimmed edge 1. Then place edge 1 against the fence and trim a 1/2-in. strip from edge 2. Label one end of the strip “A” and the other end “B.” Snap the strip in half and place A and B side by side on a flat surface. If the sled is set square to the blade, then the strip will be exactly the same thickness at A and B. Even very small deviations from 90° will show up using this method.

If the sled does not produce 90° cuts, then you should adjust the fence on the sled until it cuts accurately.



3 Mark the ends of the strip. This identifies the front and back of the final cut. Make corresponding marks on the MDF square for future reference. Snap the final strip in two, lay the pieces on their sides, and compare the thickness of the two ends. Any variation means the crosscut sled's fence needs adjustment.

■ Tablesaw: Set up for accurate miters

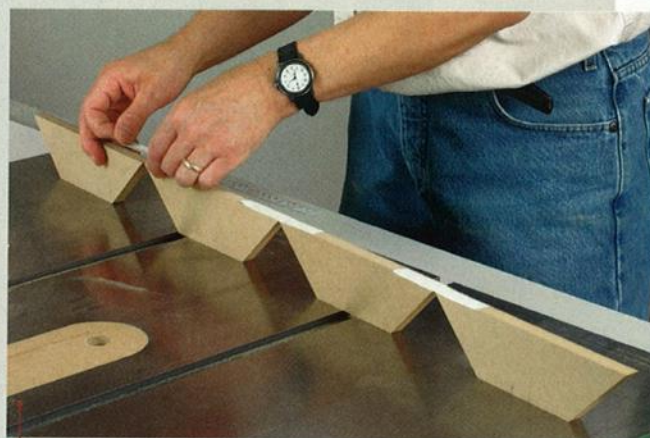


1 Make a series of cuts. Cut 45° miters at both ends of four pieces of stock, just as you would for a picture frame.

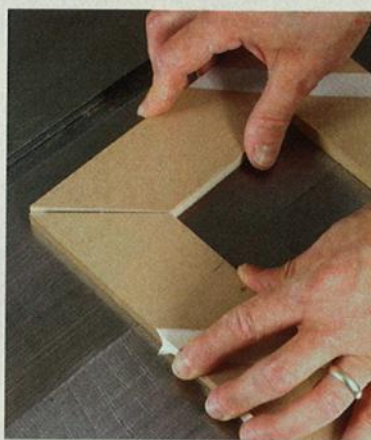
A similar set of tests can help verify the accuracy of the 45° miter-cutting setups on a tablesaw.

Cut a 45° miter at both ends of four test pieces of equal length. Tape the four pieces together to form a picture frame. Any deviation from 45° will be apparent, as the last corner will not fit together tightly. Adjust your setup, and recut the four test strips until they form a frame with no gaps at the corners.

For standing miters, cut with the blade set at a 45° angle. For flat miters, cut with the blade set at 90° and the miter gauge set at 45°.



2 Tape the corners. This helps hold the pieces in place as you assemble the frame.



3 Look for the gap. If the final corner doesn't fit snugly, it means the miter gauge isn't set at precisely 45° to the blade.

■ Jointer: Check the fence



Prepare test pieces. Joint the face and edge of two pieces of stock, checking them on a flat surface. Place the jointed edges down and jointed faces together. A gap shows adjustment is needed.

The fence on a jointer also can be set to 90° by using test cuts.

Take two 16-in. to 18-in. lengths of 8/4 stock and joint a face and then an edge of each piece. Set the two pieces on a flat surface with the jointed edges down and the jointed faces together. If the jointer fence is not set at 90°, then a tapered gap will be visible between the two faces. Another check can be made by clamping the two pieces with the jointed edges together. Place a straightedge across the two jointed faces. If the jointer fence is not at 90°, then the straightedge will rock when placed across the jointed faces or it will show a gap where the two pieces touch.

These methods will work only if the jointer is producing a smooth cut. If the jointer blades have been nicked and are leaving small ridges, the test pieces will not sit flat. You might solve this problem by moving one jointer blade slightly to one side.



MACHINES

Tablesaw Tune-Up

Make the shop workhorse run like a champ

BY ROLAND JOHNSON

Ask woodworkers to name the busiest tool in their shop, and it's a safe bet many will point to the tablesaw. A machine that can rip sheet goods down to size, cut boards to length, and create a variety of joints is bound to carry part of the workload in almost any project.

Yet in many woodshops, tablesaw maintenance consists of little more than changing blades, cleaning the tabletop, and squaring fences. Only when the blade-tilt or -raise mechanism starts to screech in protest does anything beneath the table get attention.

Our shop workhorse deserves better. A yearly inspection and tune-up should be a basic requirement; saws kept in damp or unheated conditions should be cleaned and lubricated more often. The comprehensive tune-up presented here is basically the same for all tablesaws. Check your owner's manual for any details that might differ.

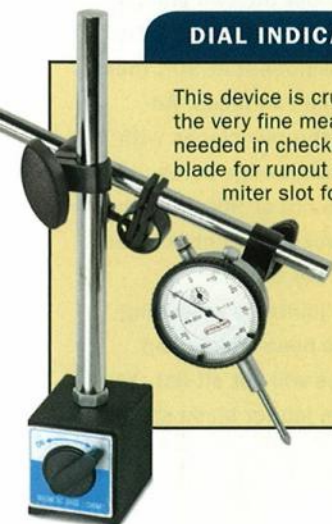
Roland Johnson is a woodworker and tool enthusiast in Sauk Rapids, Minn.

Assemble a tune-up kit

A well-stocked shop already should have many of the basic tools and supplies needed to perform tablesaw maintenance, but you might need to add a few.

DIAL INDICATOR

This device is crucial for the very fine measurements needed in checking the blade for runout and the miter slot for parallel.



DEGREASER

A grease-cutting solvent and a stiff wire brush remove caked-on pitch and sawdust from the saw's inner workings. Aerosol brake cleaner or carburetor cleaner also works well.



LUBRICANTS

To keep the blade-tilt and -raise mechanisms working smoothly, Johnson recommends quick-drying aerosols instead of grease, which tends to attract sawdust.



COMMON TABLESAW PROBLEMS

Tablesaws are so sturdy and powerful that they seem not to need any special attention. But like any complex tool, they can develop a variety of problems that erode performance. Keeping your saw clean, lubricated, and properly adjusted will make the machine safer, more accurate, and easier to use.

WOBBLING BLADE

A wobbling blade runs hotter, cuts less precisely and smoothly, and can cause kickback. See p. 32.

STOCK CATCHES ON TABLE

If the extension wings and throat plate aren't flush, lumber can hang up or bind as you feed it into the blade, possibly causing kickback. See p. 34.

ROUGH CROSSCUTS

If the miter-gauge slot isn't parallel with the blade, you can't make accurate 90° crosscuts. Tilting the blade to 45° also can throw it out of parallel. See p. 33.

LOSS OF POWER

Worn or stiff belts and misaligned pulleys can mean jerky starts and decreased power. See p. 32.

BURN MARKS WHILE RIPPING

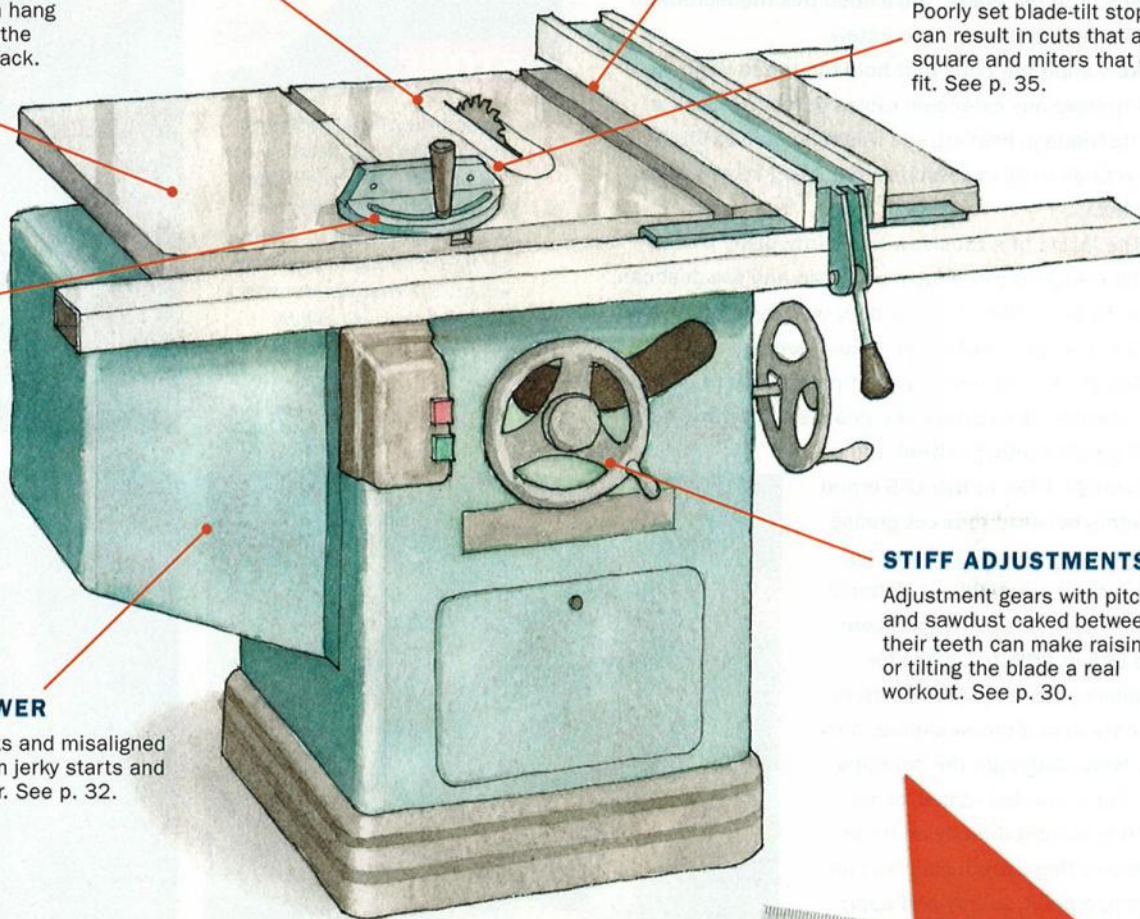
A rip fence that's out of parallel can push stock into the side of the blade, scorching the wood, causing the blade to bind, and possibly causing kickback. See p. 35.

INACCURATE ANGLES

Poorly set blade-tilt stops can result in cuts that aren't square and miters that don't fit. See p. 35.

STIFF ADJUSTMENTS

Adjustment gears with pitch and sawdust caked between their teeth can make raising or tilting the blade a real workout. See p. 30.



TOPCOAT

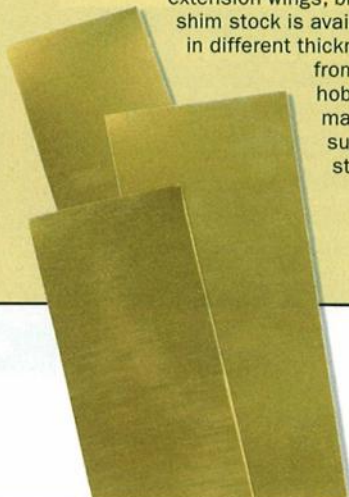
There are several spray-on products designed to protect the tabletop from rust and to reduce friction. Paste wax is also effective.

SHIM STOCK

For leveling a tabletop or extension wings, brass shim stock is available in different thicknesses from hobby and machine-supply stores.

MEASURING

You'll need a variety of measuring implements, most of which you probably have on hand. They include a drafting triangle with 45° and 90° angles, a combination square, and a long level or straightedge.



Clean and lubricate the inner workings

On most cabinet saws, removing the tabletop exposes the inner workings and makes a tune-up much easier.

First, unplug the saw, then remove the throat plate and the blade to avoid damaging the blade or yourself. Measure and record the distance from the left-hand miter slot to the blade. You'll need this measurement to reassemble the saw accurately.

Now undo the bolts that hold the top to the base and remove any extension tables or fence rails. If a strong friend is helping, you might be able to lift the top with all of its accessories, but it will be awkward and heavy.

The inside of a tablesaw is a grimy, dusty place. Without regular cleaning, wood resin and sawdust can cake up and stiffen a saw's inner workings, especially the blade-height and -angle adjustments.

Use a shop vacuum and compressed air to get rid of the sawdust, then attack the gears and pivoting parts with grease-cutting solvent and a wire brush. I like to use LPS-brand solvents because they cut grease aggressively and don't leave an oily residue (available at National Supply Source, nolansupply.com; call LPS at 800-241-8334 for retailers near you). Aerosol brake cleaner or carburetor cleaner also will work. Although the bearings in a tablesaw are sealed, avoid getting solvent directly on them. Some of these products also can damage paint, so buy and apply them carefully. In any case, buy a high-quality solvent that will evaporate quickly.

Remember, when using volatile solvents, make sure you have an adequate fresh-air supply and wear a vapor mask.

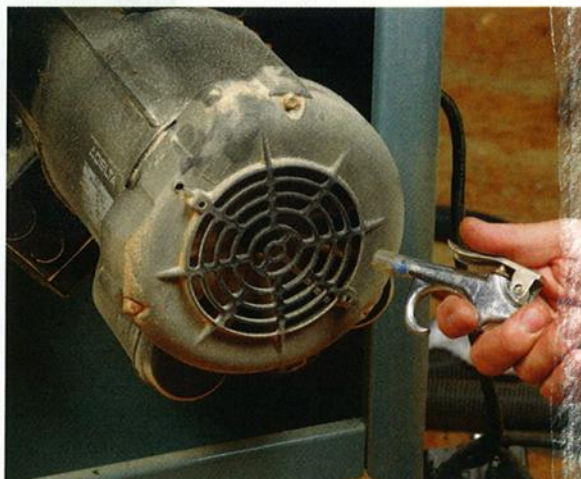
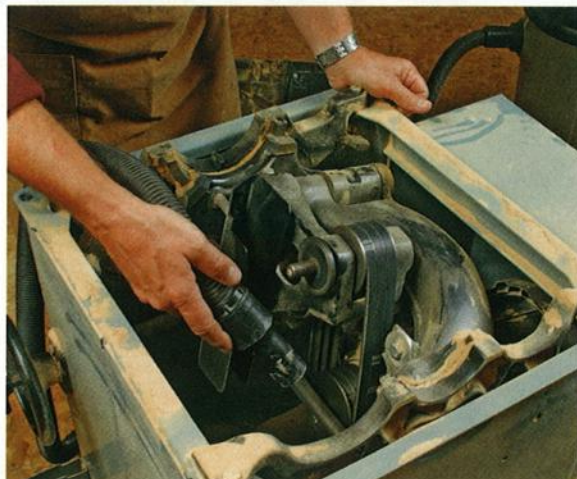
Finish the cleaning process with a compressed-air blowdown to speed drying and remove crud softened by the solvent. The overall goal in all of these steps is to clear away as much dust and pitch as possible, leaving clean, dry surfaces for an effective lube job. Be sure the solvent is completely cleaned out or dry before applying new lube to the contact surfaces.

Before moving on, give some attention to the motor. Blow compressed air through the housing until the exhaust air is clean.



STOP!

Mark your place before removing the top. Measure the distance between the blade and the left-hand miter slot. Realigning the slot to this measurement during reassembly will ensure that jigs, such as a crosscut sled, will still fit.



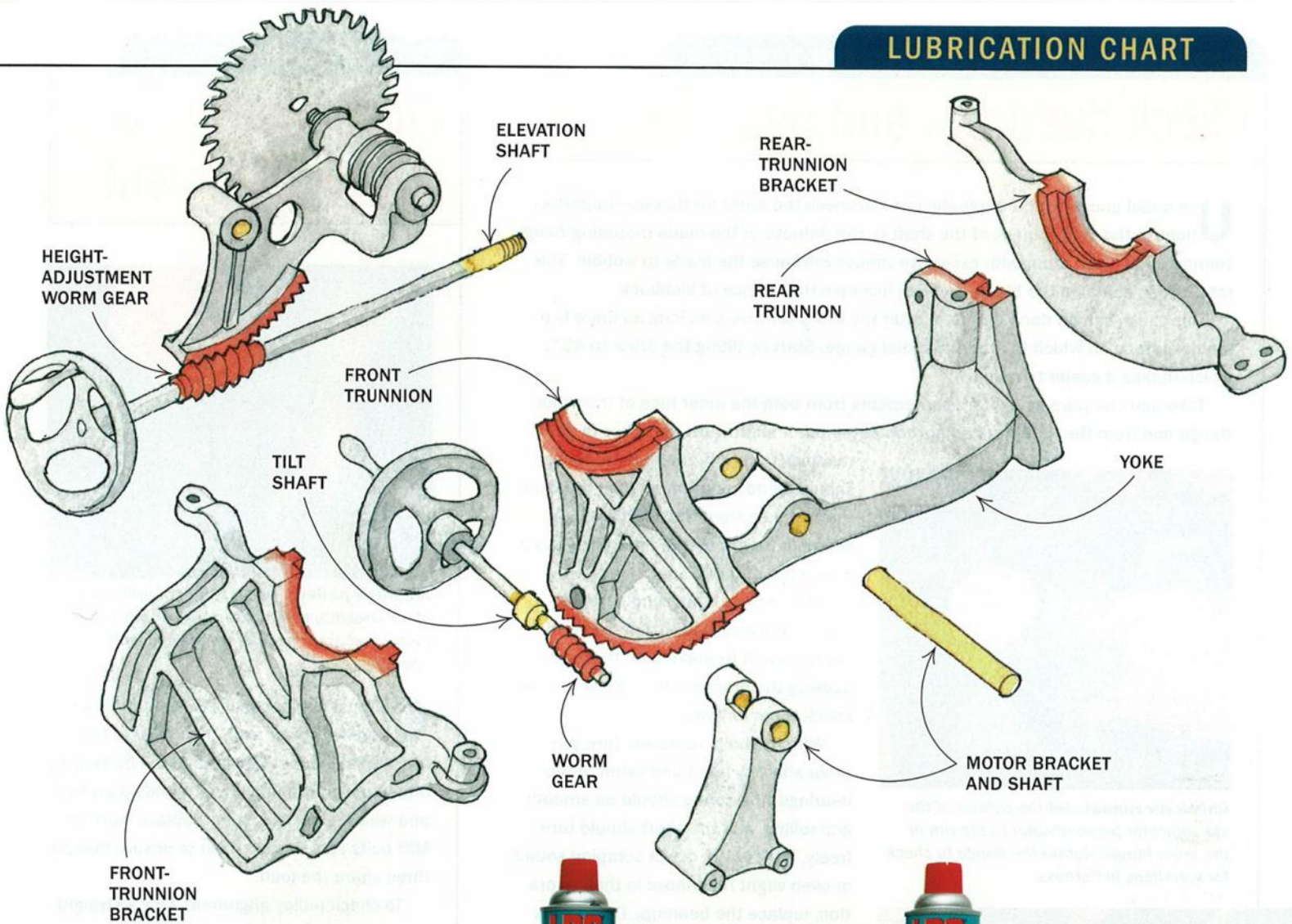
Remove loose sawdust. Two good vacuumings, with a blast of compressed air in between, should eliminate loose sawdust inside the cabinet. Clean the motor and/or fan thoroughly with compressed air to ensure cooling efficiency.

Contractor-saw tip

To get inside, remove the motor and—with a friend's help—turn the unit upside down on a low bench or short sawhorses. You also might need to remove a bottom panel, as on this saw.



LUBRICATION CHART



Clean before lubricating



To help remove minor pitch buildup and rid the gears of old grease, use a quick-drying aerosol degreaser and scrub with a wire brush. Surfaces need to be clean and dry before lubricants can adhere well and do their work.



HEAVY-DUTY LUBRICANT

Orange indicates high-wear areas that require a heavy-duty lubricant.



On the worm gears and racks, use a molybdenum-based drying lube. The spray, which withstands heavy pressure, is dense enough to stay in place without running.



PENETRATING LUBRICANT

Yellow indicates hard-to-reach areas that require a penetrating lubricant.



Use a penetrating lubricant on hard-to-reach areas. For the worm-gear shafts on the arbor-pivot and -raising assemblies, Johnson uses a penetrating spray that dries quickly.

PROBLEM: WOBBLING BLADE, EXCESSIVE VIBRATION

Check the arbor and bearings

Use a dial gauge with a magnetic base to check the arbor for runout—imperfections in the straightness of the shaft or the flatness of the blade-mounting flange connected to it. An arbor with excessive runout will cause the blade to wobble. This robs power, heats up the blade, and can increase the chance of kickback.

This check can be done before or after the top is removed, as long as there is a stable surface on which to mount the dial gauge. Start by tilting the arbor to 45°, which makes it easier to reach.

Take and compare several measurements from both the inner face of the arbor flange and from the nonthreaded portion of the arbor shaft. Turn the arbor to get readings from different points. There should be no variation at all in measurements taken from the shaft itself. Acceptable runout on the arbor flange is a maximum of 0.0015 in.



Check for runout. Set the pointer of the dial indicator perpendicular to the rim of the arbor flange. Rotate the flange to check for variations in flatness.

If the arbor shows runout, replacing it is the best option, but check the bearings first to make sure they're not causing the problem. It's a good idea to check them anyway.

With the belts removed, turn the arbor shaft by hand and listen to the bearings. The sound should be smooth and rolling, and the shaft should turn freely. If there is a dry or scraping sound, or even slight roughness in their operation, replace the bearings. Doing so is inexpensive and easy, and will greatly increase the life and performance of your saw.

You can order replacement bearings from the tablesaw manufacturer or check a local automotive-supply house or machine shop. Once you've removed the arbor assembly, all that's needed to remove the old bearings and install the new ones is an arbor press. Machine shops, electric-motor repair shops, and even most automotive-repair shops will have an arbor press and the expertise to use it.

To replace the arbor, check with the manufacturer for a new part. If the saw is out of production, search old-tool websites for a used or old-stock arbor. As an expensive last resort for a saw that's really worth saving, a machine shop could make a replacement arbor.



An old hot-rodder's trick. A long screwdriver, with the tip held firmly on the bearing housing, makes a good listening device for checking the condition of the bearings.

PROBLEM: LOSS OF POWER

Check belts and pulley alignment



Align the pulleys. Use a length of drill rod or other straightedge to determine whether the motor and arbor pulleys are aligned with one another.

On most cabinet saws, three short belts transfer power from the motor to the arbor. Misalignment can make the belts drag on the pulley, robbing power, building up heat, and wearing out the belts. Replace worn or stiff belts as a matched set to ensure that all three share the load.

To check pulley alignment, I lay a straight-edge across the side of one pulley and check how squarely—if at all—it meets the surface of the other wheel. Make adjustments by first loosening the setscrews that hold the motor pulley to its shaft. Carefully pry the pulley away from the motor or use a deadblow hammer to tap it farther onto the shaft.

Use care: Excessive force could damage the motor's armature bearings. Once alignment is accurate, tighten the setscrews.

Contractor-saw tip

The pulleys on a contractor's saw are much farther apart, increasing the chance of unwanted vibration. On many older saws, performance can be improved by installing a high-quality segmented belt and a good pair of machined and balanced pulleys.



Align the miter slots with the blade

One common tablesaw problem happens when the blade is not running parallel to the miter slots. In such a situation, if the miter gauge is set to 0° for a 90° crosscut, the actual cut won't be accurate.

To check for parallel, I use a dial micrometer mounted on a modified miter gauge or hardwood runner in the left-hand miter slot. This is the time to retrieve that baseline measurement of the miter-slot distance that you made before removing the top. Adjust the table position to set the miter slot to that original measurement.

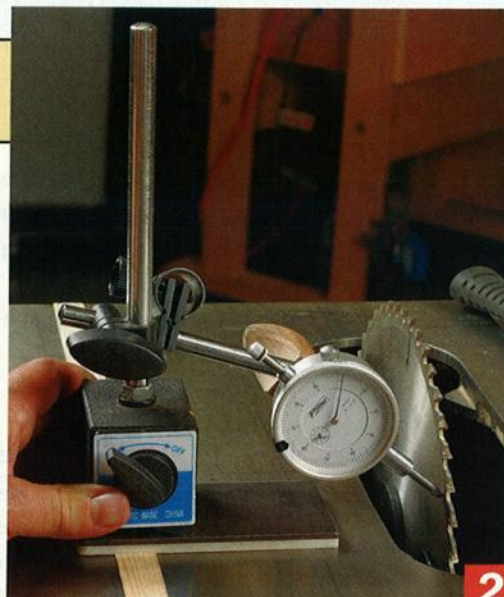
With the blade at full height, mark a tooth at the front. Measure from this tooth to the miter slot, then rotate the tooth to the back of the throat opening and measure again. Adjust the tabletop (or the trunnions on a contractor's saw) to bring the measurements in line. Repeat the parallel-checking process with the blade set at 45°, shimming the top or trunnions if needed. Then recheck for parallel at 90°. Sometimes this will take a few cycles before both positions are parallel. When you reach nirvana, tighten the bolts and recheck once more.

Online Extra

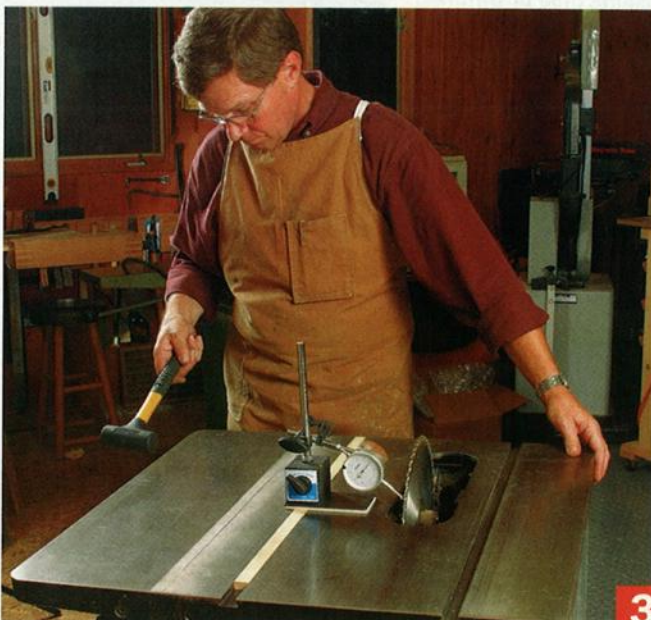
Learn how to set up your tablesaw for square and accurate cuts with our interactive graphic at FineWoodworking.com/tuneup.



1



2



3

Adjusting the tabletop.

A sandwich of plastic (plywood may be substituted) and steel, screwed to a wooden runner, creates a sliding platform for the micrometer's magnetic base (1). Use the micrometer to measure the distance from the miter slot to the front and rear of the blade (2). Measurements should differ by 0.005 in. or less. Snug the tabletop bolts, then use a deadblow hammer to make minute adjustments to the top (3).



Check again for parallel. After bringing the miter-gauge slot parallel with the blade, tilt the blade to 45° and repeat the process.

PROBLEM: POOR-QUALITY MITERS

Level the tabletop

If the blade is parallel to the miter slot at 90° but not at 45°, it means the table is out of level from front to back. Shim the top (or the trunnions on a contractor's saw) to compensate. I use automotive alignment shims and brass sheet stock. I buy 1/64-in. and 1/32-in. alignment shims and sheets of 0.005-in., 0.010-in., and 0.015-in. brass for a combination that results in very accurate adjustments.



Level the wings and throat plate

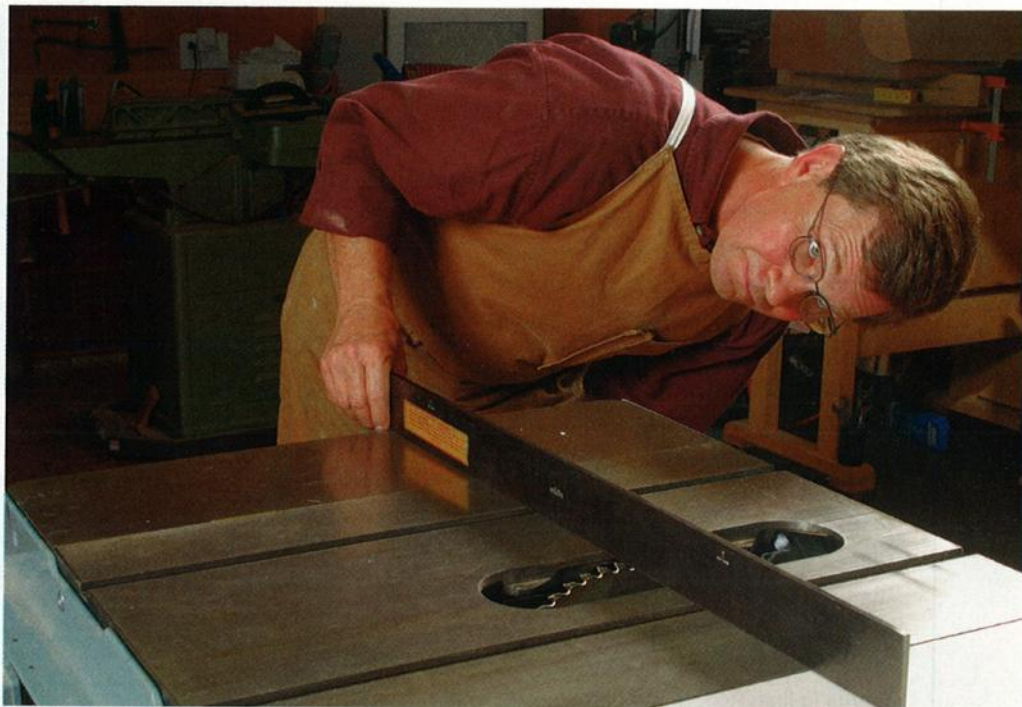
Feeding lumber over the saw is easier and safer when the throat plate and extension wings (and extension table) are flush to the saw table. Lifting a hung-up board to clear the tabletop can cause

a jam, possibly resulting in a ruined cut or dangerous kickback.

Some throat plates can be raised or lowered with set-screws, so a straightedge and Allen wrench are all you need to align the surfaces. A home-made plate can be shimmed with masking tape or trimmed

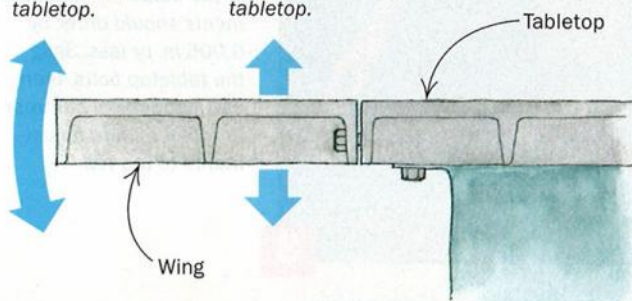
flush with a block plane, if needed.

To adjust an extension wing or table, very slightly loosen the mounting bolts and tap the surfaces flush with a deadblow hammer. Check with a straightedge, tighten the bolts, and check again to make sure everything stayed put.



Shim the wing parallel to the tabletop.

Adjust the wing flush to the tabletop.



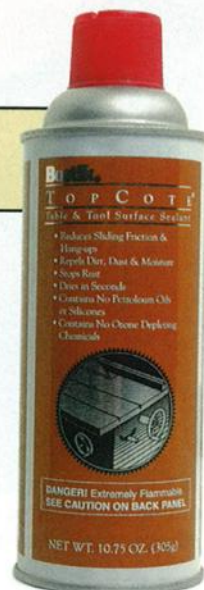
Level the wings.

Use a straightedge to check whether the extension wings are flush and parallel with the top (above). If necessary, shim the wing with brass sheet stock (right) until it is parallel with the tabletop.



Clean and coat the tabletop

After all the mechanical components are operating in harmony, it's a good idea to dress the tabletop. Start with a thorough cleaning, using a spray solvent. Then polish with a fine-grit Scotch-Brite nylon pad or 600-grit sandpaper mounted on a wood block. Finish with a coat of nonsilicone wax or one of the topcoatings designed specifically for this purpose. I use Bostik TopCote, applying a couple of coats. I apply another coat whenever I notice the wood starting to drag as I feed it over the table.



PROBLEM: INACCURATE BLADE ANGLES

Adjust the 45° and 90° stops

Virtually all tablesaws have adjustable devices that stop the arbor assembly when the blade is perpendicular to the table and when it's tilted at 45°. Most often these devices consist of a bolt and locknut mounted on the arbor-carriage assembly.

On the saw table we tuned up, the stop bolts are mounted on the front-trunnion assembly. The 45° tilt can be accessed through the slot on the front of the cabinet that is for the blade-lift crank handle. The 90° stop can be reached through the motor opening in the side of the cabinet.

To adjust the stops, set the blade to the desired angle, loosen the locknut, and then retighten it after repositioning the stop bolt. I use a plastic 45° drafting triangle to set the tilt angle and a 6-in. sliding square to set the 90° stop. Always recheck after tightening the locknut to make sure the adjustment stayed accurate.



Setting the blade upright.
The 90° stop is usually easy to reach. Simply loosen the stop bolt and use a square to set the blade to exactly 90°. Then turn the stop bolt snug to the stop, and tighten the locknut on the stop bolt.



Getting properly inclined.
The 45° stop bolt on many saws can't be reached with the arbor tilted all the way to 45°, so setting it takes some finagling. Loosen the bolt so that the blade stops before 45°. Then tighten it a little, and check the angle with a drafting triangle. Repeat the procedure until you find the exact setting for 45°.



Contractor-saw tip

Some contractor's saws allow adjustment via setscrews on the saw's top. Most saws, however, require you to reach in from underneath (right) to access the stops.



PROBLEM: BURN MARKS WHILE RIPPING

Adjust the rip fence parallel to the blade

One of the last adjustments I perform is to set the rip fence parallel with the miter slot and thus parallel with the blade. Some woodworkers angle the fence a few degrees away from the back of the blade to help avoid binding. I like to keep things parallel and rely on a well-tuned saw and stable, well-dried lumber to keep me out of trouble.

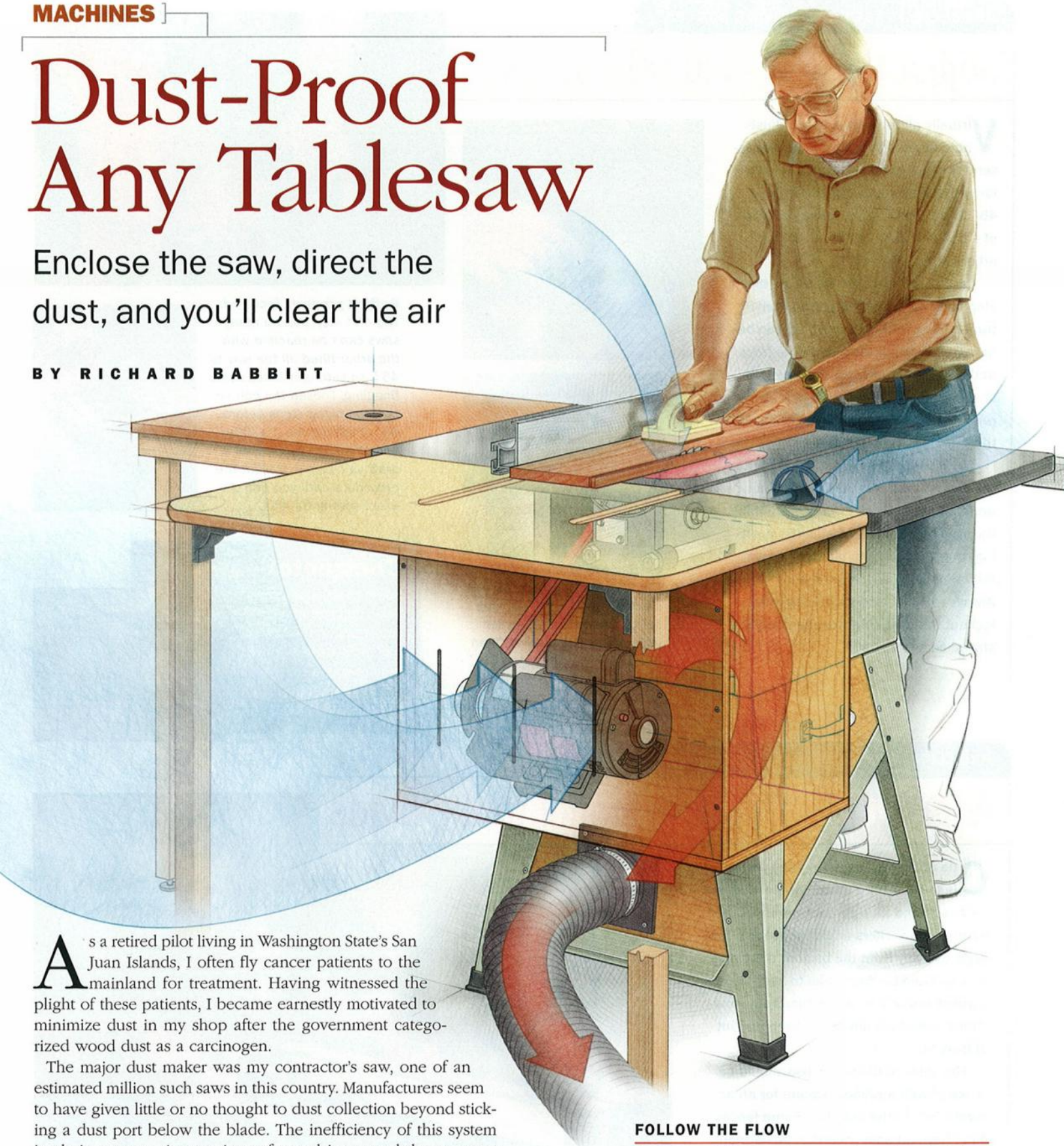
The sides of the fence also should be checked with a reliable square for an accurate 90° to the tabletop. Some fences don't have an easy means of adjustment. One solution is to attach a supplemental wood fence that is beveled or shimmed square to the saw table.



Dust-Proof Any Tablesaw

Enclose the saw, direct the dust, and you'll clear the air

BY RICHARD BABBITT



As a retired pilot living in Washington State's San Juan Islands, I often fly cancer patients to the mainland for treatment. Having witnessed the plight of these patients, I became earnestly motivated to minimize dust in my shop after the government categorized wood dust as a carcinogen.

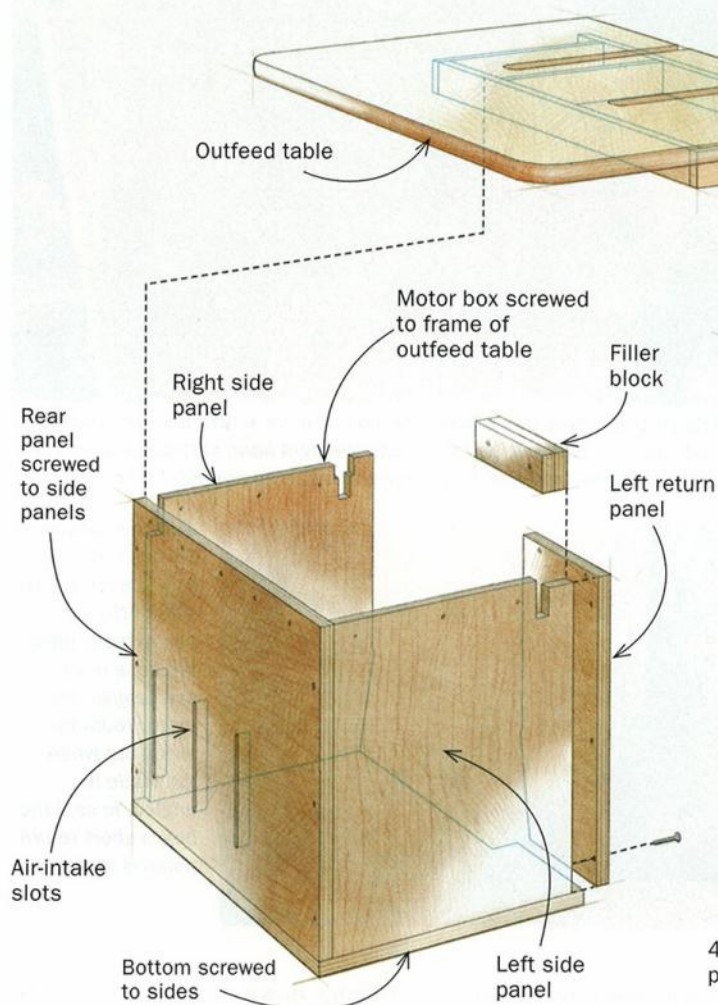
The major dust maker was my contractor's saw, one of an estimated million such saws in this country. Manufacturers seem to have given little or no thought to dust collection beyond sticking a dust port below the blade. The inefficiency of this system is obvious every time a piece of wood is cut and the operator becomes surrounded by a cloud of dust. To come up with a better solution, I put on my pilot's cap and began to think about airflow. By applying aerodynamics to my tablesaw, I was able to

FOLLOW THE FLOW

No matter which type of saw you have, the principle is the same: Close off most of the saw, allow rapid airflow in a few key areas, and you'll send the dust toward the hose and not into the shop.

ENCLOSE A CONTRACTOR'S SAW

You need an outfeed table from which you can suspend a box to enclose the motor. The base of a typical contractor's saw already has a dust chute, so three small panels will close off the bottom; the rear one gets the dust port.



vastly improve its dust collection, and keep the motor cooler in the process.

While I'll focus on the contractor's saw, the principles and techniques work on any saw. Two of *Fine Woodworking's* editors will describe how they dust-proofed a hybrid saw and a cabinet saw.

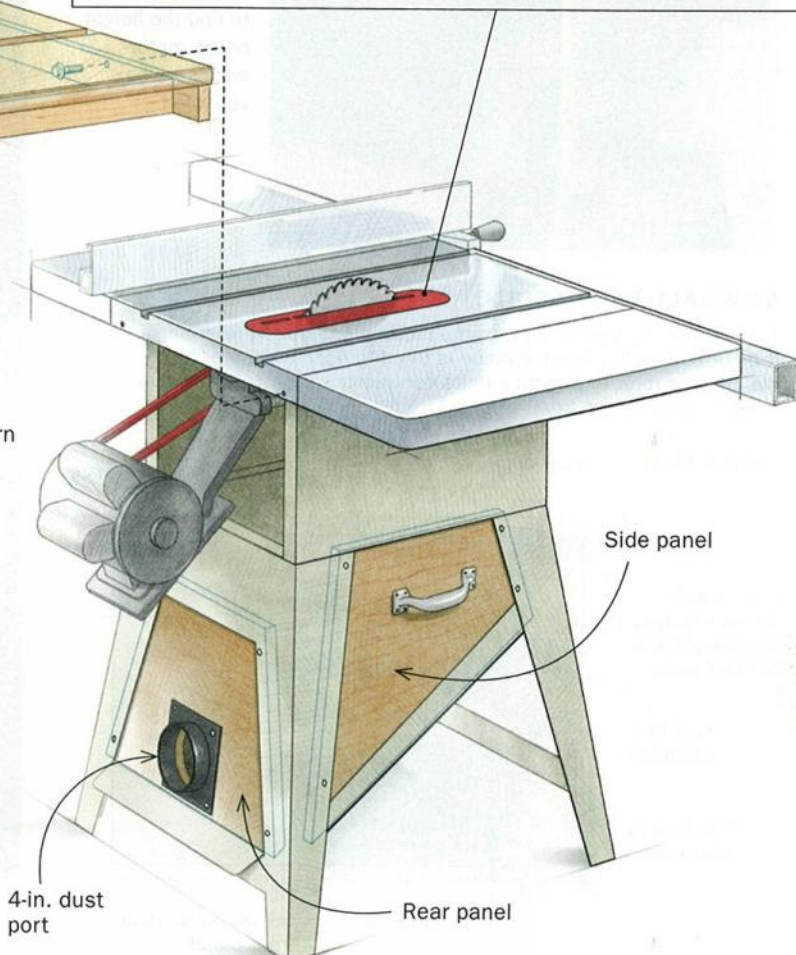
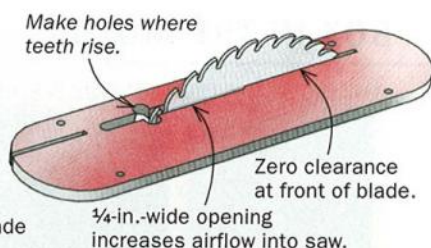
Dust goes with the flow—if you direct it

The average contractor's saw, with its open design, is equivalent to sticking the dust hose in the middle of the room. Some dust-laden air will be drawn in, but the majority will be too far from the hose and will float off into the shop. You need to increase the velocity by restricting and directing the amount of air entering the base of the saw. My plan uses three pieces of plywood to enclose the lower part of the saw, and five more to build a small box around the rear-hanging motor. This enables me to direct the airflow to the dust port.

This system requires a dust collector rated at a minimum of 1,100 cubic feet per minute (cfm). Most 1½-hp mobile dust collectors fit the bill, but if yours doesn't have a 1- or 2-micron filter,

HOT-ROD THE INSERT PLATE

Widen the back of the slot in a zero-clearance insert plate to create suction where the dust usually shoots out. Increase the effect by adding a pair of holes at the point where the teeth come up (with the blade height set to 1 in.).



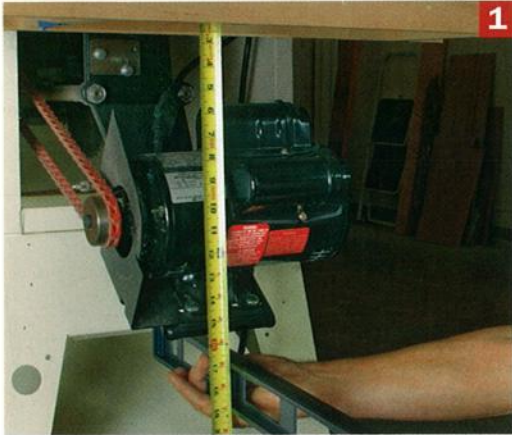
you should invest in one. The smallest particles are the most dangerous.

Begin by enclosing the motor—The motor enclosure is suspended from an outfeed table. The bracing under my Rockler table is placed almost perfectly for this installation, but if you have another outfeed table, you can either adapt the bracing or attach a shopmade frame to the underside of the table.

The first step is to calculate the size of the box required to enclose the motor at both the 0° and 45° blade settings. On most contractor's saws, the motor is mounted on a hinged plate and hangs down behind the saw, supported by the drive belt. To make the enclosure box as compact as possible, you'll need to pull the motor up slightly by shortening the belt. The easiest way to do this is to buy 4 ft. of link belt (in-lineindustries.com). Be sure to unplug your saw before working on it.

Because the motor will be completely sealed in, you can remove any belt guard. Now tilt the blade to the 45° position and adjust the belt length to give ½ in. of clearance from the motor's capacitor to the underside of the outfeed table. This in turn will

BOX IN THE MOTOR

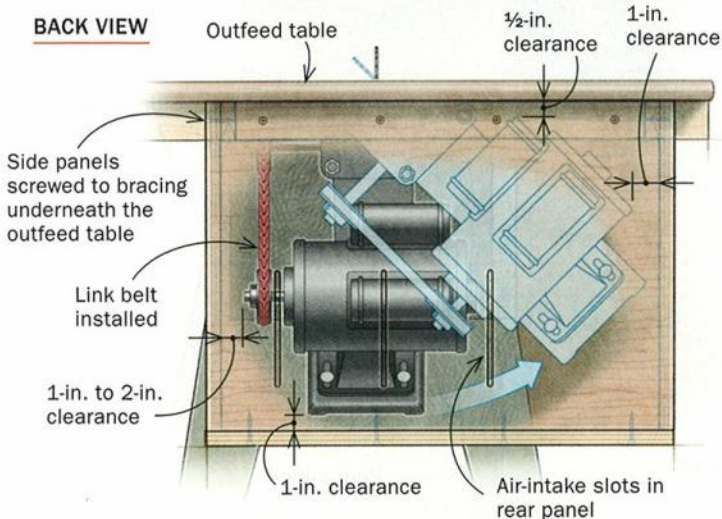


1 Measure the opening. After installing a link belt to adjust the height of the motor, use a tape measure and level to find the height of the motor-enclosure box you need.

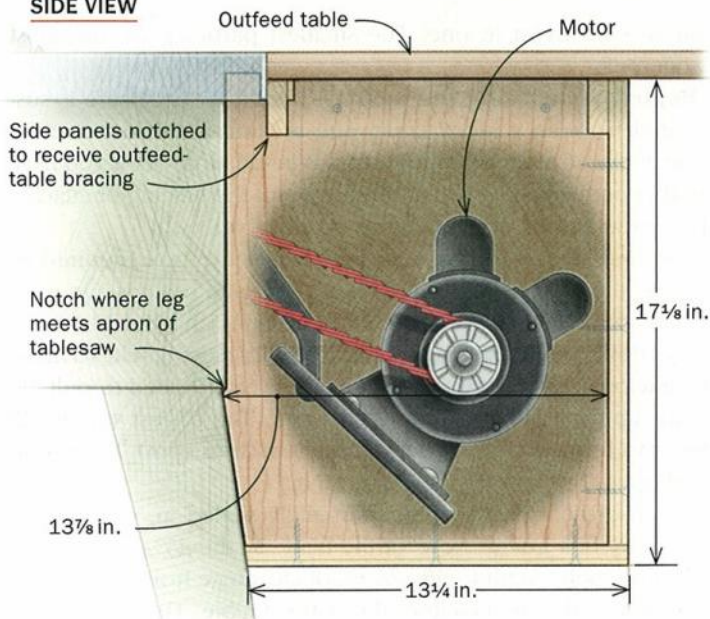
AS SMALL AS POSSIBLE

To minimize the size of the box, the motor should be $\frac{1}{2}$ in. from the outfeed table when the blade is tilted to 45° . The motor box dimensions refer to Babbitt's Delta contractor's saw. Your saw may need a different-size box.

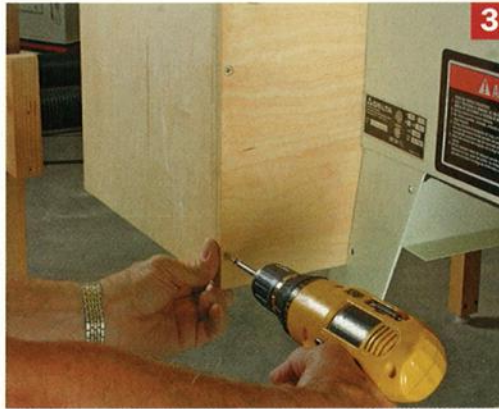
BACK VIEW



SIDE VIEW



2 Attach the motor-box sides. The sides can be screwed to the bracing that supports your outfeed table. Cut the right-hand side of the box to fit the back of the tablesaw and notch the top to go around the bracing.



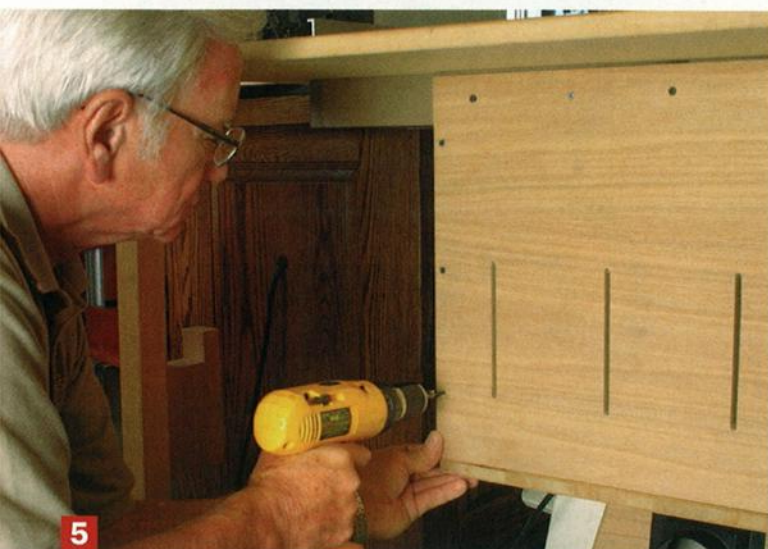
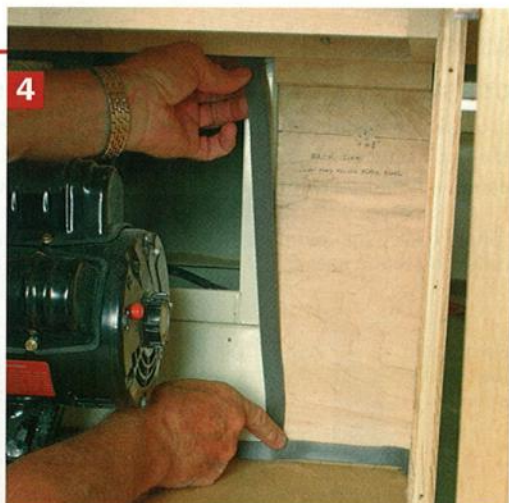
3 Add the return. On this right-tilt saw, the left-hand side of the motor box extends past the base of the saw to give the motor room to swing out when the blade is angled. To seal the box, a short return panel is attached.

determine how far the motor hangs down at the 0° setting. To get the vertical dimensions of the box, reset the blade tilt to 0° , set a tape measure on the floor, run the tape up past the motor to the underside of the outfeed table, and lock it. Hold a level against the lowest part of the motor mount and across the tape, note the dimension, and add 1 in. for clearance. This will be the vertical dimension of the left, right, and rear panels (all references to right and left are from the operator's position). Hold the level vertically an inch away from the back of the motor and mark the underside of the outfeed table.

Begin with the right side panel—I have a right-tilt saw. For a left-tilt one, reverse the descriptions for the left and right side panels. The right panel must seal against the rear apron of the saw's base, plus a portion of the 7° splayed leg. I held a piece of cardboard tightly against the saw's side and scribed it. We know the height of the panel; for the width, measure from the top of the saw's base to the line you made on the underside of the outfeed table.

Depending on the design, your saw may have an indent where the vertical part of the saw meets the splayed leg. This is the widest part of the right panel. Cut the panel to height and width, then use the template to cut the profile to fit the tablesaw. Cut slots in

Look for gaps. Use weatherstripping or duct tape to close off any gaps between the motor box and the tablesaw.



Close the box. Screw on the back. Slots in the back panel allow air to enter at high speed, cooling the motor and picking up the dust.

the top edge to accommodate bracing under the outfeed table. Use drywall screws to attach the panel to the bracing.

Making the left side panels—When the blade is angled at 45°, the motor extends beyond the left side of the saw. To allow for this, the main left-side panel doesn't contact the back of the saw. It is the same height as the right panel but ½ in. wider and doesn't have to allow for the indent or the splayed leg. Locate the left panel an inch away from the tilted motor and attach it in the same way.

The gap between the front of the left panel and the left side of the saw is enclosed by a short return panel. This panel's top edge will butt up against the underside of the left table extension. Scribe a piece of cardboard to measure the side splay of the saw's left rear leg and use this to bandsaw the return panel to the correct shape. Now screw the return panel to the left side panel.

The bottom of the motor enclosure will be attached later, but cut it to size now. Add ¾ in. to the length for a shelf to receive the rear panel. Cut a hole in the front edge for the power cord.

Create the dust-collection area in the saw's base

The base enclosure on my saw consists of two side panels and a rear panel that houses the dust port. Place a piece of cardboard

SEAL THE REST OF THE SAW



Close off the base. Screw panels to the existing framework. Attach a 4-in.-dia. dust port to the rear panel.



Allow for access. The base side panels have handles attached. This makes them easier to install and to remove for saw access.



Seal the underside of the table. Large gaps between the saw's base and table are best filled with a foam sealant.



Add a simple adjuster. A shop-made magnetic panel covers the curved slot for the height-adjustment crank. Adjust the opening to achieve optimum airflow.



How to dust-proof a hybrid saw

After reading Richard Babbitt's article, I was curious whether I could achieve the same results on my DeWalt hybrid saw. I knew the base was open to the floor, but a closer inspection showed huge gaps between the base

and the tabletop, and even the legs and side panels did not have a good seal. Not surprisingly, dust collection was never very efficient. Working with Babbitt, I came up with a design that adopted the principle of directing the air.

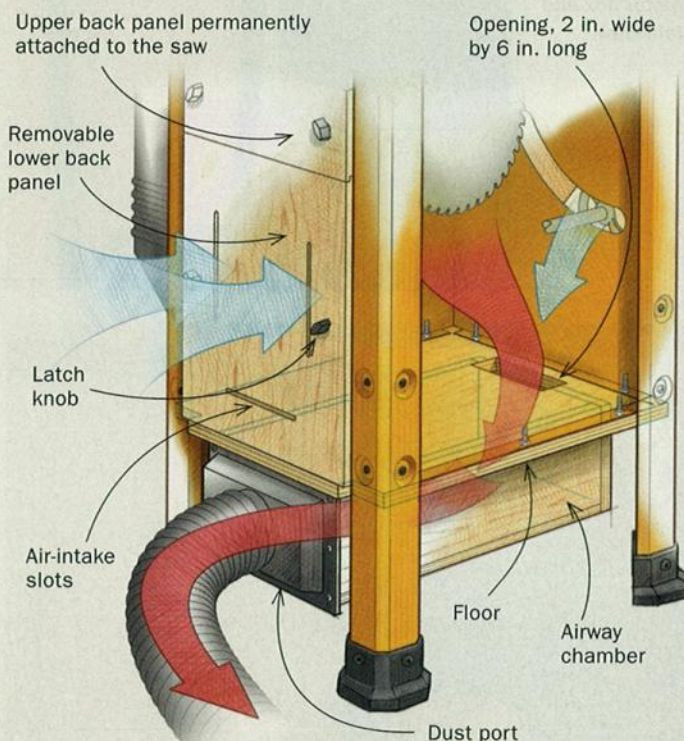
The first task was to remove the plastic combination blade-shroud and dust chute. Not having an easy way to create an angled dust chute, I installed a plywood floor in the base with a 2-in. by 6-in. opening at the front. From this floor I hung the airway dust chamber with the dust port at the rear. Not wanting to drill holes in the legs, I secured the back panel to the legs with latches that allow for easy access to the inside of the saw. The large gaps between the base and the table were filled with expanding foam sealant; weatherstripping filled the gaps between the sheet-metal legs and the side panels, and small pieces of magnetic sheet (refrigerator magnets) covered holes around crank handles, etc.

The improvement in dust collection has been dramatic. During several weeks of use that included cutting medium-density fiberboard and plywood, almost no dust escaped the saw. Inside, the motor and the mechanics remained remarkably clean.

—Mark Schofield is the managing editor of *Fine Woodworking*.

CONSTRUCT AN AIRWAY DUST CHAMBER

Like Babbitt's contractor's saw, this design draws in clean air through the back slots and the tilt-control slot. But, instead of an angled dust chute, a floor opens into a lower dust chamber linked to the dust port.

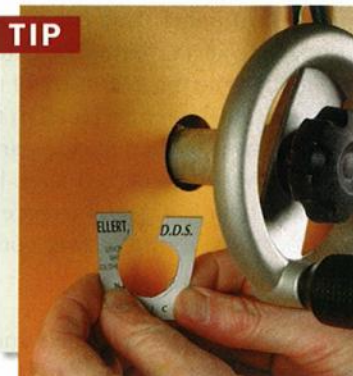


Air goes in, dust comes out. Despite the semi-open base, this hybrid saw was successfully dust-proofed using the same principles employed on a contractor's saw. High-speed air enters slots in the rear panel, washes over the motor, picks up dust from the blade, and exits at the bottom via a 4-in.-dia. hose.

over the rear opening in the saw's base and mark the opening on it. Add 1½ in. to the sides and transfer this outline to the plywood. The first cut should be on the bottom edge with the blade tilted to match the angle of the dust chute. After cutting the sides of the panel on the bandsaw, on center, draw a 4½-in.-dia. circle with its bottom 1¼ in. from the lower edge of the panel. Cut this out with a jigsaw. Now drill two clearance holes evenly spaced into each leg, staying ¾ in. from the inside edge. Screw the panel to the legs and seal the bottom of the interior with self-stick weatherstripping. Now that you are finished working on the back of the saw, you can install the bottom panel of the motor box.

Make the lower side panels in the same way, using a cardboard template. Stick weatherstripping on the top edge of the panels.

TIP



Use fridge magnets

Plastic magnetic sheet, often used for free advertisements, can be easily cut to close small gaps, like the one around the blade-angle crank.



Even cabinet saws can be improved dramatically

I was skeptical that dust collection on my old General 350 cabinet saw could be improved, for two reasons. First, it was already mostly enclosed. Second, I had already built a box to close off the one gaping hole in the cabinet—the square cutout that allows the motor to pivot when the blade is angled. But after seeing photos of my saw, Babbitt suggested a number of modifications.

The best upgrade was to cut three slots in the plywood box, located to send a stream of air across the motor, cooling it and helping to keep the gears and trunnions dust-free.

Then, starting at the bottom of the saw, I replaced a permanent pile of dust with a three-part plywood floor to funnel chips toward the port. The next task was to direct some air across this channel to push the dust to the port. A piece of plywood and a metal louver did the trick (below right). I then sealed other gaps with expanding foam and weatherstripping, used magnetic sheet to cover screw holes and gaps around handles, and fitted an adjustable cover to the tilt-control slot.

After several months of use, there is no buildup of dust around the base of the saw, I get almost no dust coming off the back of the blade, and when I remove the insert to look inside, the motor and trunnions are very clean.

—Asa Christiana is Fine Woodworking's editor.

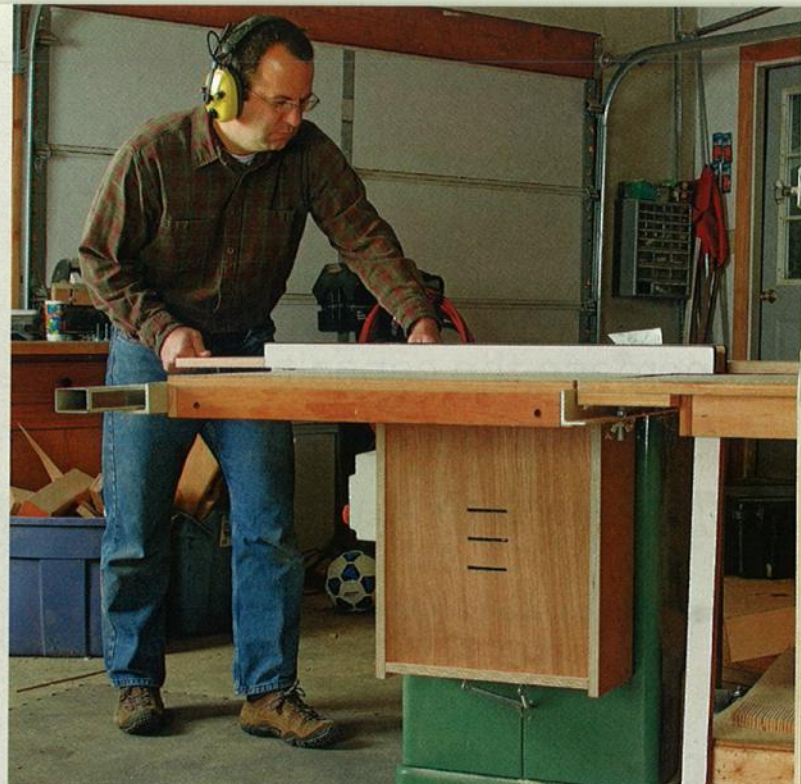
Front and back panels control the airflow

We've now closed off all the conflicting air inlets except for the back panel and the large tilt-crank slot. This is where we start to direct the airflow. Cut the back panel to fit the opening in the rear enclosure. Note where the motor is positioned with the blade vertical, and align the 1/4-in.-wide by 6-in.-long high-velocity air-intake slots so that the air flows over and around the motor.

There are a couple of ways to seal the tilt-crank slot: If you live near a sign company, see if you can acquire a piece of magnetic sign board large enough to cover the slot. Alternatively, cut a scrap of 1/2-in.-thick plywood 1 in. wider than the opening. Drill two holes diagonally opposite each other and epoxy in two magnets.

Open and close this panel to find the most efficient airflow. Too small an opening may starve the dust collector of air and reduce the flow; too large an opening may reduce air velocity entering the rear of the saw. I generally keep mine open 1 1/2 in. to 2 in., and a little wider when running a dado blade. After several hours of use, check for sawdust buildup inside the saw by removing the back panel or the insert plate. Some dust sloped on the sides away from the main airflow is normal. You aren't attempting to get all the dust out of the saw, just to get the vast majority into the dust collector, not your nasal passages. □

Woodworker Richard Babbitt attempts to keep the air clear in his shop on San Juan Island, Wash.



Add intake. Christiana had a plywood box covering the motor opening. So he just routed three slots, positioned to wash cool air over the motor.



Install a floor. To channel dust toward the dust port, install a floor in the base, with two plywood side panels angled downward.



Let air sweep the floor. A thin plywood panel blocks all of the louver slots in the access door, except the lowest. Because that slot is still several inches above the new floor, install a sheet-metal louver to direct incoming air down to the floor. Attach the panel with construction adhesive.

Soup Up Your Bandsaw

Increase the capacity and get better cuts from any size machine

BY MICHAEL FORTUNE

In my first year of design school in the early 1970s, I remember the shop manager telling me that the bandsaw was the most useful piece of equipment in a woodshop. This struck me as a dubious statement, given that we were standing in a workshop filled with state-of-the-art European woodworking equipment. But time and again he proved it.

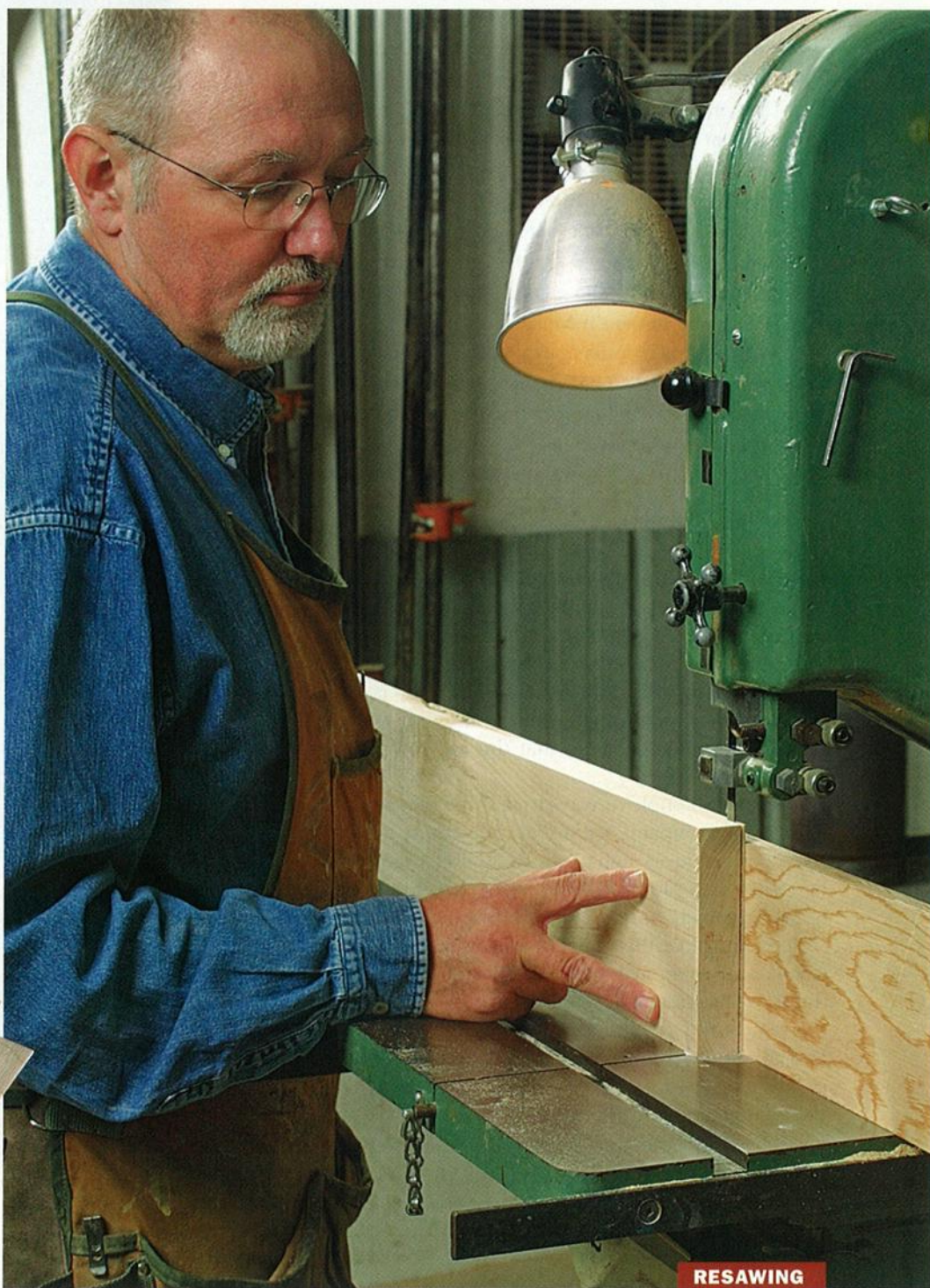
After I graduated in 1974, my first purchase was a 15-in. General bandsaw. However, I soon realized I could achieve the accuracy and versatility I had experienced at school only if I set up the saw the way my shop manager did.

Once I figured out the keys to success, I came to rely on that bandsaw. With a single blade, I routinely cut smooth tenon cheeks, fine inlay stringing, and perfect veneers that use the



Precise cuts are easier than you think.

It doesn't take a high-end blade, high tension, replacement guides, or a special fence to get excellent cuts.

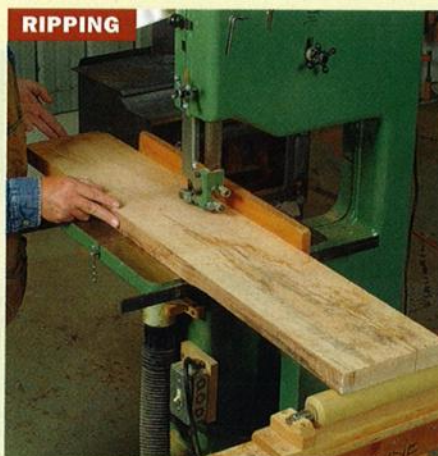
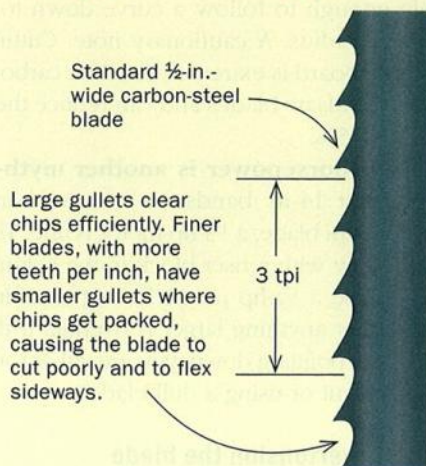


RESAWING

Tip 1

A SINGLE BLADE CAN HANDLE MOST TASKS

A ½-in.-wide, 3-tpi blade—properly set up—will handle general ripcuts, resawing (opposite page), and even cutting curves in thin stock, not to mention cutting precise tenons.



entire height capacity of my machine. I also do all of my ripping on that 15-in. bandsaw. The task is safer and requires less horsepower than the tablesaw, and the narrow kerf consumes less wood. New employees and students are surprised at first by my preference for ripping on the bandsaw, but they are converted quickly. Although I have three excellent industrial tablesaws in my shop, they are used almost exclusively for dadoing, squaring panels, and cutting shoulders on joints.

There are three key elements to getting the most from your bandsaw: blade type, blade alignment, and moderate tension. My approach contradicts some of the common advice for setting up bandsaws.

It does not require high blade tension, special equipment, exotic blades, high horsepower, or continual fence adjustments to accommodate blade drift.

Start with a coarse blade

During teaching assignments, I run into many woodworkers experiencing difficulties with their bandsaws. They complain about severely cupped kerfs, poor tracking, and saws that seem underpowered, so their bandsaws are relegated to cutting curves in thin stock.

The number-one culprit behind all of these difficulties is a bandsaw blade that has too many teeth, with small gullets in between. Sawdust generated in the kerf

must be removed efficiently. A tremendous amount of heat is created by the friction from the sawdust that is jam-packed in each small gullet right at the point where the wood fibers are being cut. The intense heat can cause the blade to lose its temper and dull prematurely. The heat and pressure buildup also can cause the blade to flex sideways and backward, creating a dished cut. A typical reaction here is to tighten the tension on the blade. But over-tensioning the blade creates a whole new set of problems (see Tip 2).

My bandsaw does everything, every day: cutting joints, resawing wide laminates in exotic woods, making curved patterns in ⅛-in.-thick stock. It is not practical to

A riser block increases cutting capacity

Most 14-in. cast-iron bandsaws can be outfitted with a riser-block kit that's available as an option. Adding a riser block increases the resaw capacity of the machine from about 6 in. to 12 in. With this increased capacity, though, you'll also need longer blades.

The riser block mounts between the upper and lower frames of the saw. Two pins help position the block on the frame, and a heavy-duty bolt, washer, and nut connect it to both parts of the frame.

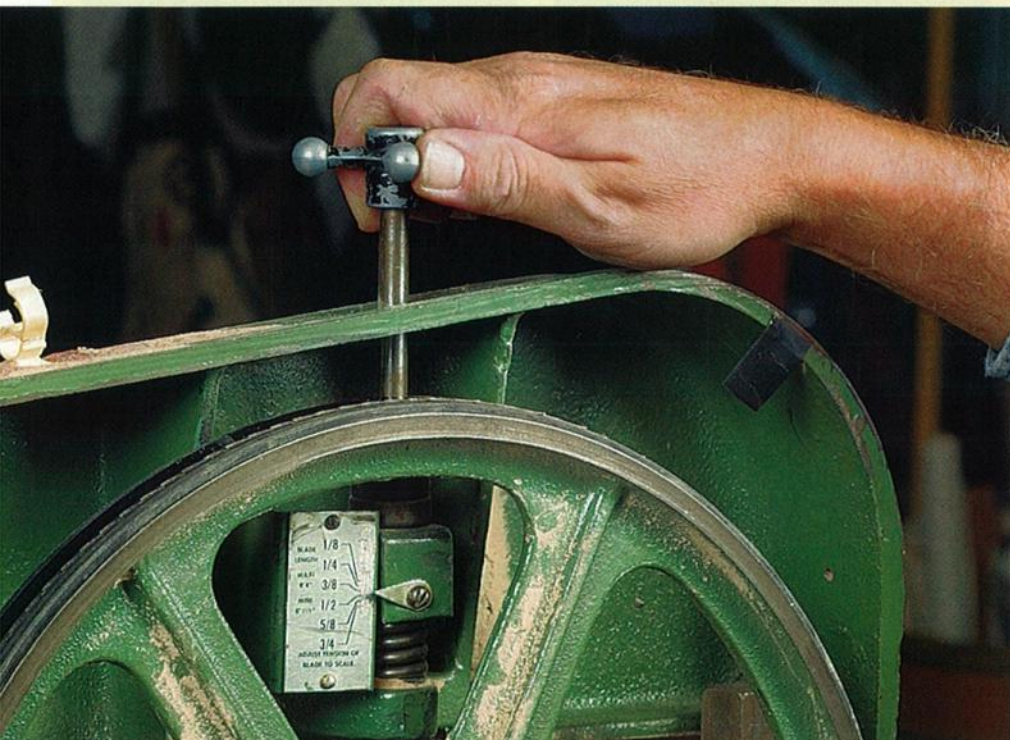


Attach the replacement blade guards and the guidepost. The riser-block kit includes longer blade guards for both the back and front of the saw, and a longer guidepost.

Tip 2

HIGH BLADE TENSION IS NOT NECESSARY

High tension eventually will groove the tires, pulling the blade out of alignment (for more on blade alignment, see Tip 3). High tension even can flex the machine's frame out of alignment.



Use less than the recommended tension. For a 1/2-in.-wide blade, turn the tension gauge (above) to the setting for a 3/8-in.-wide blade. The first step in overhauling a bandsaw is to check the tires for grooves (right). If necessary, replace them.



change the blade and the guide blocks for each situation, nor is it necessary, in fact.

With rare exception, a standard carbon-steel 1/2-in.-wide, 3-tpi, skip-tooth blade installed on my bandsaw performs all of the above tasks.

Blades are inexpensive, so keep a sharp one loaded—The blades I use are made by Starrett but are welded and distributed by BC Saw and Tool in Canada (888-251-2236; bcsaw.com). By delightful coincidence, these blades are relatively inexpensive. It helps that I buy them in groups of 10, which earns me a 25% dis-

count. For example, 94 1/2-in.-long blades, which fit a 14-in. bandsaw, cost about \$6.71 (U.S.) each, or \$8.95 if purchased one at a time. This is one of the rare cases when inexpensive equals good.

Unfortunately, not all blade distributors weld bandsaw blades properly. A poorly welded, misaligned sawblade will not give you the smooth and effortless results you are after.

Simply using a 3-tpi blade, with its larger gullets, will eliminate many problems. Even 4 tpi is too fine a tooth pattern for general woodworking and resawing. If you

want a fine cut, use a coarse blade, even on thin stock. In my experience, the old rule of thumb about having two teeth engaged in the stock at all times is bogus. The reason I use a 1/2-in.-wide blade is that it is stiff enough to resaw but flexible enough to follow a curve down to a 2 1/2-in. radius. A cautionary note: Cutting particleboard is extremely hard on carbon-steel bandsaw blades and can reduce their life by 75%.

High horsepower is another myth—

For most 14-in. bandsaws with a 1/2-in.-wide, 3-tpi blade, a 1/3-hp motor is fine. The same saw with a riser block in the column could use a 1/2-hp motor for big resawing tasks, but anything larger is overkill. If the motor is bogging down, you are either forcing the cut or using a dull blade.

Don't overtension the blade

It is important that the tires on the bandsaw remain in excellent shape. Grooves in the rubber tire on either the upper or the lower wheel will make it impossible to keep the blade on the centerline, in line with the rip fence. And the most common cause of grooves in the tires is overtensioned blades. Very high tension even can flex the saw frame out of alignment.

I slightly undertension my 1/2-in.-wide blade. Because of its excellent ability to clear sawdust, the blade is not inclined to flex, wander, or heat up. For the 1/2-in.-wide blade, I adjust the tension scale to the 3/8-in. setting. If no scale is present on the machine, I tighten the adjustment knob (with the machine off and unplugged) until the blade deflects about 1/4 in. to the side without making my fingertips go white.

A side benefit of lower blade tension is that I seldom have to release the tension on the saw, as is commonly recommended to prolong blade life.

Align the blade to eliminate drift

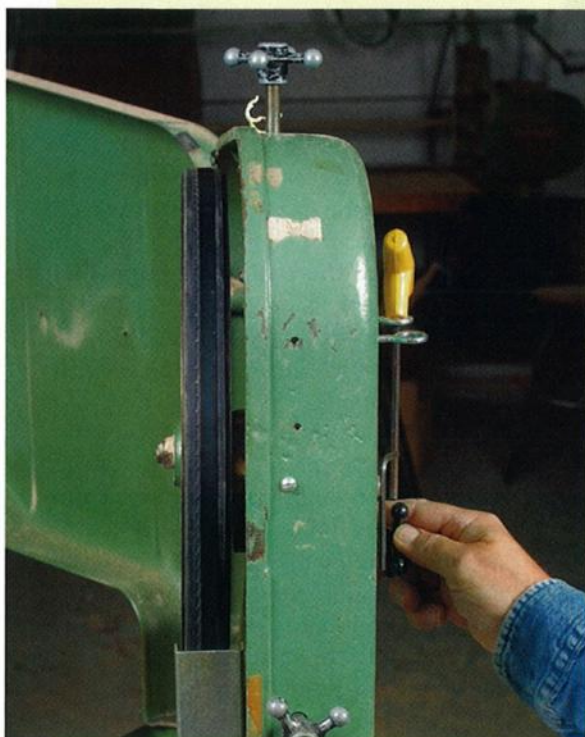
When I bought my bandsaw in 1974, I set the fence parallel to the miter-gauge slot in the table, and I haven't had to adjust it since. The reason is that I use the tracking adjustment on the upper bandsaw wheel to align the blade (see the drawings on the facing page). A nightmare of fence adjustments ensues if each new blade is allowed to track differently.

Simply by keeping the centerline of the blade (regardless of width) in line with the centerline of the upper wheel, I am able

Tip 3

YOU CAN ELIMINATE BLADE DRIFT BY ADJUSTING THE TRACKING

Advice on blade alignment usually centers on the rip fence instead of the blade. You can eliminate blade drift by adjusting the position of the blade on the upper wheel.

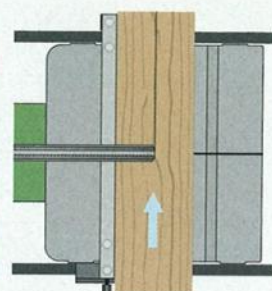


A simple adjustment. Adjust the angle of the upper wheel so the blade rides at the center, which on most small bandsaws is crowned slightly.

ADJUST THE ALIGNMENT OF THE BLADE, NOT THE FENCE

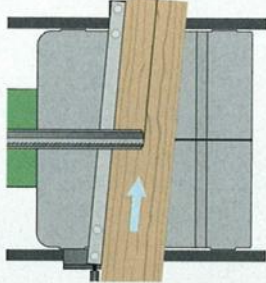
First, align the rip fence parallel with the miter-gauge slot and leave it there. Then eliminate blade drift by centering the blade on the upper wheel. The upper wheel has a slight crown on it. Therefore, if the blade is close to the front of the upper wheel, it will be angled on the wheels, causing the saw to cut to the right. If the blade is close to the back of the wheel, the reverse will be true.

CENTERED BLADE



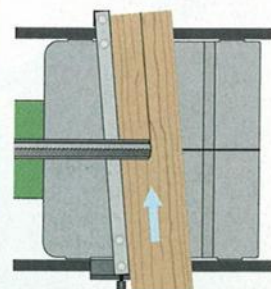
Saw will cut straight.

BLADE TOO FAR FORWARD



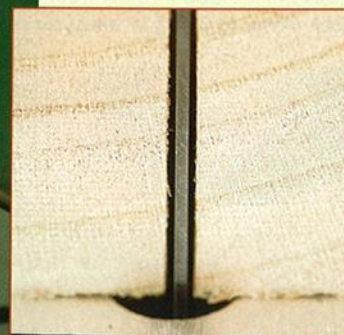
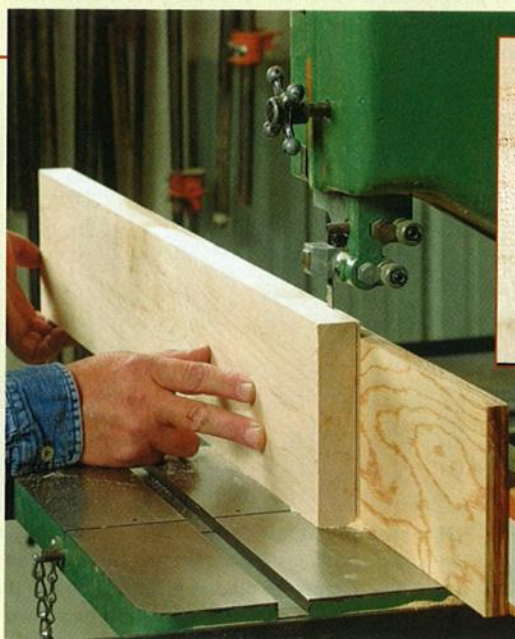
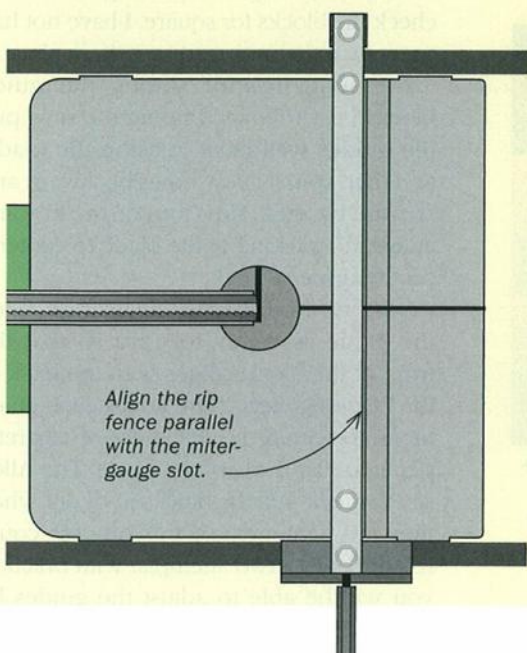
The fence must be angled to the right for a straight cut.

BLADE TOO FAR BACK



The fence must be angled to the left for a straight cut.

ALIGN THE FENCE JUST ONCE

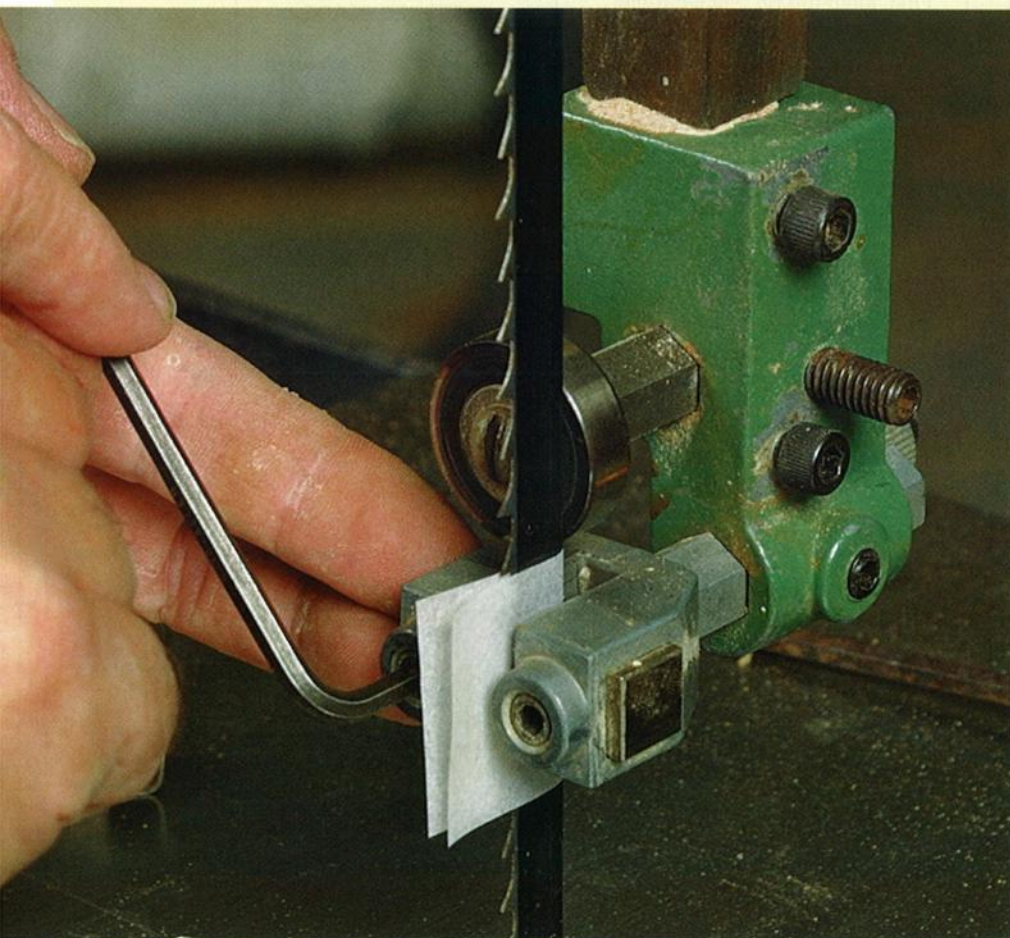


Now push gently and let the blade do the work. Pushing too hard will make the blade flex sideways, which will cause it both to overheat and to drift off line. With the blade, fence, and guides properly aligned and adjusted, the back of the blade should be centered in its kerf (inset).

Tip 4

REPLACEMENT GUIDES AREN'T NECESSARY

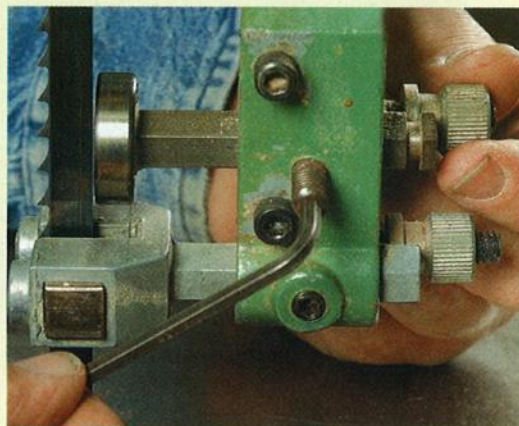
A set of metal guide blocks will keep your blades on track for many years. The key is to set them very close to the blade and just behind the gullets.



Closer than you might think. Many people use a dollar bill for setting the blocks, which keeps them 0.003 in. away from each side. Cigarette paper (or a feeler gauge) will set each block closer to 0.001 in. away, resulting in smoother, more precise cuts.



The blade weld must be smooth. A good sawblade company will weld blades precisely and grind the welded area flat. After setting the guides, turn the wheel by hand to be sure the weld passes through the guides smoothly.



Other important guide settings. The guide assembly should be adjusted so that the metal blocks remain just behind the blade's gullets. Then the thrust bearing is set $\frac{1}{2}$ in. behind the blade, as shown, so it contacts the blade only during use.

to keep the blade aligned correctly at the blade guides.

The relationship between tracking the blade on the centerline of the upper wheel and having the fence aligned parallel to the miter slot should produce a kerf with equal space on either side of the blade.

Much has been made in books and articles of the alignment of the two wheels to each other. In my shop and in my travels to schools around North America, I have never found this to be a problem. Tracking the blade properly on the upper wheel has always been enough, except in the case of a severely damaged bandsaw.

Now square the table and align the fence—The table is now aligned with the cutting direction, but it also should be adjusted so that it is square with the vertical line of the blade.

Last, the fence should be aligned parallel to the blade and square to the table. I use a $3\frac{1}{2}$ -in.-high birch plywood rip fence screwed onto the metal fence. I have shimmed the plywood with masking tape to get it perpendicular to the table. Taller plywood fences can be screwed to the existing plywood fence, but I use these only when I am resawing to the maximum capacity of my bandsaw, about $6\frac{1}{2}$ in.

Use metal guide blocks, set close

Again, simple is the way to go. When setting up my bandsaw in 1974, I took out the metal guide blocks and squared their working faces against the side of the wheel on my bench grinder, being careful to check the blocks for square. I have not had to replace them or resquare them since.

The sequence for setting the guide blocks is as follows. Unplug the saw, pull the guides well back, tension the blade, and then spin it a few times backward and forward by hand. Now turn on the saw and adjust the tracking of the blade to center it on the upper wheel.

Next, turn off the saw again, and bring the guide assembly forward so that the front of the blocks aligns with the back of the blade's gullets. Then adjust each guide block to within the thickness of cigarette paper, or 0.001 in., of the blade. The Allen screw might pull the blocks in or out when they are tightened, so this process could require one or two attempts. With practice, you will be able to adjust the guides by

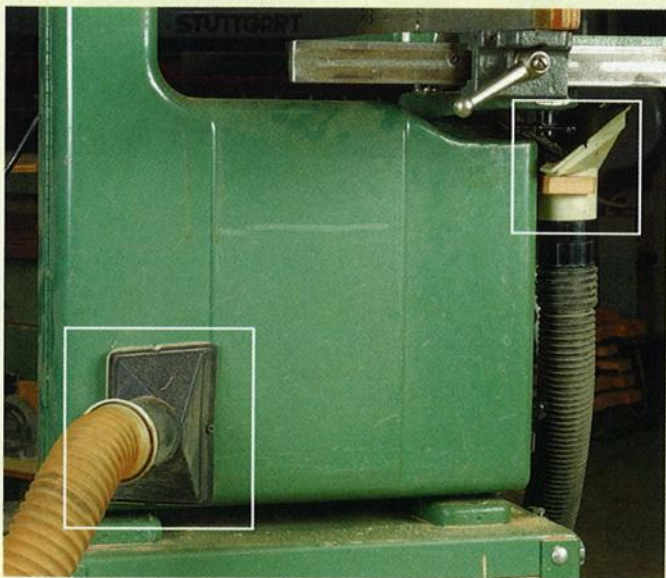
Tip 5

ADD DUST COLLECTION TO KEEP YOUR SAW RUNNING WELL

Sawdust extraction is very important. Wood dust will get compressed onto the lower wheel by the revolving blade. The resulting bumps will cause the blade to vibrate and wander off center.

Many saws provide for some dust extraction directly below the cutting area, but that isn't enough. Attach a second dust pickup at the lower left corner, where the air current generated by the lower wheel makes dust accumulate.

Also, attach a wooden brush with stiff natural bristles to the frame of the saw so that it continually cleans off the lower wheel. The lower dust port will catch the debris.



Collect dust at two points. Many bandsaws have dust collection below the cutting area, but Fortune also recommends installing a vacuum port at the bottom left of the lower wheel. If dust and pitch build up on the tires, the blade will not track properly. Install a brush (right) to remove dust from the lower wheel.



eye, looking for the smallest crack of light between the blade and the guide blocks.

Last, bring the thrust bearing in the rear to within $\frac{1}{32}$ in. of the blade. This bearing is the only part that requires replacing, when it becomes stiff or scarred. But it is a standard part and can be bought in most automotive- or bearing-supply houses.

With the guide blocks set this close, and with the back of the gullets just aligned with the front of the blocks, there is no room for the blade to twist or for the teeth to hit the metal guide blocks.

If I thought there was some advantage to replacing the guides or the blocks, then I would, but I find the original system gives me excellent results. With the blade and

fence aligned properly, the metal guide blocks are not rubbing constantly against one side of the blade or the other and creating friction heat.

The lower guides are set in the same way as the upper ones, though I often leave them backed slightly away from the blade, unless I am resawing particularly difficult wood. I have worked in several shops in Europe, and none of the bandsaws I used there had lower bearing assemblies.

Feed stock with mild pressure

With the saw properly set up, it is necessary to place only two of your fingers against the workpiece: You should be able to use one finger to push the stock and the

other to hold it against the rip fence. If you have to use the butt of your hand to push the stock, something is wrong—either the blade is dull or it is no longer tracking on the centerline of the upper wheel and is misaligned with the fence, causing the wood to bind.

Use mild but consistent feed pressure, allowing the blade to do the work. The sawdust must have a chance to be cleared from the kerf. For safety, once your pushing fingers are within 6 in. of the blade, use a push stick. □

Michael Fortune designs and builds furniture in Lakefield, Ont., Canada, and teaches throughout North America.



MACHINES

Get More from Your Drill Press

The right bits, jigs, and techniques turn a metalworking tool into a versatile woodworking machine

BY ROLAND JOHNSON

Originally designed as a tool for machinists, the drill press has become a standard fixture in woodworking shops. It is capable of drilling both small and large holes more accurately and safely than a handheld drill, and it has a built-in depth stop. The rack-and-pinion pressing action of the machine gives easy leverage for boring large holes in hard material. Throw on a simple, shop-built table and fence, and you add the ability to support and stabilize large and small workpieces in precise, repeatable positions.

Most woodworkers are familiar with the basic function of a drill press, but not everyone knows how to squeeze the greatest versatility and performance out of this woodworking mainstay.

The first step is to make sure the machine is drilling holes that are straight and true, perpendicular to the table. For basic troubleshooting on a drill press, you'll need an accurate square,



Tune-up is quick but crucial



A wobbly chuck can be corrected. You'll need a dial indicator and some drill rod to test for runout. If you find more than 0.005 in. of wobble, use a deadblow hammer to knock the chuck free. Clean any gunk off the taper, and reinstall the chuck.

a deadblow hammer, a dial indicator with a magnetic base, and a length of drill rod (available at machine shops and many hardware stores, as well as by mail order).

The most important factor for accurate drilling is the squareness of the table to the bit. Use the square to determine if the table is perpendicular to the chuck. If the table is out of square from side to side, fixing it is a simple matter of loosening the bolt that secures the table, making an adjustment, and tightening the bolt. If the table is out of square from front to back, the auxiliary table (described on pp. 50-51) can be shimmed to compensate.

If you have a dial indicator, use it and the length of drill rod held in the chuck to check the chuck for runout. Any wobble should be less than 0.005 in. measured at 1 in. from the jaws. If there is any more wobble than this, bits will tear the rim of a hole upon entry and re-entry. If the chuck is not concentric to the shaft, use a deadblow hammer to knock the chuck free of the shaft, and check the taper to make sure it's clean and smooth. Use a rag and some solvent to clean the taper. Anything more abrasive than steel wool will change the taper and will weaken the bond. Replace the chuck and recheck the runout.

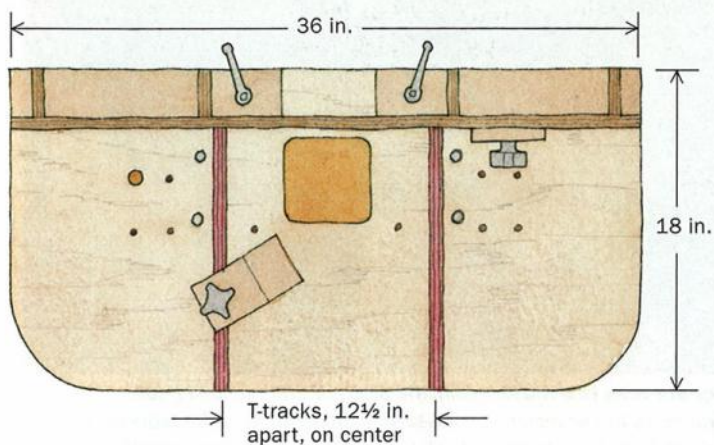
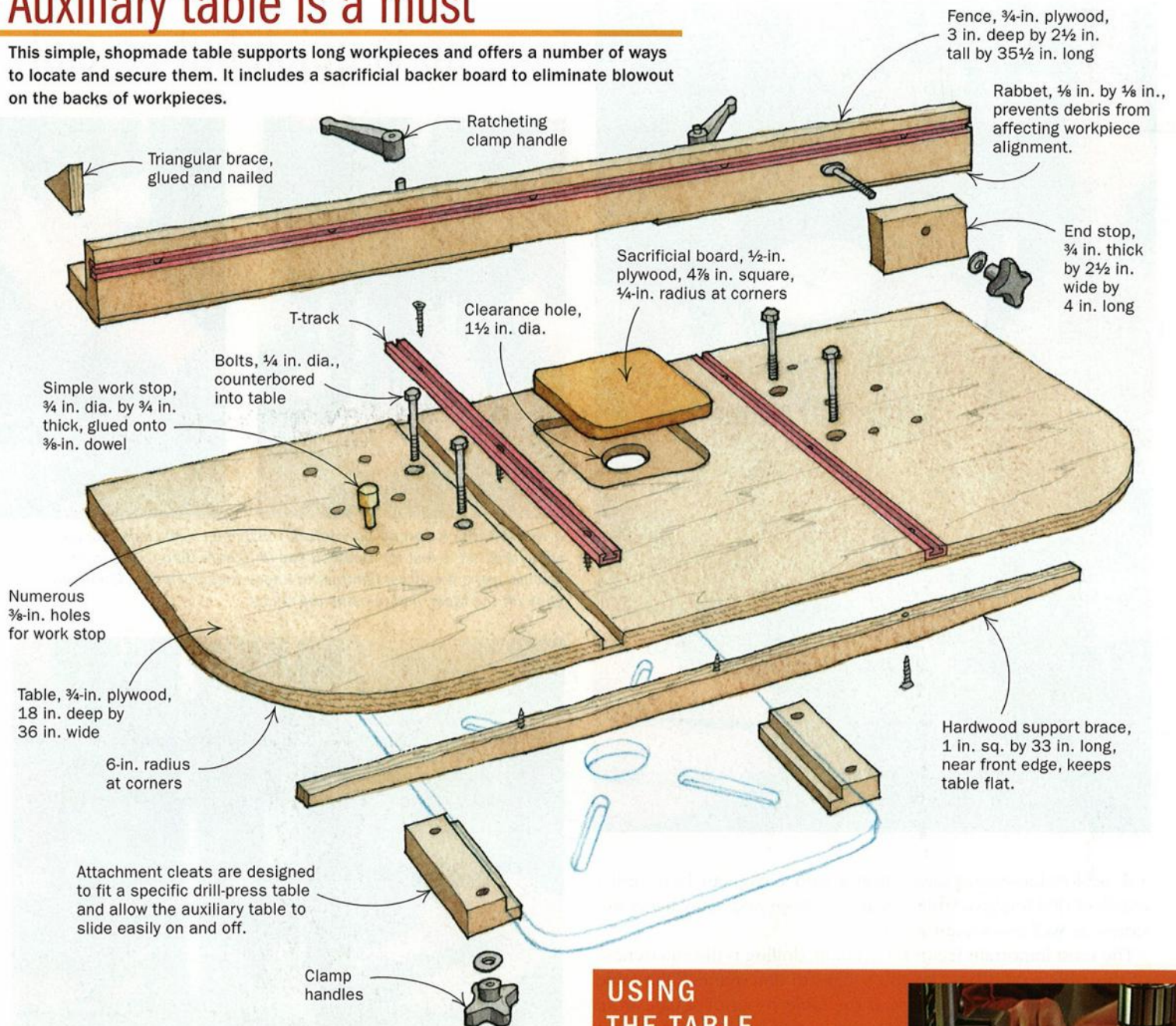
When reinstalling the chuck, you can angle the hammer blow to get it to seat properly on center. At that point, if you are still measuring too much runout, remove the chuck and check the



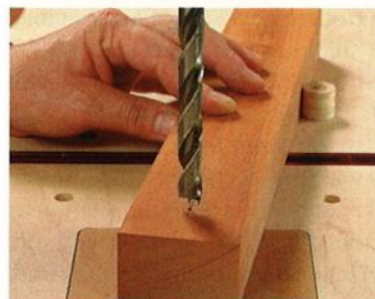
Squareness is a must. Again, the piece of drill rod is helpful. Drill-press tables include a side-to-side adjustment. If the table isn't square from front to back, you'll have to shim the auxiliary table (see drawings, p. 50).

Auxiliary table is a must

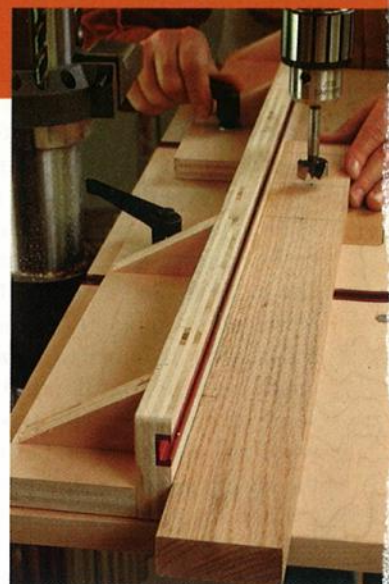
This simple, shopmade table supports long workpieces and offers a number of ways to locate and secure them. It includes a sacrificial backer board to eliminate blowout on the backs of workpieces.



USING THE TABLE



A pin is the simplest stop. It offers a quick way to keep a workpiece from spinning (above). The fence works well for holes in a row (right). The T-tracks and clamp handles make for quick adjustment and a secure grip.



taper itself. You might have to contact the manufacturer to replace that shaft.

If you are a bit more ambitious, the rest of the drill press comes apart for cleaning and lubrication, which will smooth out any sticky action. Also, if you notice excessive vibration when the press is running, it may be caused by poor-quality or old V-belts. These can be replaced with segmented belts.

Note to lefties: Many machines can be set up for left-handed crank operation simply by swapping the return spring and handle assembly side-for-side.

An auxiliary table is a must

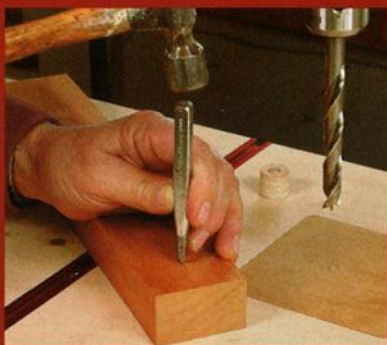
Even though many drill presses are used exclusively for woodworking, they still are equipped with a machinist-oriented table that tends to be too small for many woodworking operations. An auxiliary table that bolts to the drill-press table greatly enhances versatility and safety. A wood or melamine surface is also kinder to workpieces. My version consists of a $\frac{3}{4}$ -in. piece of veneer-core plywood, with aluminum T-tracks inset to accommodate a fence and various hold-downs.

Through-holes will tear out without a fresh backer board below the hole. I inset a small, sacrificial piece of plywood into the auxiliary table. For critical holes, flip or rotate the board to find a clean area, and replace it when it is riddled with holes. The replaceable insert also allows the bottom end of a sanding drum to be set below the table surface.

Four basic settings

There are a few simple settings on a drill press. You'll need to understand and use them all to get the most from the machine. The most frequent adjustment you'll make is tightening and loosening the drill chuck. Use all three tightening locations to be sure each jaw is well-seated, especially with big bits. This also can help to center the bit.

Drilling tip



For greatest accuracy when using brad-point and twist bits, use a center punch before drilling.

To accommodate various thicknesses of workpieces and various lengths and types of tools, you'll adjust the table quite often. Usually this means cranking the table up and down a gear rack on the support column, and locking it in place. Most tables also can be tilted for angled holes.

It also is important to match the speed to the bit. For woodworking, this does not have to be an exact science. Basically, you should not run any bit faster than 3,000 rpm, and you should slow the speed considerably for bigger bits. For example, a 1-in.-dia. bit should run at 300 rpm to 500 rpm in hardwood. On moderately priced drill presses, you'll have to turn off the machine to change speeds by moving the belt(s) across stepped pulleys. Some heavier-duty machines offer

infinitely variable speed that can be changed on the fly.

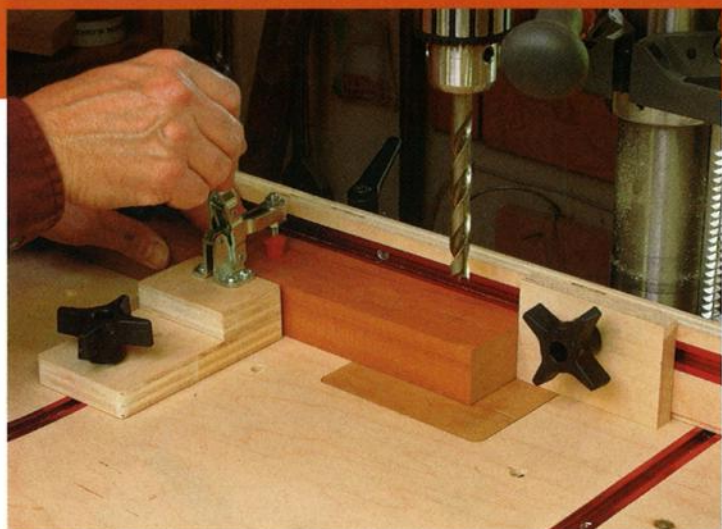
Last, you occasionally will use the depth stop. On many drill presses, this is a rotating collar located behind the feed handle. Higher-end machines have a better system: a vertical rod that travels with the quill, with stop collars setting the depth.

Safety: Spin and climb are the enemies

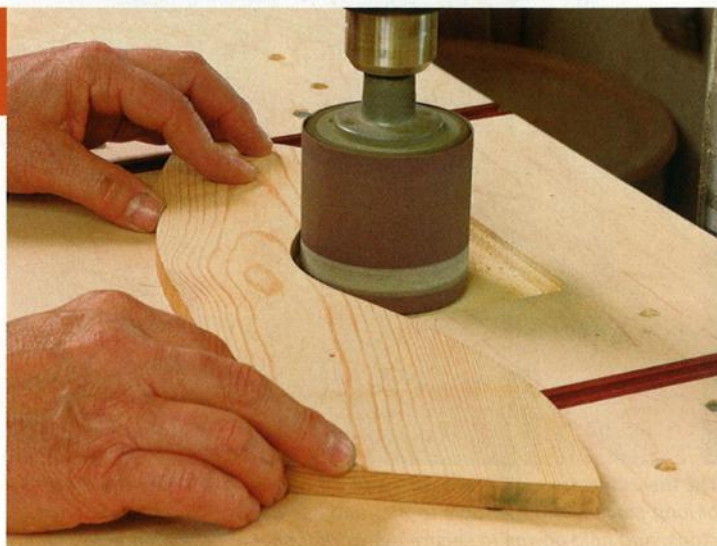
Two nasty events that can occur when drilling holes are spin and climb. If a bit grabs the wood—from too fast a feed rate, a dull cutting edge, or a sudden change in density of material (think plywood)—the work can go from zero to the drill's rpm in an instant, a potentially dangerous situation.

Almost any type of stop will prevent spin. I drilled a series of $\frac{3}{8}$ -in.-dia. holes in my auxiliary table, into which I simply drop a doweled stop. It works quickly for pieces of almost any size and shape. Just be sure that the work is against the stop when you begin. A fence will give the same protection, but it sometimes is not as quick or convenient to use, especially with odd-shaped pieces.

Drill-bit climb is another danger. This occurs as a large bit breaks through the back surface of the wood and jams in the hole,



T-tracks add versatility. Tracks in the table and fence make it easy to secure the fence, end stop, and various hold-downs.



Sanding drums are good for curved work. The cutout in this table allows the drum to contact the workpiece properly.

Other drilling techniques

Make a V-block for round stock. Use a hold-down for even more stability and accuracy.



Tilt the table for end-grain and angled holes. To drill into the ends of long pieces, turn the table to 90° and use the auxiliary table's fence, stops, and hold-downs to secure the work (above). For angled holes such as through-mortises in the top of a stool (right), tilt the table and use the fence as a work stop.

creating a reverse screw action. This causes the work to climb the drill bit until something stops it. If the workpiece clears the stop or fence, climb quickly can lead to spin. The cure is to clamp the piece to the tabletop. I prefer to use a small toggle clamp mounted to the T-tracks in my auxiliary table. I also use these clamps on special drilling jigs that I make for repetitive tasks. They can be mounted on tall wood blocks for clamping thicker or taller items.

Drilling clean, accurate holes

Experience will give you a feel for the proper feed rate, but as with any machine, don't push too hard. Let the bit cut, pulling on the crank handle just enough to keep chips coming steadily.

For deep holes and also for certain bits (such as Forstners), it is important to clear chips often. Do this by lifting the bit until it almost, but not quite, leaves the hole. Pulling the bit all the way out of the hole can tear the top edge on the way out or in.

For the ultimate accuracy in locating a hole, use careful layout with a sharp pencil, and then use a center punch to place a divot where the crosshairs meet. On most bits, the tip will gravitate to the center of the divot. When this happens, to avoid bending the bit or drilling a crooked hole, allow the workpiece to move slightly into a better position.

Use a V-block to drill round stock—A simple V-trough cut into a piece of heavy stock will keep round stock from rolling while being drilled.

Angle the table or make a jig for angled holes—If you angle the table, the small scale will offer a fairly accurate reading. If a precise angle is needed, make a setup block on the tablesaw at the exact angle, and use it to set the drill-press table to the desired angle with the drill bit. Forstner bits work best for drilling angled holes, because the cutting rim will keep the bit from wandering.

Pivot the table for end-grain drilling—To drill into the end grain of a long workpiece, such as when drilling bedpost sections,



pivot the table to 90° and use hold-downs to attach the workpiece to the table. Twist bits work better than brad-point or Forstner bits for drilling into end grain.

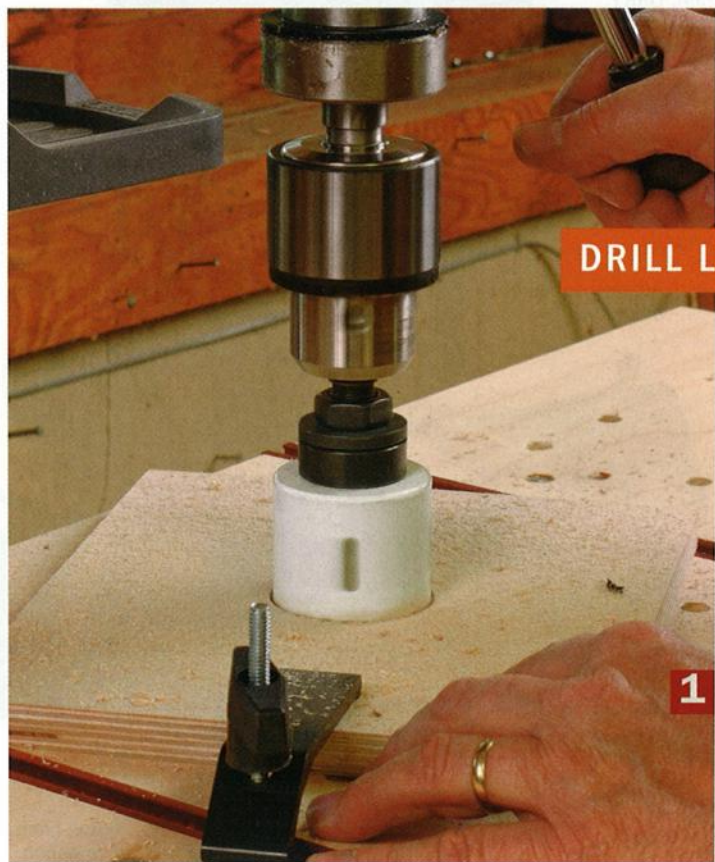
Use the fence when drilling mortises—To bore the sequential holes that rough out a mortise, use a Forstner bit and overlap each successive hole by about 25% (see photo, p. 48). This leaves little to clean out with a chisel, creating a quick, accurate mortise without the need for a hollow-chisel mortiser.

Use hole saws for large diameters—To cut a large hole easily in materials up to 1½ in. thick, use a hole saw. Hole saws are pressed steel cups with saw teeth cut into the rim. They are available in many sizes, starting at ¾ in. dia. and increasing in small increments to over 5 in., and they mount on an interchangeable arbor with a centering drill bit. The assembly chucks into the drill press. Use slower speeds for these tools.

The trick for plug cutters—Plug cutters work great for cutting edge-grain plugs that cover screw holes. There are basically two types: One cuts a tapered plug and the other cuts a straight plug. The best way to cut plugs is to use stock that is thicker than the plug length, cut to the depth of the plug cutter, and then make a resawing cut on the bandsaw to free the plugs.

Drill presses are great for sanding

Sanding drums work well for edge-sanding, especially when the piece has an irregular or curved edge. For a smooth, fair curve, use as large a drum as possible, and keep the pressure light and the piece moving steadily. Drums are available in at least a couple of variations, one that takes cylindrical sanding sleeves and another that accepts flat sandpaper. □



DRILL LARGE, CLEAN HOLES WITH A HOLE SAW



Drill from both sides. With the workpiece secured safely, drill partway through the first side (1) so that the center bit pops through the back. Then flip the stock and find the center (2). Finally, finish the cut (3) and remove the plug. Because it is only half-buried in the saw, the plug is knocked free much more easily.

An essential set of bits

For most drilling tasks in wood, use brad-point bits. They have a center spur for accurate location, outer spurs for cleanly cutting the wood fibers at the rim of the hole, and helical flutes that quickly evacuate waste, allowing deep holes without constantly backing out the bit to clear waste. They also cut a relatively flat bottom.

With their straight leading edges and knife-edge or toothed cutting rim, Forstner bits cut even cleaner holes, with flatter bottoms, than brad-point bits. Because they register off their rim, these unique bits can enter angled surfaces and turned work cleanly and accurately. The only drawback is that they must be raised frequently to clear chips.

Twist bits are inexpensive workhorses that work well for boring end-grain holes and, when sharp, cut clean enough for many wood-working needs. They will keep a sharp edge when drilling hardwood, composite material, plastic, and soft or ferrous metals. One great feature of a twist bit is that it is relatively easy to sharpen on a bench grinder.

Straight holes aren't ideally suited to traditional wood screws. For better holding power, tapered twist bits also drill the countersink and even can drill a counterbore for plugging.

For countersinking alone, a Weldon-style countersink gives the cleanest results.



BRAD-POINT



FORSTNER



TWIST



TAPERED TWIST



COUNTERSINK

Master the Mortiser

Simple tips for sharp chisels, precise setups, and clean cuts

BY ROLAND JOHNSON

A mortiser, also called a hollow-chisel mortiser or mortising machine, can cut a perfect mortise in well under a minute. Benchtop models are most common, although larger, freestanding machines also are available.

The key words there are “can cut.” Mortisers define the word finicky. If yours isn’t set up and used correctly, you’ll wonder why you bought one.

Fortunately, mortiser-induced headaches can be treated with relative ease. Simply follow the steps outlined here, and you’ll find that quick, clean, and accurate mortises become the norm, not the exception.

A sharp chisel and bit are a must

A mortiser won’t work effectively when the bit and chisel are dull, so keep both parts sharpened (see photos, facing page). No need for a lot of tools, just a chainsaw file, a round and a flat slip stone, a little sandpaper, an abrasive pad, and some honing oil. Don’t expect a brand-new bit and chisel to be adequately sharp. Almost all I’ve seen needed extra attention out of the box.

Hone the outside faces of the chisel—I begin sharpening by honing the four outside faces of the chisel. To ensure an adequately flat honing surface, I use spray adhesive to mount P400- and P800-grit sandpaper to a granite

KEYS TO SUCCESS

Mortisers require extra attention, but the payoff makes it all worthwhile. Don’t ignore any of these steps.

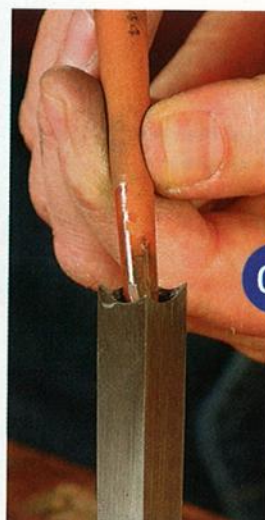


Cutters need sharpening

Like any cutting tool, a mortising chisel and bit must be sharp to work well. A few minutes spent sharpening pays many dividends.



Smooth the outside surfaces of the chisel. A chisel with rough outside faces can't be sharpened and won't be easy to plunge and retract. Use fine sandpaper on a flat surface to smooth all four sides.



OR



Hone the bevels. A little work with a round slip stone (left) or a special, cone-shaped, diamond-coated abrasive (right) produces fresh, sharp edges that ensure a cleaner cut. Use a flat slip stone to remove the burr that results.

plate. A piece of plate glass glued to $\frac{3}{4}$ -in.-thick hardwood plywood also makes a good flat surface.

To reduce clogging, I spend time tuning up the bore. The smoother the bore, the easier it is for chips to slide up the auger bit. I use a chainsaw file to remove any internal burrs or machining grooves. A small, round, tapered slip stone works well for cleaning up the ejection slot.

Hone the bevels—A round slip stone is all that's needed to hone the bevels. Keep in mind that not all mortiser chisels have the same bevel angle. Clisco, a British manufacturer, and Asian and Japanese sourced chisels use a 60° bevel angle, while Forest City, a U.S. maker, uses a 45° bevel.

With the shank of the chisel secured in a vise, place the stone flat against a bevel and work it back and forth with a light touch. Be sure to wet the stone first with a few drops of honing oil. To avoid creating a groove, keep the stone moving from side to side along the bevel and don't stay in one spot for more than a few strokes. Try to remove about the same amount of material from each bevel.

If you prefer a process that's somewhat less fussy, there is a special cone-shaped tool (Mortise Chisel Sharpening Set; \$30, rockler.com) that allows you to sharpen all four 60° bevels at once. If the chisel has a 45° bevel, tilt the cone and sharpen only a portion of the bevel at a time.

Honing the bevels will produce a burr along the outside edge of the chisel. To remove it, hold a flat slip stone flat against the outside face of the chisel and drag the stone lightly toward you.

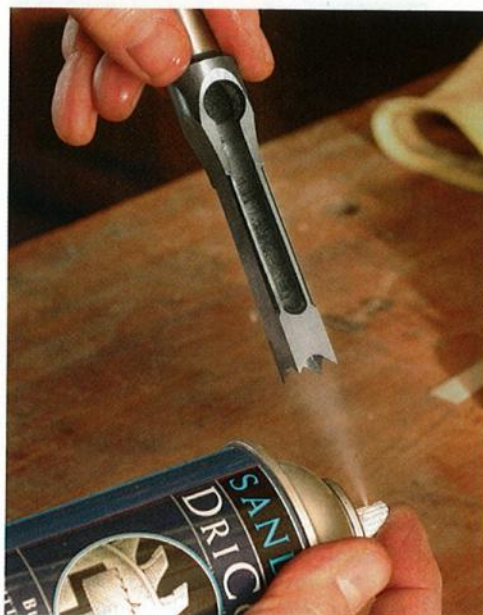
Sharpen the bit—Depending on the manufacturer, the auger-style drill bits for mortiser chisels are either a single spur/flute brad point or a double spur/flute without a centering point. I find that the single spur/flute with its higher-helix flute evacuates chips faster than the double-flute bits. But any type you use must be sharp and burr-free.

In an auger-style drill bit, all the cutting gets done in just two places: at the spurs and at the flutes. So that's where



Sharpen the bit.

Use a flat slip stone to hone the bit in two places: the spur and the cutting edge. If your bit has a centerpoint (not all do), hone each of the three facets of the point, too.



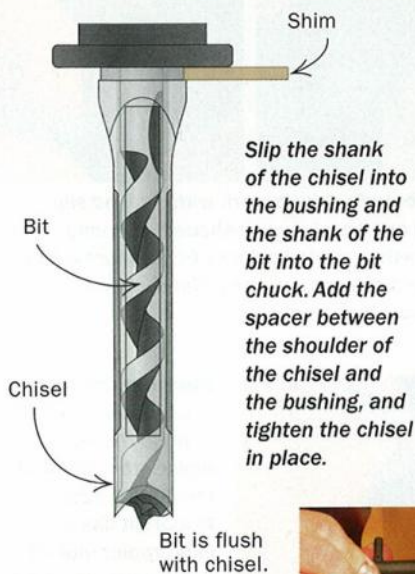
Add some

lubricant. To help reduce friction during cuts, spray both the chisel and bit with dry lubricant after sharpening. Later on, when cutting mortises, an occasional squirt of lubricant on the chisel and bit will fight friction.

Set the right gap

A sharp chisel and bit are not the end of the story. The two parts must be installed correctly to minimize friction and maximize chip removal.

1 TIGHTEN THE CHISEL IN THE BUSHING

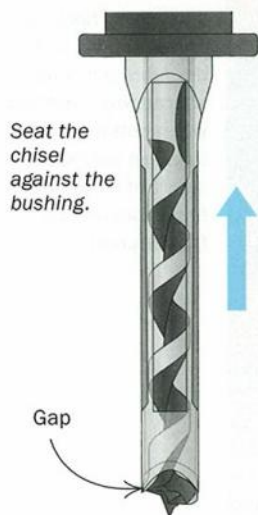


2 TIGHTEN THE BIT IN THE CHUCK

While holding the spur of the bit about flush with the points of the chisel, tighten the shank of the bit in the drill chuck.



3 NOW READJUST THE CHISEL



Remove the spacer and raise the chisel until it butts against the bushing. A squaring board ensures that the chisel is square to the fence. Tighten the locking knob.



you need to sharpen. If the bit has a brad point, I usually sharpen the point, too. The machining process at the factory sometimes leaves ridges or burrs at the transition area between the spurs and flutes. Use a slip stone to smooth any you find. After that, polish the flutes with a medium-grit abrasive pad to create a slick route for the chips to follow.

Install the chisel and bit correctly

The installation of the chisel/bit in the mortiser should follow a precise sequence. If you do it properly, the chips will eject easily and the hole will be square to the workpiece.

Determine the gap—

When installing the chisel and bit, it's important to have

the proper gap between the chisel bevels and the end of the bit. I vary the gap based on the size of the chisel and the material. Softwood typically produces large chips that can clog the chisel quickly. Large mortise chisels and bits also make large chips, even in hardwood. I like to leave a $\frac{1}{16}$ -in. to $\frac{3}{32}$ -in. gap when using small ($\frac{1}{4}$ in. and $\frac{5}{16}$ in.) and medium ($\frac{3}{8}$ in.) bits in hardwood. A little more clearance, about $\frac{3}{32}$ in. to $\frac{1}{8}$ in., is adequate for small and medium bits in softwood. For large bits ($\frac{1}{2}$ in. and larger) in hardwood and softwood, a full $\frac{1}{8}$ -in. gap works best. These clearances aren't carved in stone, so if you find the going tough or your chisel plugging frequently, try increasing the gap between the chisel and bit.

Set the gap—Knowing the gap that's needed, you can go ahead and install the bit and chisel. Be aware that the points on the chisel are very sharp, so use care. I usually wear a leather glove on the hand supporting the chisel and bit.

First, rip a piece of scrap stock to the thickness of the intended gap to use as a spacer. Then place a short length of board on the mortiser table to forestall any damage to the points of the chisel or the cutting flutes on the bit should either be dropped.

Insert the bit into the chisel. Then slip the shank of the bit into the bit chuck and the shank of the chisel into the mounting bushing. (Some machines require a sleeve sized to fit the chisel shank.) At the same time, place the spacer between the shank of the chisel and the bushing. Then tighten the chisel. After aligning the spur of the bit with the chisel points, tighten the bit.

To complete the gap-setting procedure, remove the spacer and raise the chisel until the shoulder is seated tight to the bushing. Tighten the chisel, and the offset will be correct.

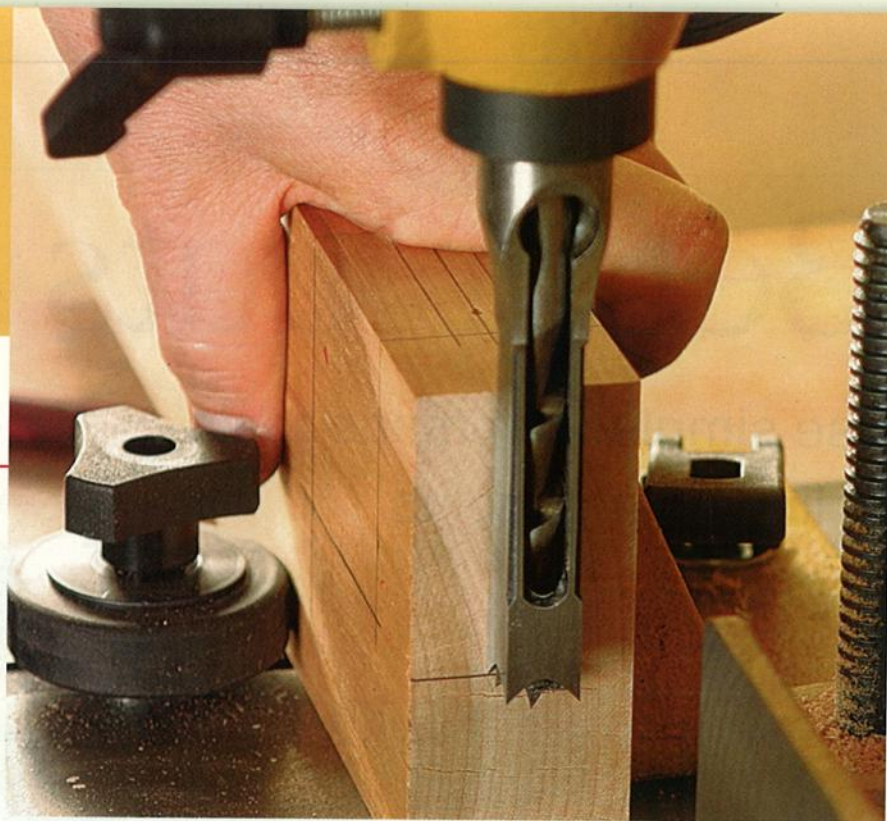
The chisel must be parallel to the fence—Slip a flat piece of wood—I call it a squaring board—between the fence and the chisel. Next, loosen the fence and chisel and, keeping its shoulder

Start cutting mortises

With the chisel/bit sharpened and installed, the general setup procedure is over. Now make the final machine adjustments for the mortise you want and follow a specific cutting sequence.

1 SET THE MORTISE DEPTH

After marking the mortise depth on the end of the workpiece, lower the chisel and bit to the marked line and set the depth stop on the machine.



tight to the mortise-head, rotate the chisel and pull the fence forward until the chisel sits flat against the board. Then tighten the chisel.

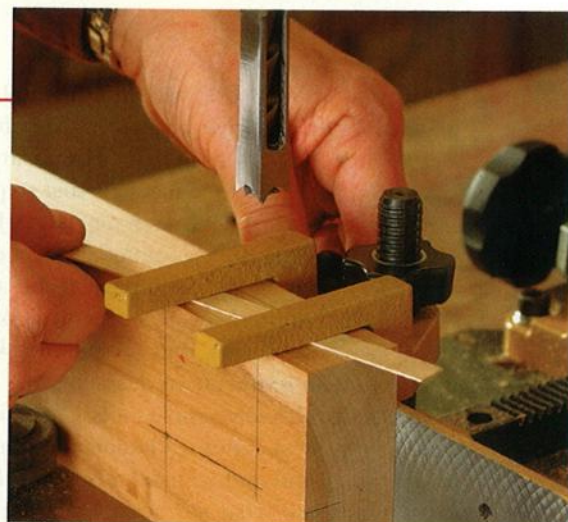
Square the chisel to the table—Make sure the centerline of the chisel is square to the table in two directions; front to back and side to side. Use a square to do the checking. Don't panic if all's not well. Most mortisers have the mortising head and support column mounted to the table with bolts. It's a simple matter to loosen those bolts and shim (I use automotive alignment shims) the appropriate side of the column base to get the chisel square to the table.

Square the fence to the table—When the fence isn't square to the table, the mortise won't be square either. Check it with a square. If it's off more than say, 0.005 in. over 3 in., you'll need to shim the fence bracket where it attaches to the base or add a wooden fence that can be shimmed or beveled to square.

Hold-downs keep the workpiece on the table—Position the hold-down so that there is just enough clearance to allow the workpiece to slide under the hold-down without binding. I keep a 1/64-in.-thick strip of stock handy as a spacer.

2 ADJUST THE HOLD-DOWN

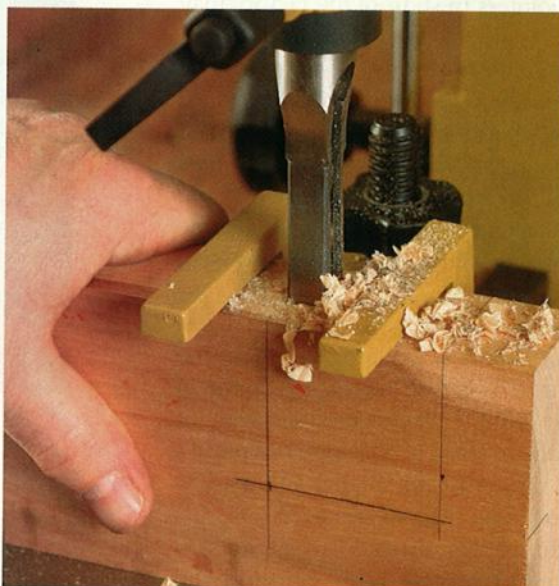
A thin, wood spacer creates a slight clearance between the top of the workpiece and the hold-down, making it easy to slide the workpiece sideways.



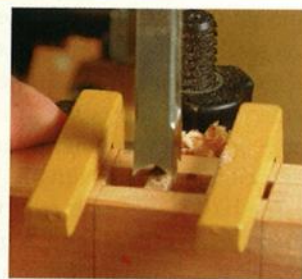
Avoid overlapping cuts

In the first cut by a bit and chisel, all four faces of the chisel will get equal support, so the bit is sure to stay square to the table throughout the cut. But if the next cut overlaps the first so that one side is unsupported, the chisel will tend to bend slightly toward that unsupported side. That causes the outside of the bit to rub against the inside of the chisel, which leads to friction, heat, and noise.

To avoid the overlap problem, make a pair of cuts, one on each end of the mortise. Then make a series of unconnected cuts to begin to remove the waste stock in between the ends. Leave a little less than a bit's width between these cuts. That way, the chisel is always fully supported. After that, go back and make cuts as needed to clean up the mortise. □



3 CUT EACH END OF THE MORTISE FIRST



Make two cuts, one at each end of the mortise (left). Then make a series of cuts, leaving a web of wood in between each cut. Last, make cuts (above) to clean out the webs.

Better Cuts on Your

Use simple shopmade tools to line up the tables and knives

BY JOHN WHITE

If you want to work with rough lumber—which will save you money and give you access to better woods—you need a jointer. No other tool can flatten and straighten warped boards. But an out-of-tune machine that snipes the ends of boards or mills curves into stock isn't of much use. Because of wear, damage, or imperfect castings, jointers may become misaligned over time. Fortunately, most machines can be adjusted without a lot of specialized equipment or mechanical skills. And while you're at it, consider replacing dull knives, a task many woodworkers attempt only in moments of desperation.

Jointers are relatively simple tools. The infeed and outfeed tables flank a cylindrical cutterhead containing three knives. The tables on most small and midsize jointers move along sloped dovetailed ways, which are wear surfaces. Over the years the tables may begin to droop. Occasionally, jointers fresh from the factory may exhibit these bad traits, too.

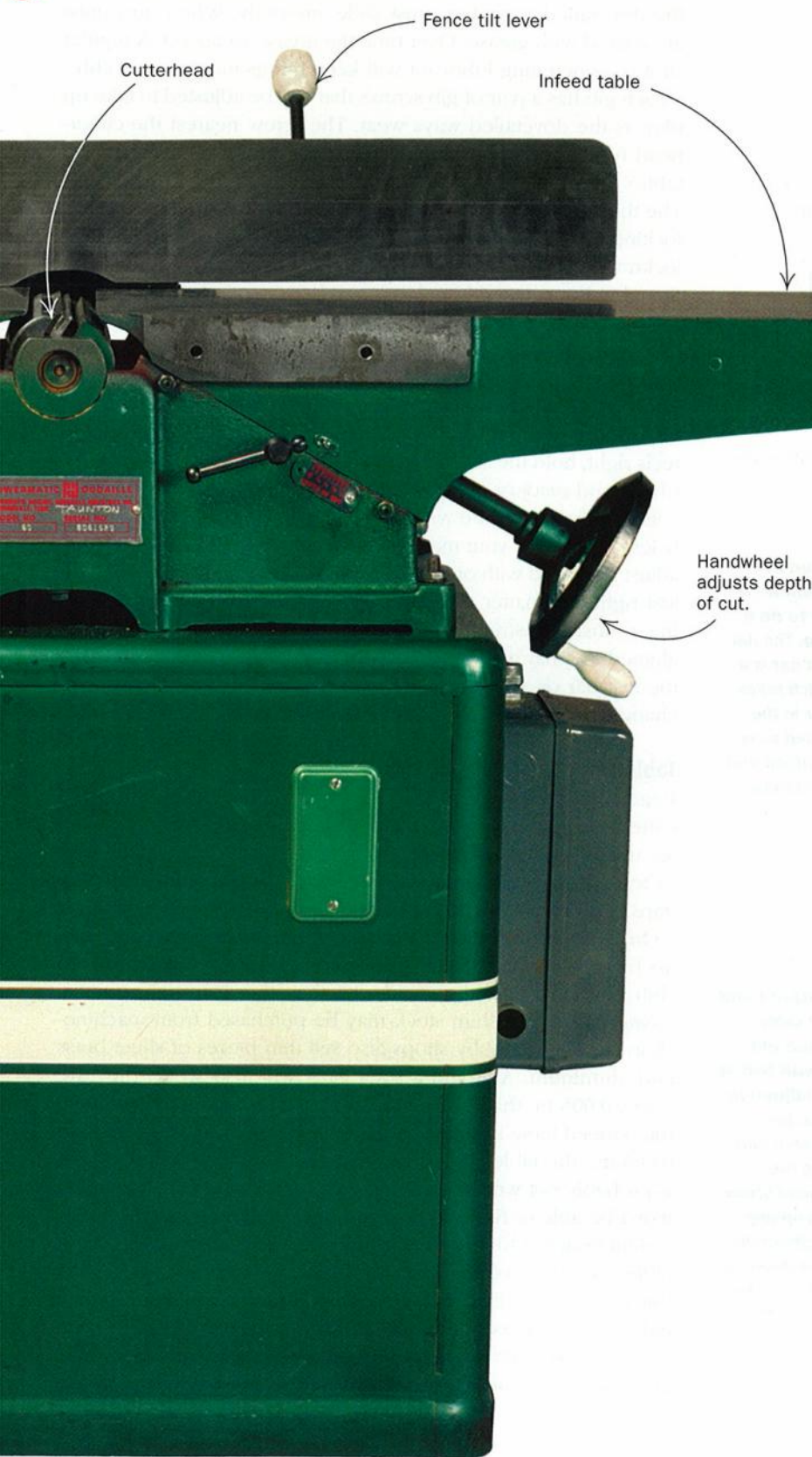
The infeed table and fence guide the stock as it crosses the cutterhead. The outfeed table picks up the freshly jointed surface and guides and supports the stock as the pass is completed. The jointed surface is only as straight as the path the wood takes across the cutterhead. If the tables slope, the wood follows the same path. If the tables are misaligned, stock may have a snipe (a deeper cut) or a hump (an uncut section) at the end of the cut or a curve along its length.

The basic tools required for a tune-up are a set of feeler gauges, a small try-square, and a good, short straightedge such as the blade of a combination square. A 6-in. dial caliper may come in handy for gauging shim stock, but the job can be done without one. To check the tables for flatness, you'll need a long machinist's straightedge or a test bar (for directions on making and using a test bar, see p. 61) to span the length of both tables.

Unplug the tool before starting. It's also not a bad idea to tape the edges of the knives to protect both you and the



Jointer



FOUR-STEP PROGRAM



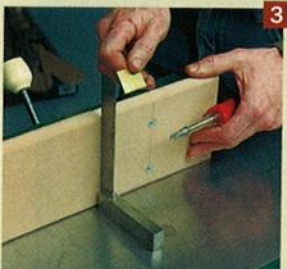
1 ADJUST THE GIBS

Gibs are located inside the dovetailed ways and do not have to be removed (shown here only for clarity). To ensure the tables move smoothly, tighten the gib screws to remove excessive play.



2 LEVEL THE TABLES

Use a straightedge (commercial or shopmade) to check that tables are in the same plane. Metal shims can be inserted along the dovetailed ways to correct for tilt.



3 SQUARE THE FENCE

If the cast-iron fence is warped, attach a piece of plywood or MDF to the fence and shim it flat and square.



4 SET THE KNIVES

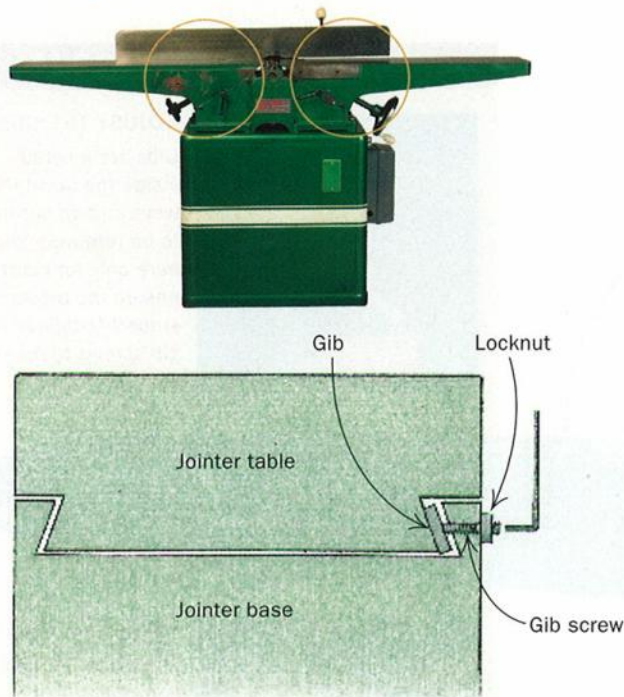
Knives must be parallel to the tables and set to the correct height. Shopmade magnetic holders can assist with the installation.

Online Extra

To watch the author tune up a jointer as outlined in this article, go to FineWoodworking.com/tuneup.

ADJUSTING THE GIBS

Over time the dovetailed ways may wear and cause one or both tables to go out of alignment. Tightening the gib screws removes slack and may correct the problem.



You need not disassemble a jointer to do a tune-up. The narrow, flat bar is a gib, which takes up wear in the dovetailed ways of the infeed and outfeed tables.



The outfeed and infeed tables have one gib each with two or three adjusting screws. Loosen the locknut and snug up the Allen-head screw to take up any slop. Tighten the screw nearest the cutterhead a tad more than the bottom one.

knives. It's all too easy to brush a finger or tool across their exposed edges.

Remove excess play from the tables

Each table has an adjustable gib to take up play as the dovetailed ways wear (see drawing, left). Loose gibs can cause the tables to be out of line with one another. The gibs bear firmly against the dovetailed ways but must slide smoothly. When new, gibs are coated with grease. Over time the grease wears off. A regular shot of penetrating lubricant will keep things moving smoothly.

Each gib has a pair of gib screws that can be adjusted to take up play as the dovetailed ways wear. The screw nearest the cutterhead has to resist the lifting force caused by the weight of the table's overhang, and it should be tighter than the lower screw. The third screw on many machines has a handle that serves as a locking mechanism. Start by backing off the locking lever and the locknuts on the gib screws. Then tighten all screws equally until the table is just locked in place, then back off each of the screws about a quarter-turn. At this point the tables should move with little resistance. Now slowly turn the gib screw nearest the cutterhead while moving the table up and down using the adjusting knob or lever. When the screw is properly adjusted, moving the table should require only moderate effort. Once this adjustment feels right, hold the screw against turning and tighten the locknut. Check and readjust, if needed.

Repeat the procedure with the lower gib screw, but apply slightly less pressure. If your machine has a center screw with a locknut, adjust it last and with only light pressure. Getting the gibs adjusted just right is a matter of both technique and feel, much like tuning a musical instrument. If you're lucky, the tables will now be aligned in a flat plane within 0.005 in. or less. Check them using the test bar or a long straightedge. If you have an older jointer, chances are that more will need to be done.

Tables can be shimmed level

Begin by removing the fence. Place a short straightedge across the cutterhead gap and lift both tables until they clear the knives and are in the same plane. Lock them in place. Lay a long straightedge or test bar across both tables. Use feeler gauges to measure any gaps (see left photo, facing page).

On an older machine it's a good bet that the tables are sagging. To fix it, place thin metal shims along the dovetailed ways to shift one table into alignment with the other (see right photos, facing page). Flat shim stock may be purchased from machine-shop suppliers. Hobby shops also sell thin pieces of sheet brass and aluminum. Aluminum soda cans will also work; they are about 0.005 in. thick. Use a feeler gauge to measure how much the outfeed table is out at the far end. If you measure more than 0.005 in., the table should be shimmed. Anything less than that is probably not worth bothering with for the simple fact that you won't be able to find shim stock thin enough to make the fix.

Shimming is a trial-and-error process. As a rough guide, if your table is out by 0.006 in., start by cutting two pieces of 0.002-in.-thick shim stock that measures about 1 in. by 2 in. and apply a light coat of grease on them. To place the shims, back off the outfeed table's gib screws a turn, lift up on the low edge of the table, and slip the shims into place on the lower end of the

LEVELING THE TABLES WITH A SHOPMADE TEST BAR



I had hoped that a builder's level would be adequate for tuning up a jointer's tables, but I found it unfit for the task. Machinists use precision

straightedges that are meant for just such applications, but at \$200 for a 4-ft. version, woodworkers would have a hard time justifying such a purchase.

In search of a shopmade solution, I adapted a machinist's technique for creating precision squares. Technically, the resulting tool isn't a straightedge, because only the three slightly proud screws along one edge are in line. It is more properly called a test bar.

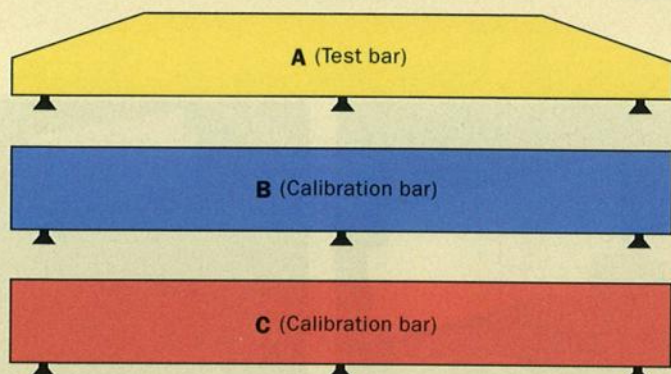
You'll need three bars of the same length and spacing of screws. The screws are adjusted by laying pairs of the bars flat with the screw heads

touching. With each pairing, the height of the center screws is adjusted until all three sets of screws touch without either a gap or rocking. This process is repeated several times with different pairings of the bars until all three mate in any combination. When this is achieved, the laws of geometry dictate that the screw heads on each bar lie in a perfectly straight line.

MAKING A TEST BAR

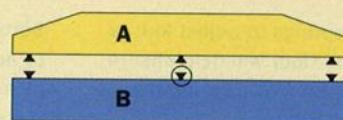
1. Rip three pieces of $\frac{3}{4}$ -in. MDF, each about 5 in. wide and as long as your jointer.

2. Slope the ends of one board (A) to reduce its weight; it will become the test bar.

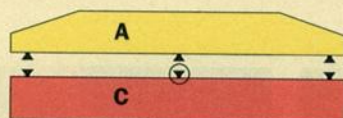


3. Next, predrill the edges of each board and attach three fine-thread, $1\frac{1}{4}$ -in. drywall screws. Place two screws at the far end and one near the center of each board. File the head of each screw to remove any burrs. Adjust them all so that $\frac{1}{4}$ in. of screw is exposed.

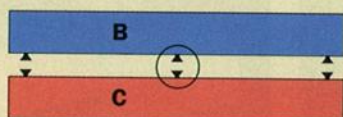
ADJUSTING A TEST BAR



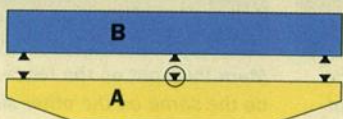
1. Align board A against board B. Adjust only the center screw on board B until all six screws touch.



2. Place board C against board A. Adjust only the center screw of board C until all six screws touch.



3. Place board B against board C. Adjust both center screws an equal amount (in or out) until all six screws touch.

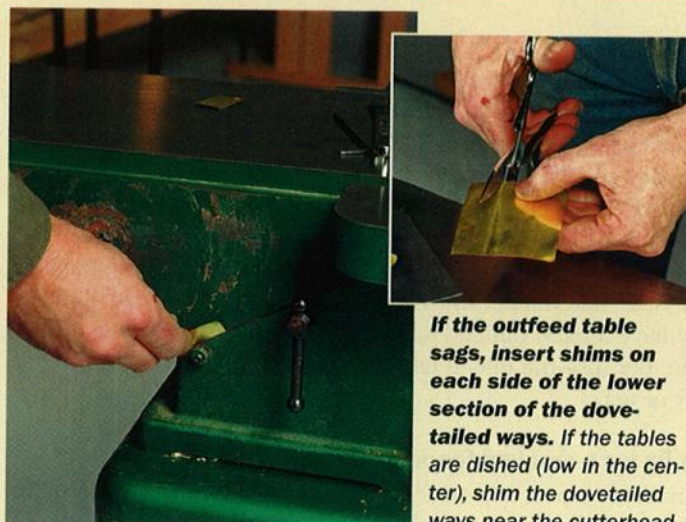


4. Again place board B against board A, but this time adjust only the center screw of board A. Repeat steps 2 to 4 until no more adjustments are needed.

USING A TEST BAR



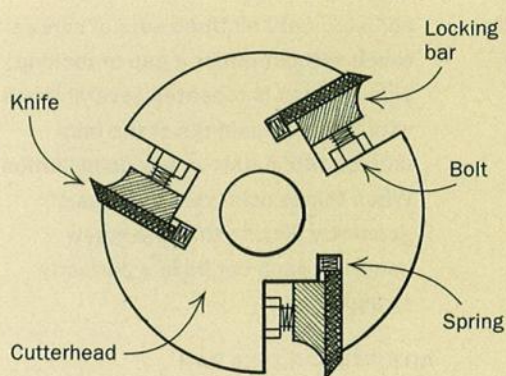
Use the test bar and feeler gauges to check the tables for flatness. Tables may sag over time. New machines, however, may be out of adjustment, too.



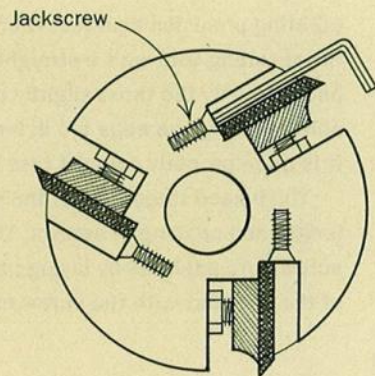
If the outfeed table sags, insert shims on each side of the lower section of the dovetailed ways. If the tables are dished (low in the center), shim the dovetailed ways near the cutterhead.

SETTING THE KNIVES

Types of cutterheads



Some cutterheads use springs to adjust knives up or down. A clean shop floor will help ensure that you can track down an AWOL spring that will inevitably roll off the table.



Some cutterheads use jackscrews to adjust knives up or down. The jackscrews fit into holes bored into the cutterhead slot.



Replaceable, double-sided knives make life easy. Aftermarket kits such as this one made by Esta are available to fit most jointers.

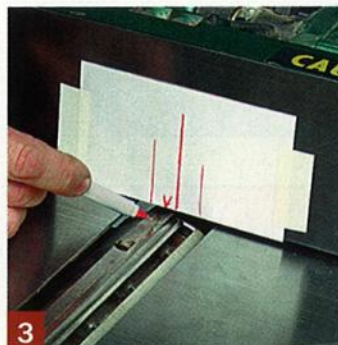
REMOVING THE KNIVES



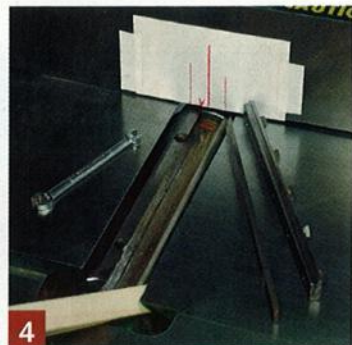
1 First find top dead center of the cutterhead: Slide a flat block of wood with a projecting screw head until the screw butts up against the cutterhead.



2 Mark this spot on the fence. Then do the same on the other side.



3 Using a ruler, split the distance between the marks to locate top dead center. Place another mark to indicate where the cutterhead slot lines up.



4 Align a knife to top dead center and wedge the cutterhead in place. Loosen the locking bar bolts and replace one knife at a time.

dovetailed ways. Once the shims are in, adjust the gib screws again. Then realign both tables flat to one another and check for flatness using the long test bar or straightedge. The process may have to be repeated a few times.

Jointer tables may be tilted the other way and dished. Follow the same procedure but place shims at the upper ends of the dovetailed ways on the outfeed table. If you notice that the table is twisted, add thicker shims on the low side. Some small jointers may have a fixed outfeed table, and you have to shim the infeed table. Because the infeed table is adjusted frequently, shims may shift or tear.

The fix for a crooked fence

A small crown or dip over the length of the fence is tolerable as long as the fence remains vertical to the tables. A twist or wind, however, will give you fits, because it will cause stock to

rotate as it passes by. To correct the problem, drill holes in the soft, cast-iron fence and attach a piece of cabinet-grade plywood or medium-density fiberboard (MDF) and shim it flat. Once the fence is mounted back on the jointer, square it up and take a test pass with a board that has a flat face. Check the resulting edge with a square, being sure to place the square against the board surface that ran along the fence. Adjust the fence stop as needed to get a square edge on the board.

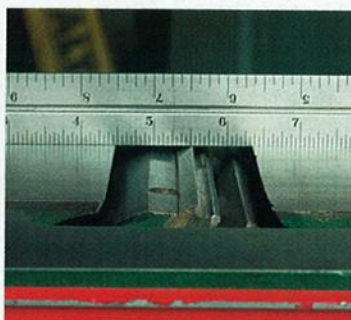
Sometimes you have to replace a jointer's knives

Nobody seems to enjoy replacing jointer knives. That's because it's difficult to keep the knives in alignment when you are tightening the bolts that are threaded into the lock bars (also called gibs). Patience is required, no doubt about it. Magnetic knife holders, either commercially bought or shopmade, can help.

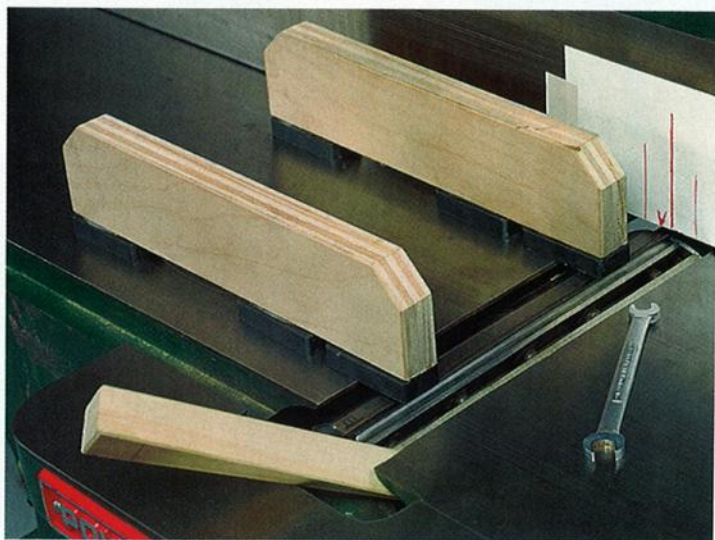
REPLACING THE KNIVES



On many jointers, the outfeed table should be about 0.015 in. above the cutterhead.



On others (see your manual), set the outfeed table so that it is level with a knife (at top dead center) when about $\frac{1}{32}$ in. of metal behind the bevel is exposed.



Bar magnets (available from hardware or electronics stores) glued to a block of wood (do this on a level surface) with silicone adhesive make a decent knife holder/straightedge. Tighten the bolts on the locking bar so that each knife (at top dead center) is level with the outfeed table.

First find top dead center—Before replacing the knives, top dead center (TDC) of the cutterhead must be located (see photos 1 through 4). TDC is a point directly above the centerline of the cutterhead. When a knife's edge is at TDC, it is at the high point of its arc, the ideal spot to align it level with the outfeed table.

Remove one knife at a time—Rotate the cutterhead until the edge of one knife is at TDC. Lock the cutterhead in place with a softwood wedge against the infeed table. Remove the knife and clean all of the parts, including the slot, of sawdust and pitch. Smooth the face of the locking bar and bolts with emery cloth or a stone to remove burrs, which may cause the knife to creep when tightened. It's important to remove and replace only one knife at a time to avoid distorting the cutterhead.

I do a lot of sharpening, but jointer knives take a lot of time and equipment to do well. I keep an extra set of knives on hand and send the old ones out to be resharpened after swapping them.

Adjust the knives—Cutterheads and knives come in various configurations (see drawings, facing page). Some cutterheads have springs beneath the knives. Better machines may have jackscrews in place of springs. Consider yourself lucky if you own a jointer with a cutterhead that accepts disposable knives, such as those made by Esta (estausa.com). With these, no depth adjustments need be made after the initial setup (see top photo, facing page).

Jackscrews allow the height of knives to be adjusted easily. Each knife rests on a pair of jackscrews that are set inside a hole in the cutterhead slot. Wedge the cutterhead at TDC, remove the first knife, install a fresh one and snug up the bolts, leaving just enough slack for the knife to be moved without slop. Unless the owner's manual says differently, adjust the jackscrews until about $\frac{1}{32}$ in. of the back of the knife (measured below the bevel) protrudes above the cutterhead slot (see top photo, near left).

Next, lay a short straightedge on the fence side of the outfeed table and extend it over the knife. Adjust the outfeed table until the knife just grazes the straightedge. Then place the straightedge along the rabbeting side of the outfeed table and adjust the other jackscrew, if necessary, to bring the knife into line. Rock the cutterhead back and forth; the knife should just kiss the straightedge. Tighten the bolts in progression to avoid warping the cutterhead, and check the setting again. Repeat for the other knives without changing the outfeed-table height.

On some machines the back edge of the cutterhead slot may be machined away so you cannot accurately measure from the back bevel of the knife to set the cutterhead height relative to the outfeed table. Instead, you have to set the outfeed table with a straightedge and feeler gauge 0.015 in. above the cutterhead (see top photo, far left). Make the measurement along the smooth surface of the cutterhead midway between slots.

On a cutterhead with springs instead of jackscrews, align a knife to TDC and wedge the cutterhead in place. Replace the dull knife, pressing it down against the springs. Snug up the bolts, leaving enough slack so that the knife may be moved but without slop. Place a pair of shopmade or commercial magnetic knife holders over the knife, which will lift it to the height of the outfeed table (see bottom photo at left). Lower the outfeed table until the back edge of the bevel on the knife drops below the outside surface of the cutterhead, then raise the table until the bevel and about $\frac{1}{32}$ in. of the back edge of the knife protrude above the cutterhead. (Be sure to check your owner's manual on this matter.) Tighten the bolts in progression. Repeat for the other knives.

Make a test cut—Before powering up the machine, double-check all of the bolts and screws that were adjusted. Then be sure to remove all tools from the machine. Spin the cutterhead one more time by hand to make sure that it moves freely and that no stray tools or parts have fallen into the slots.

Set the machine for a shallow pass and joint the edge of a reasonably straight board. If the end of the cut is deeper (snipe), raise the outfeed table slightly. If there's a hump of excess material left behind, lower the outfeed table. A lot of chatter marks mean one knife is slightly higher than the rest. Recheck the height of the knives. Aside from occasional knife replacement, the full tune-up may not have to be repeated for years and years to come. □

John White is the former shop manager for Fine Woodworking.



BOSCH
1615EVS
CAUTION: INSTRUCTIONS FOR SAFE OPERATION ARE
WHEN SERVICE INSTRUCTIONS NOT REQUIRED
REPLACEMENT PARTS
DOUBLE INSULATED

POWER TOOLS]

Whether you make furniture for a living or are just getting started at woodworking, you are bound to own power tools. From drills to sanders, we'd be lost without their handheld power, precision, and performance. Some simple maintenance will keep you in the shop and not going out to buy replacement tools.

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A Closer Look at



Universal Motors

What to do when your power tools lose power

BY BARRY WIXEY

Universal electric motors are used to power portable power tools as well as shop vacuums and small stationary and benchtop tools. Compared with the induction electric motors found on large stationary tools, universal motors tend to be lighter and less expensive. They also are noisier, run faster, and wear out quicker, but with some routine maintenance, you can keep them humming.

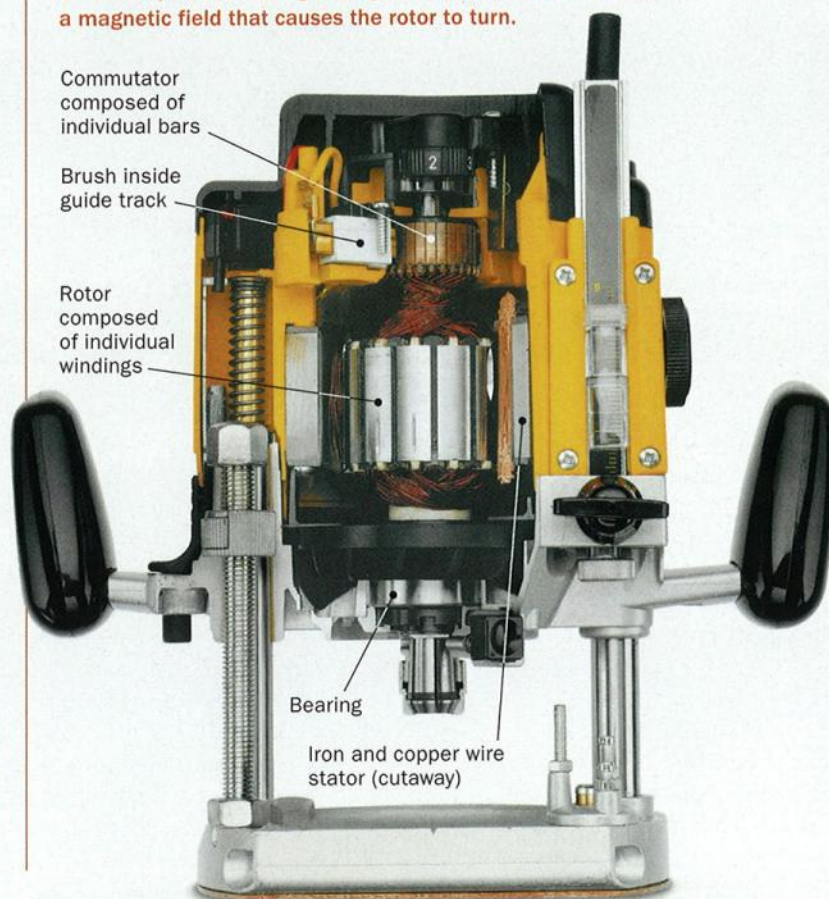
How universal motors work

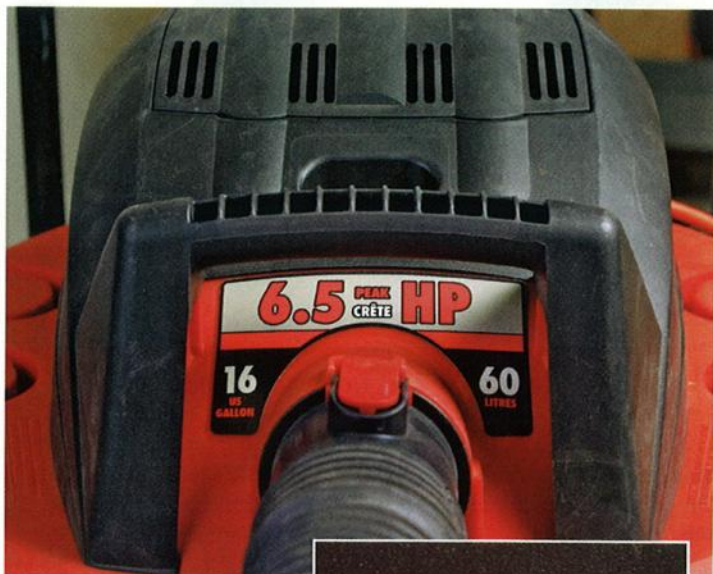
Universal motors consist of a rotor surrounded by a stator, both made from copper wire and iron. The rotor contains a number of separate coils or windings of copper wire, and the ends of these windings are attached to the bars on the commutator. Electrical power is fed to the rotor via this commutator and two carbon brushes, and to the stator through conventional wires.

When current flows through the stator, it becomes an electromagnet. When power is applied

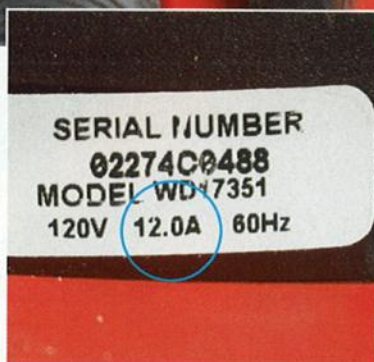
THE PARTS OF A UNIVERSAL MOTOR

Electrical power coursing through the rotor and stator creates a magnetic field that causes the rotor to turn.





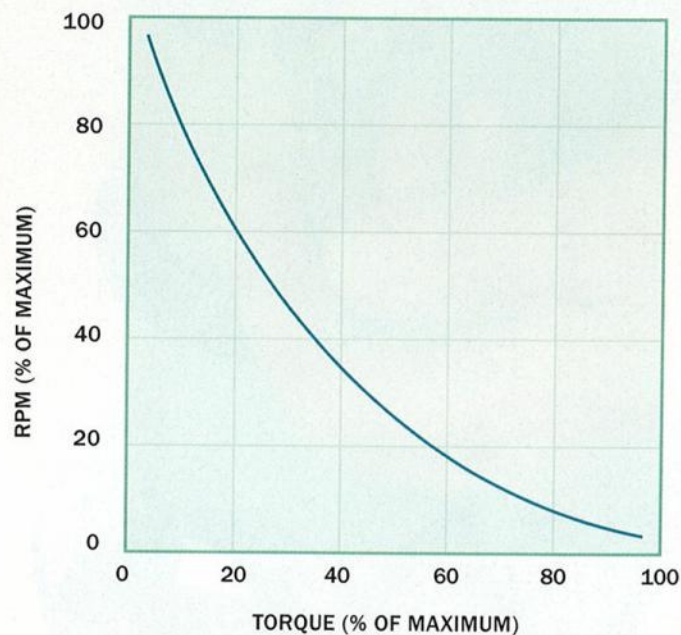
Big claim up front, small print at the back. This shop vacuum states in large print that it can produce 6.5 hp at peak power. The small label on the rear states that it only consumes 12 amps. Assuming average motor efficiency, the maximum continuous horsepower is only around 1.35 hp when drawing 12 amps.



UNDERSTANDING POWER

Universal motors without electronic speed control will slow down as the load, or torque, increases. Eventually, the motor stalls at near-maximum torque.

UNIVERSAL MOTOR CURVE



to a bar on the commutator through the brushes, that particular winding causes the rotor to become an electromagnet, too, whose north and south poles are nearly aligned with the north and south poles of the stator. The north pole of the stator repels the north pole of the rotor, which causes the rotor to rotate. This in turn lines up a new set of bars and brushes, which move the magnetic fields back to their previous positions, and the poles are repelled over and over again, keeping the motor turning.

The speed of a universal motor is controlled in two different ways. Cheaper tools use a rheostat (like a light dimmer) to reduce the voltage supplied to the motor and hence to slow it down. This system will not maintain the motor's speed when it is under load and is likely to be found on such items as inexpensive drills.

Some products use a constant motor-feedback system that either measures or calculates the motor speed and adjusts the voltage accordingly to try to maintain that speed. This type of system commonly is found in high-end routers.

What to look for in a motor

Manufacturers test universal motors to determine a specific amount of useful life. This testing usually consists of a mixture of mild use, heavy use, and stalls. It is not uncommon for the minimum life expectancy of upper-end professional tools to be 500 hours or more, whereas the minimum life span of some low-end consumer tools may be less than 100 hours. How do you determine which tool has the better motor?

Peeking through the cooling grills on most power tools allows you to see how many bars there are on the commutator. As a general rule, the greater the number of bars, the greater the life expectancy of the motor. Also examine the size of the contact area between the brush and commutator: The larger the area the better. Most important, check the amp rating of the tool. A higher-rated motor is designed to take heavier use.

Consider amps and watts, not horsepower—Like most people, you probably are confused by the outrageous power claims on some products. I have seen rout-

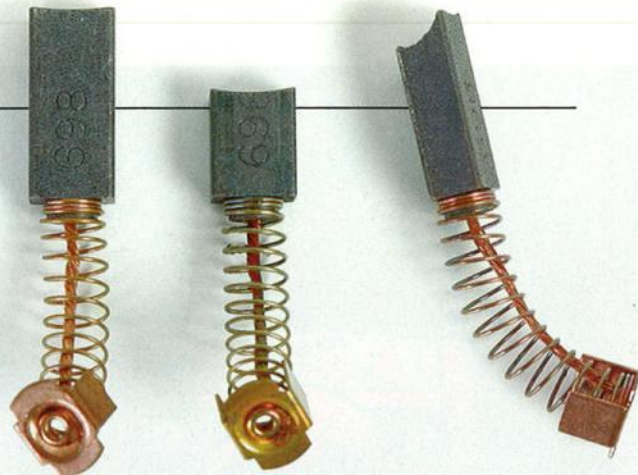
ers rated at 3.5 hp and wet/dry vacuums boasting more than 6 hp.

But the horsepower ratings start to fall apart when you do the math and consider all of the variables. A standard household outlet is rated for 15 amps at 120 volts; $15 \times 120 = 1,800$ watts; and $1 \text{ hp} = 746$ watts, so $1,800 / 746 = 2.41$ hp. To muddy the waters even more, this 2.41-hp rating assumes the motor is 100% efficient. Motor efficiency is the amount of mechanical power out to electrical power in. In universal motors this efficiency is in the neighborhood of 65% to 75% when the motor is near its peak load. So assuming 70% efficiency in the example above, the output could be only 1.7 hp, with the balance of the power going to waste, mostly as heat.

So how can a 120v tool be rated any higher than around 1.7 hp? What you are witnessing here is a rating game reflecting a tool's peak power, not its continuous power. This game was started many years ago by a well-known major tool brand and has been adopted by some other power-tool companies over the years.

MOTOR MAINTENANCE

Periodically remove the plastic caps and pull the carbon brushes out of the motor. Check if they have chipped or worn down below the recommended minimum length.



The good, the bad, and the ugly. The brush on the left is new. The center brush has worn down and should be replaced. The one on the right has cracked and will cause excessive sparking in the motor.



File to fit. The brushes should slide into the housing easily so that the spring can keep the brushes in good contact with the commutator. If the fit is tight, smooth the edges of the brush with a fine file.

When approving a power tool, scientists at Underwriters Laboratories (UL) do not even consider horsepower as a means to rate the power of tools. The only power ratings they use are either amps or watts to measure a tool running continuously without failure. If a power-tool company puts an amp rating or a watt rating on a tool that is UL approved, you can be assured that it can put out that much power continuously. The horsepower claims that a company makes can be derived by any test method the company chooses to adopt. The bottom line: When comparing power between different tools, it is best to look at the amp or watt rating.

Motor life—use and abuse

As mentioned before, no motor is 100% efficient, because the harder you push a motor, the more heat the motor produces. Compounding this is the basic nature of a universal motor. The torque versus rpm curve (see the graph on p. 67) shows that as the torque is increased by forcing a tool to take a bigger or faster cut, the rpm drops until the motor stalls. As the speed

decreases, so does the fan speed and consequently the airflow needed to cool the harder-working motor.

If the temperature of the motor's copper wires gets too high, the varnish insulation can burn off, cause the wires to short out, and even eventually melt the copper.

An occasional stall where the power is removed immediately or the circuit breaker trips will not harm the motor or reduce its life. However, allowing a circular saw with no overload protection to stall repeatedly as you rip that oak beam will gradually raise the internal temperature to burnout levels. It's all about keeping the motor cool.

Maintenance for universal motors

If the air vents and the inside of the motor become packed with sawdust, excessive heat can develop quickly, even if you run a tool below its designed capacity. Dust also can clog the track that the brushes slide in so that the springs can't push the brushes properly against the commutator. This lack of contact causes arcing (sparks between the brushes and

commutator) that can overheat the windings and destroy the commutator. Therefore, your most regular maintenance should be to remove any dust in your power tools with a vacuum.

Even when the brushes are making perfect contact, both they and the commutator will wear away gradually. On most universal motors you will be lucky to get 100 hours out of a set of brushes, but they can be replaced a number of times. Check the brushes regularly and compare their length to that specified when your manual says it is time to replace them.

This information should be helpful the next time you purchase a power tool. Check the motor specifications carefully so you are sure of the real power you are buying, and then take a look at the tool's overall construction. With proper use and regular maintenance, motors will give many years of trouble-free performance. □

Barry Wixey has been a tool designer for nearly 30 years. You can view his creations at wixey.com.

Keep Your Router Running

Routine maintenance and simple repairs

BY JOHN WHITE



In most shops a router gets plenty of hard work, so it's not surprising that an occasional problem can show up. But just because your router has been acting finicky doesn't necessarily mean it's time to replace it. You can often get it back into tip-top shape if you know where the problems are likely to be hiding. And chances are, the fix won't cost you much time or money.

The problems can be distilled into one of three categories: The most common relates to the height-adjustment mechanism. Over time it may become difficult to adjust. Or it does not lock properly, causing the motor to creep out of position.

Second on my list of common problems has to do with the collet. Sometimes it won't grip the shank of the bit tightly enough, causing the bit to slip.

Worn brushes are the third most common problem. When brushes have worn too much, the motor might not start. If the motor does manage to run, it can unexpectedly cut out under load.

Height-adjustment problems

It's not unusual for the height-adjustment mechanism to stick or bind, especially on a plunge router. When that happens, it's difficult to make precise adjustments.

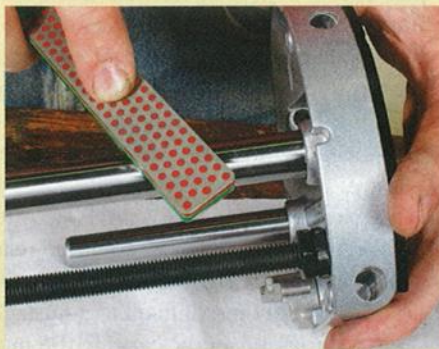
When the height adjustment is not working quite right, the first thing to do is check the sliding components and the lock mechanism. A buildup of grime prevents parts from sliding or meshing properly. And parts that aren't properly lubricated suffer the same problem. The fix here is simple enough. It's just a matter of cleaning and lubricating the

PLUNGE PERK-UP

It takes just a few simple steps to rejuvenate most any plunge router that is suffering from a balky height-adjustment mechanism.



Clean the posts. Remove the springs from the guideposts before cleaning the outside of the posts with WD-40.



Smooth out any burrs. A burr on the guidepost can make for a sticky plunging action, so a little smoothing with a diamond stone could be in order.



Work on the bores. A cleaning stick, made from a piece of paper towel wrapped around a dowel, is used to clean out the holes that accept the guideposts.



Brush on some grease. Give the springs a generous coating of lithium grease before reinstalling them in the guideposts.



parts. Unfortunately, some routers have a complex lock or height-adjustment mechanism that makes disassembly difficult. In this case, first try cleaning and lubing without taking apart the router. Disassemble the machine only if you can't get it to free up.

On a plunge router, first remove the springs from the base unit. Then use a penetrating oil, such as WD-40, and a paper towel or rag wrapped around a rod (a wood dowel works fine) to clean out the holes that accept the two guideposts. Then clean all of the old grease off the springs and wipe down the guideposts.

Use a paper towel or a rag wetted with WD-40 to get into the threads, grooves, gear tracks, and other nooks and crannies of the lock and depth controls of your machine. An old toothbrush also comes in handy here. Go over any moving or sliding parts, looking for burrs, rough spots, binding, or excess wear. Use files, stones, and emery paper to correct any problems you find.

Also, examine the springs, nuts, and washers for burrs and distorted or worn-out parts. Washers especially can get cupped or chewed up, making the controls hard to work and lock handles difficult to tighten. If the router has a rack-and-gear mechanism, use a needle file to clean up any burrs down in the gear teeth that can cause interference.

On a fixed-base router, use a paper towel or rag wetted with WD-40 to clean the barrel of the motor and the inside of the base. Some fixed-base routers have a motor housing that threads into the base. Make it a habit to clean out chips and sawdust that get caught between the base and motor. A thin coat of wax to the sliding surfaces can reduce wear and help extend the life of the parts.

Eventually, these parts can wear to the point that it becomes hard to thread the motor or lock it in place. If you find that's the case, and if the base is metal, the most cost-effective fix is simply to replace the base. Little can be done for plastic routers because typically both the base and the body are worn out.

Now you can reassemble the machine, lubricating as you work along. Shafts and threads that are somewhat protected from sawdust can get a coat of light oil (such as sewing-machine oil) or



FIXED-BASE FIX-UP

A finicky height-adjustment mechanism on a fixed-base router can be smoothed out with a minimum of fuss.

Keep it clean. Wipe down the inside of the base and outside of the motor with penetrating oil, such as WD-40.

lithium grease. On parts that get more exposure to sawdust, such as the guideposts or a sliding motor, it's best to use a stick lubricant or a good wax to make the parts slide smoothly.

Caring for the collet

A typical router bit spins at 25,000 rpm. To prevent slippage, the collet on the router must maintain a viselike grip on the shank of the bit. So it makes sense to keep the collet in good working order.

In time, grime can build up in both the collet nut and the collet, effectively reducing the squeeze on the shank. A collet that isn't properly lubricated can also have less gripping strength.

The nut and collet can also begin to wear or get distorted. And it doesn't take a lot of wear or distortion to cause problems. Indeed, a change of just a couple of thousandths of an inch can prevent the chuck from fully gripping the bit.

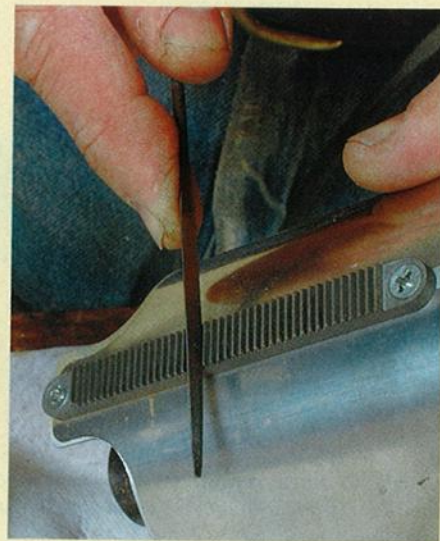
A collet that's worn or distorted can lead to vibration. And that could damage the shank of the bit or the inside of the collet. Or it can cause the bit to creep from the collet, changing the depth of cut as you rout. Should the bit creep far enough, the entire shank could come out in the middle of a cut—the woodworking equivalent of a nuclear meltdown.

Fortunately, it takes only a moment to make sure the surfaces of the collet are clean and properly lubricated. The procedure is pretty straightforward. Remove the router bit and unscrew the nut, then lift the collet from the spindle. On some routers, the nut stays attached to the collet.

Once the collet is out, you can blow out any sawdust. Also give a quick visual inspection to the taper inside the end of the spindle. The tapered surfaces should be smooth, almost polished. And the tapers should be straight, not worn into a bell shape.

Check the collet for cracks, which sometimes show up along the edge, particularly on thin-walled collets. Replace the collet if you spot one. Any burrs or rust need to be smoothed out. I use a fine stone on the tapered surface. On the inside, emery paper (220 grit or finer) wrapped around a dowel works well. It's

Take care of your teeth. Some routers have a rack-and-gear mechanism. Any burrs on the teeth need to be smoothed with a needle file.



A misaligned rack-and-gear mechanism won't operate smoothly. Sometimes it takes just a few light taps from a hammer to realign the parts.

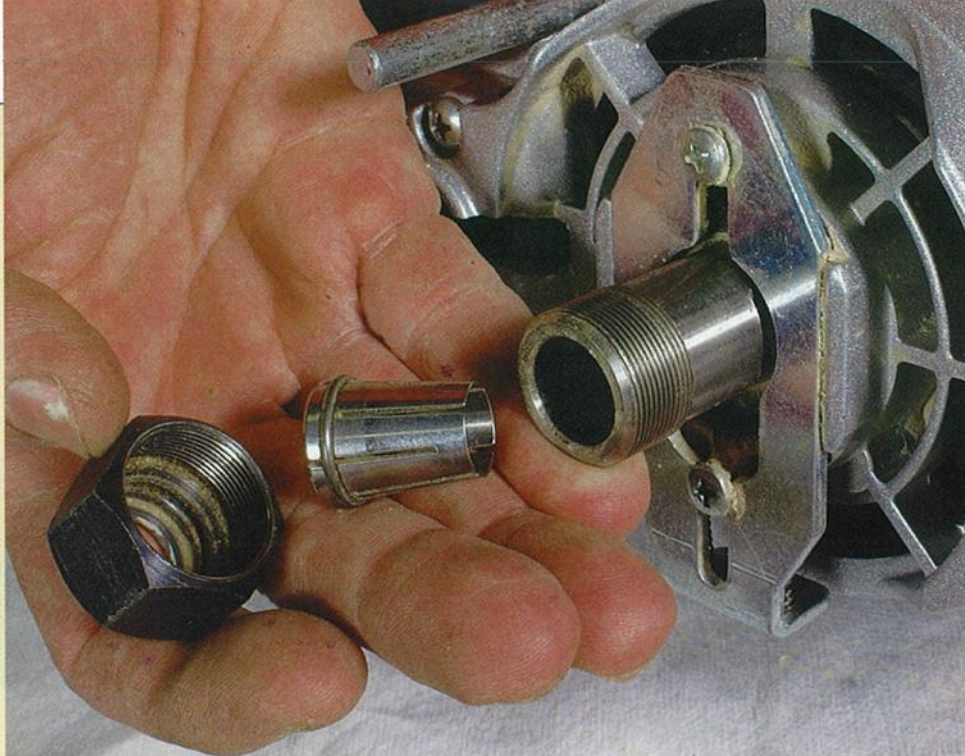


CLEAN THE COLLET

The collet grips the shank of the router bit. But the collet won't grip as well if it isn't clean.



If necessary, remove the ring. Some collets are attached to the nut with a snap ring. External snap-ring pliers, sold by auto-parts stores, are used to remove the ring.



Clean out burrs or rust. Use a dowel wrapped in 220-grit or finer emery paper to remove burrs or rust inside the collet.



Make sure the center of the collet is clean. The inside of the collet grips the shank of the router bit. So after cleaning the collet, run several pieces of clean towel through the center of the collet to remove any residual oil or grit.

important to use a light touch when using a stone or emery paper. The idea is to remove the rough spots without changing the shape of the parts. The collet must fit precisely in the spindle taper. Be sure to clean off any grit left by the emery paper or stones. The grit will cause rapid wear if not removed.

If you find that a bit has spun inside the collet, chewing up the bore, the collet should be replaced. This sort of damage cannot be fixed and will allow bits to slip, damaging their shanks.

If the spindle taper is chewed up, the router is probably due for retirement. On some routers the spindle taper is a separate part that threads onto the end of the spindle. But it typically requires special tools to remove and replace it.

If the critical surfaces are in good shape, it takes just a few steps to clean and lube the parts. Slightly moisten the corner of a paper towel (or clean rag) with WD-40. Then wipe down the inside of the nut, the collet and the inside and outside of the end of the spindle. After that, use your fingernail to get the towel into the threads on the spindle.

Before cleaning the outside of the collet, tear off a small piece of the oil-treated towel and use a thin dowel to force the towel through the bore of the collet. Because the bore is the part of the collet that actually grips the bit shank, clean off any oil.

Worn-out brushes need replacing

To produce high power in a light, compact package, a router uses a universal-type motor. Common to this motor is a pair of small carbon blocks, called brushes, that rub against the commutator, a part that spins with a surface speed of some 60 mph. These brushes eventually wear down. When they wear too much, the router starts to complain. So it's a good idea to check the brushes once in a while. And replace them before they wear too much.

One sign of worn brushes is an increasing amount of sparking that can be seen through the air vents on top of the router. Another common symptom is a motor that cuts in and out under load, or one that intermittently fails to start.

REPLACING THE BRUSHES

A router with badly worn brushes won't run well. Replace the brushes before they start to cause problems.



Accessing brushes from the side of the router. On a router with side access to the brushes, remove a cap, then simply pull out the brush (along with an attached spring and lead wire) from the motor housing.

Accessing brushes from the top of the router. Some routers need the top housing removed to get at the brushes. Use a paper clip shaped into a long hook to grab and remove each brush.



Running a router with badly worn brushes for any length of time can damage the soft copper surface of the commutator. Once that happens, the replacement brushes are going to wear faster than they should. Or worse yet, the motor may be ruined.

There is no sure guideline for how often to check the brushes for wear. Most owner's manuals recommend a check every 50 to 100 hours of running time. But running time isn't easy to track, so I just check them once or twice a year.

So how do you know when a brush needs to be replaced? A few manufacturers mold a wear line on the brush. Once worn to the line, it's time for a new brush. Most of the time, however, the brush won't have a wear line. When that's the case, check whether the owner's manual tells you when to replace the brush.

If the manual isn't helping (and that's not uncommon), there's a pretty good rule of thumb that applies here: Replace the brush when it becomes shorter than it is wide. For example, a typical 1/4-in.-thick by 3/8-in.-wide by 3/4-in.-long brush (when new) should be replaced when it wears to 3/8 in. long. By the way, worn or damaged brushes should always be replaced in pairs.

Most router manufacturers have made brush-changing a simple procedure. On many machines, you can reach the brushes by removing two dime-sized plastic caps set 180° apart on the top of the machine. With the caps removed, the brushes will easily slide out of their brass housings. Brushes held in by threaded caps are typically bonded to a spring and lead wire.

Some routers have the brushes inside the plastic housing that covers the top part of the motor. Held on by a few screws, the

cover is usually simple to remove, although some makers hide the screws under labeling that must be peeled off or cut. With the cover removed, the brush assemblies should be easy to spot. Most likely, they are going to be held in position by flat coil springs.

A paper clip comes in handy here. Straighten the clip and bend one end into a small hook. Slip the hook under the spring, then pull it back to release the brush. Be careful, though. The brush could shatter if the spring snaps back against it.

After checking the length of the brush, it's also a good idea to inspect its general condition. A bad electrical connection or heavy use can burn the brush, causing it to crack or crumble.

While you have the brushes out of the router, take a moment to look over the springs and lead wires that usually are attached to the back of the brush. On the springs, look for evidence of burning or cracking. And check the wire to see whether it is frayed, broken, or even pulled out of the brush. Any one of these problems is a good reason to install fresh brushes.

Replacement brushes are typically available from the manufacturer. If they can't supply brushes because the motor is too old, a motor repair shop might be able to help. By the way, when installing new brushes, make sure they slide easily into their housings. If they don't, file them down as needed to get a good fit. □

Online Extra

For John White's tips on replacing a router's brushes, go to FineWoodworking.com/tuneup.

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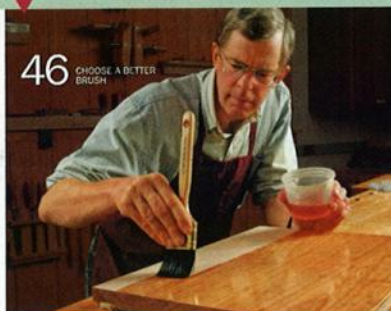
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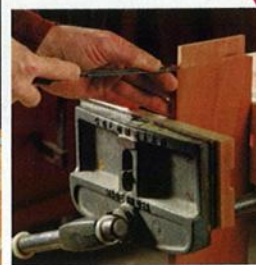
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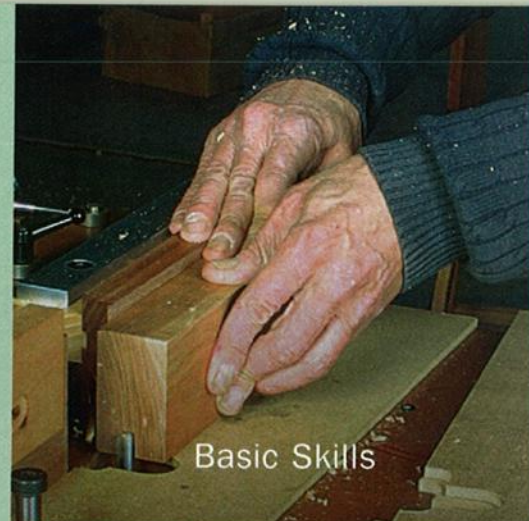
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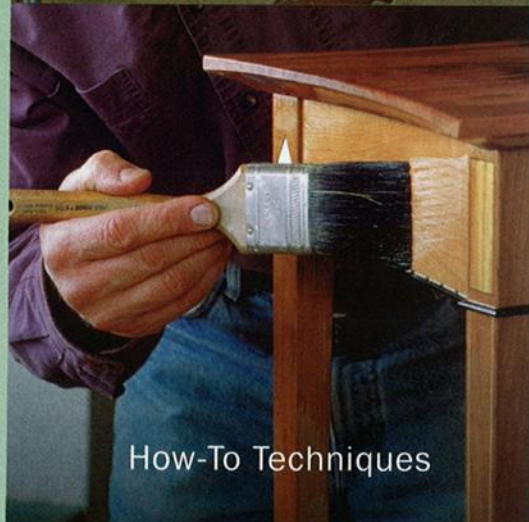
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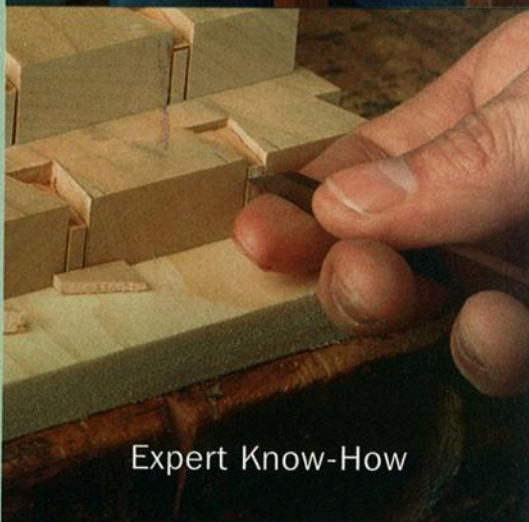
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Miter Saw Tune-Up



Fine-tune your saw
for better cuts
and more capacity

BY JOHN WHITE

Miter saws are showing up more and more in cabinet- and furniture-making shops. Although some of the early miter saws weren't reliably accurate, the current generation has evolved into tools capable of furniture-grade precision for joinery and trimwork.

One big advantage of a miter saw is that you can get a cleaner cut—especially on long lengths—than you get with a tablesaw miter gauge because you're moving the blade into the stock, not the other way around. The result is less wobble when the cutting edge meets the workpiece.

To get consistently clean cuts with one of these machines, whether you own a chopsaw or a sliding compound-miter saw, you first have to tune it up and then carry out periodic maintenance. A few shopmade accessories help, too.

START WITH A THOROUGH CLEANING

Begin a tune-up by removing dust and chips from the base of the saw. You can safely use compressed air to blow out the crevices under the saw's table, but don't use it to clean off the rods of sliding saws because the blast of air can force dust past the seals to the bearings. A shop vacuum is the better choice. Take off the blade and clean out the inside of the blade housing and the guard, removing any pitch buildup that may interfere with the guard's motion. Spray penetrating oil, an efficient pitch solvent, on a clean towel and use it to wipe down the guard mechanism and the guide rods for the sliding mechanism. Don't leave excess oil on the rods; wipe them with a dry towel once they are clean. Use light machine oil to lubricate the pivot points where the head rotates when the saw is pulled downward.



Lubricate with two different kinds of oil. Use penetrating oil on the sliding mechanism and light machine oil on pivot points for the head rotation.

MAKE SURE THE FENCE IS FLAT AND SQUARE

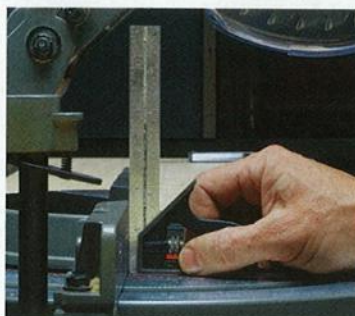
Most miter-saw fences consist of an aluminum casting with a large semicircular segment connecting the left and right halves of the fence. The circular part of the casting is a weak spot that can get bent, throwing the two faces of the fence out of line. Check the fence with a straightedge. The left and right sides should be in perfect alignment. If the fence is bent, you have two options to correct the problem: You can try to straighten the casting, or you can add wood shims to the front faces. To straighten the casting, remove the fence from the saw and set it up across two blocks on the benchtop. With the high side of the fence uppermost, press down on it with moderate pressure for just a moment, then recheck it for straightness. Don't use a lot of pressure because most fences are not that stiff, and you can easily overdo it.

SQUARE THE FENCE TO THE TABLETOP

The face of the fence should sit square to the tabletop, but for most types of cuts a small discrepancy won't matter with this tool. If you have to use the saw to make miter cuts on large moldings, you can add a wood face to the fence and shim it as needed to square it to the tabletop. Masking tape makes a convenient shim material because it's thin enough for making small adjustments, and it'll stay in place as you screw the wood face onto the aluminum casting.

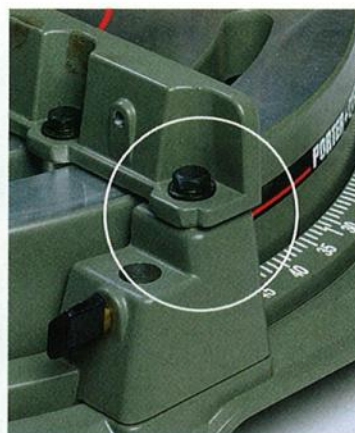
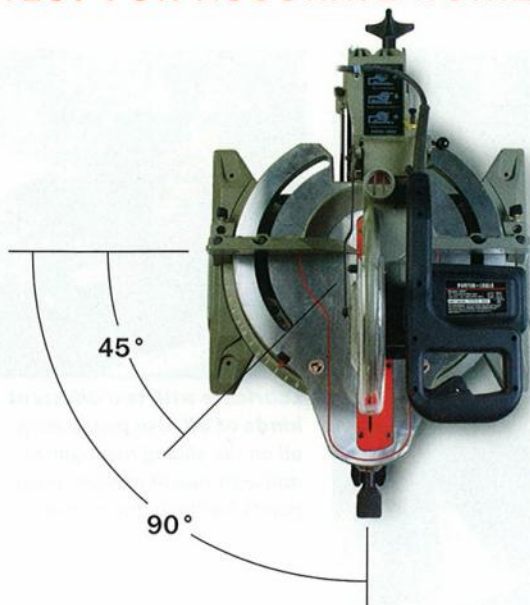


Start with a flat fence. Slightly bent fences may be pushed back into alignment. White checks the fence with feeler gauges.



The fence should sit square to the tabletop. For most tasks these saws perform, this is not a critical condition. Slightly out-of-square fences can be shimmed into alignment with the addition of a new wood face.

TEST FOR ACCURATE HORIZONTAL ANGLES



Built-in adjustability. The two screws on either end of this fence pass through holes that are slotted, which allow you to square the fence to the blade.

Most owner's manuals say to use a square to align the blade to the fence, but I think that approach is a waste of time. You're better off measuring the squareness of an actual cutoff and adjusting the setting as needed. Joint and mark one edge of a board that's 4 in. wide or more. For all of the test cuts, place this edge against the fence and use it to check the cuts with a square.

Correct for out of square by shifting the fence. But before loosening the bolts that clamp the fence to the table, scribe a pencil line at each end of the fence to mark its location. These marks will make it easier to judge how much you move

the fence as you square it up. Once the saw has been properly aligned, set the pointer on the miter-angle scale to line up precisely with the 0° mark.

CHECK THE 45° MITER SETTING

To check whether the saw will cut accurate 45° miters, you'll need two scraps at least 3 in. to 4 in. wide and a couple of feet long. As in the tests for square cuts, one edge on each board should be jointed straight and marked as the test edge.

With most saw designs you can only check whether the 45° stops were machined properly at the factory. The saw's turntable is positioned by a pin that

engages a series of notches under the table. The notches can't be repositioned, so you're depending on the manufacturer to have properly located them when the saw was made. Make test miter cuts with the turntable swung both to the right and to the left to discover if they're both accurate. As a final test, cut one miter with the turntable in each location. This last test is a good indicator, because in day-to-day shop work, most miter joints are made from this combination of cuts. After sawing, butt the cut ends together on a flat surface and check the resulting corner with a square placed on the outside corner of the joint.

Ideally, you'll find that all three combinations produce 90° corners. If the joint made with one board cut on each side is good, but the joints made with both boards cut on either the left or the right side are off, chances are the fence was not set quite right. In that case you should readjust the fence for square. If the saw can't produce good miter joints in all combinations of left and right cuts, remove the turntable and examine the alignment notches. With luck, you'll find sawdust packed in one or more of the notches, and the problem will be solved with a simple cleaning. Another option is to align the fence to create a good joint on one side of the blade, with a loss of accuracy to other turntable positions.

ADJUST THE FENCE FOR A SQUARE CUT

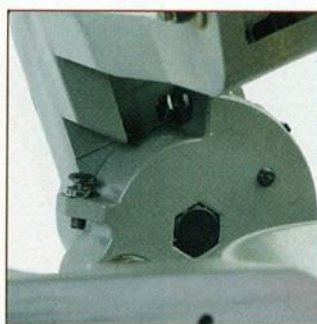
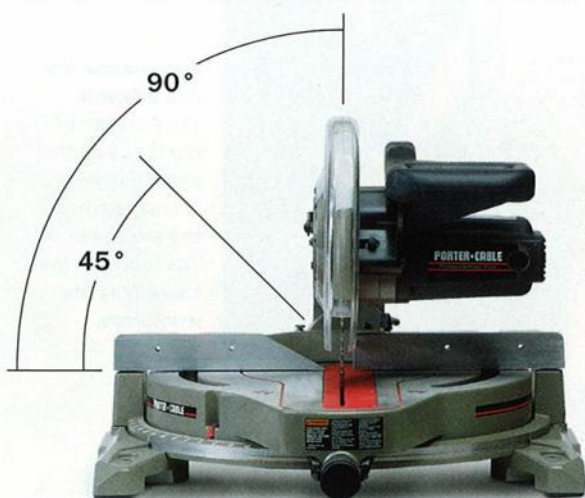


Ignore the owner's manual. Joint the edge of a piece of scrap, place it against the fence, and make a cut. Check the cut edge with a square to determine the blade-to-fence setting.



Give yourself a reference line. Use a pen or pencil to mark the location of the fence on the tabletop before making adjustments, which can easily be made by pivoting the fence.

TEST FOR ACCURATE VERTICAL ANGLES



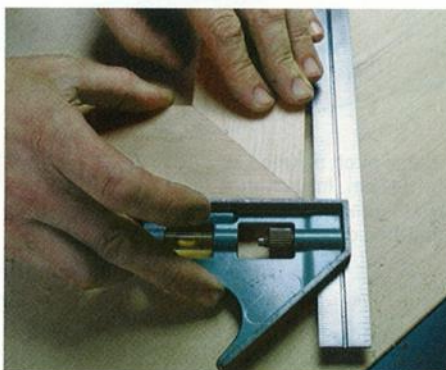
Vertical adjustments are easy. Two bolts with locknuts act as 45° and 90° stops.

To check the vertical alignment, follow the same procedure used for the horizontal setting, employing a test scrap 2 in. to 3 in. wide and a couple of feet long. Joint one edge until it's dead-on straight, then mark it. This edge will sit flat on the tabletop for all of the test cuts.

Set the saw at both the vertical and horizontal 90° settings and lock them in place. Make a test cut on one end of the scrap and check it with a square. If the cut end isn't square, adjust the stop, which is a simple job on most saws—typically it is a bolt and locknut easily accessed at the back of the saw. Some saws come with a special wrench to loosen the locknut because clearances can be tight.

To make an adjustment, tilt the saw head to take pressure off the stop bolt,

then loosen the locknut. Turn the bolt to correct the alignment, lock it down again, and make another test cut. It may take a couple of tries to get a perfectly square cut on the test piece. Once you're there, set the pointer on the



You need two pieces to test miters. Scraps at least 3 in. wide are better than narrow pieces to get a good reading on a miter.

bevel-angle scale to line up precisely with the 0° mark.

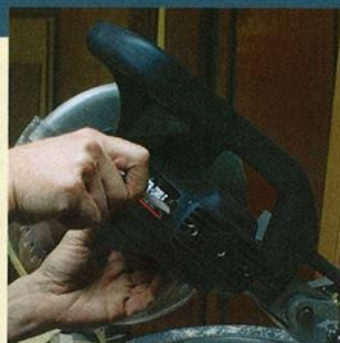
With the vertical and horizontal square stops set, you can adjust the stop for cutting 45° bevels. You'll need two boards about 3 in. wide and a couple of feet long. Square up the boards and mark the best edge on each board. Lock the saw head to the 45° vertical stop. Miter-cut one end of both boards, with the boards held vertically against the fence, keeping the designated edges against the tabletop. Cutting the boards vertically gives you a bigger miter to check for accuracy than what you'd get by cutting a bevel in the thickness of the boards. Assemble the joint on a flat benchtop. If the two boards don't form a square corner, it'll probably take several adjustments to get the joint square, but the effort is worth the trouble.



Two wrenches required. To adjust the 45° and 90° stops, you may have to tilt the saw head to access the bolts and locknuts.

Troubleshooting at a glance

SYMPTOM	SOLUTION
Rough sawcuts	Replace the mediocre blade that came with the machine with a new 80-tooth crosscut blade.
Loss of power, sparks in the motor	Replace the brushes (see the photos at right).
Out of square or off-angle cuts	Tune up settings and stops as indicated.

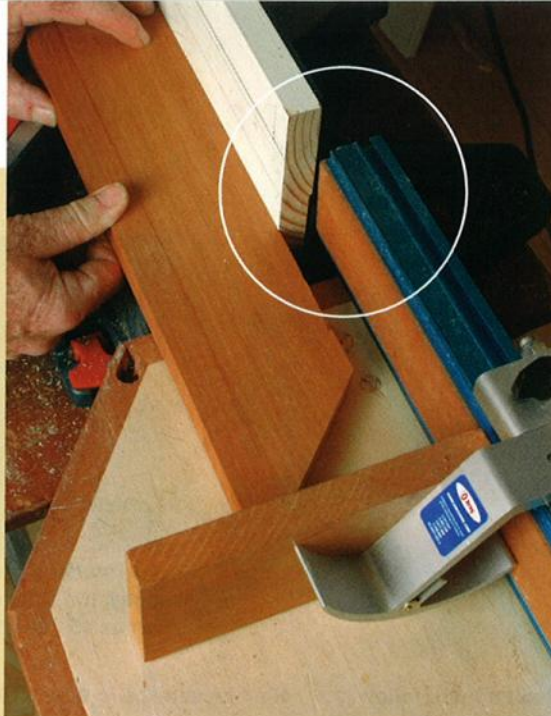


This brush is still in good shape. Worn-out brushes can lead to sparks coming from the motor, and they can indicate a loss of power. Replace brushes when they get too worn, which would be about half the size of the one shown here.

Add wings to your saw



Good cuts need good support. A pair of extension wings with stop blocks support long pieces and make for accurate cuts.



The fences are not aligned. The purpose of the fence on the extension wing is only to carry the stop block. The fence on the saw aligns the workpiece.

Shape wing to prevent interference with the miter saw's swing.

Two-part coupler attaches extension wing to saw table.

Table, $\frac{1}{2}$ -in. Baltic-birch plywood, 10 in. wide by 54 $\frac{1}{2}$ in. long, with $\frac{3}{4}$ -in.-thick by 1 $\frac{1}{2}$ -in.-wide hardwood trim mitered at the corners

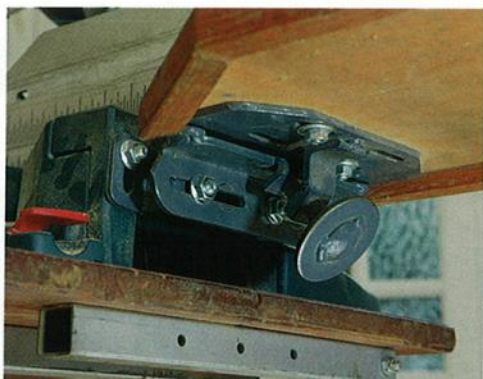
42-in.-long miter track (part No. 7402), screwed to the table

T-bolt

Knob locks sliding fence to table.

SHOPMADE EXTENSION WINGS

If you have a freestanding miter saw, extension wings not only support long pieces, but also aid accurate measuring and cutting. They hook to the saw using a coupler system and fold up and lean against the wall when not in use. This design has two wings, each 56 in. long, that can expand to support an 8-ft.-8-in. piece.



A good connection. This two-part coupler (available at sawhelper.com; 800-441-1388) ensures that removable extension wings align evenly with the saw's table.

Hinge allows leg to fold for storage.

Leg sections, $\frac{3}{4}$ -in.-thick Baltic-birch plywood, 8 in. wide by 21 in. long

Groove, $\frac{3}{8}$ in. deep by $\frac{3}{8}$ in. wide, routed in each leg

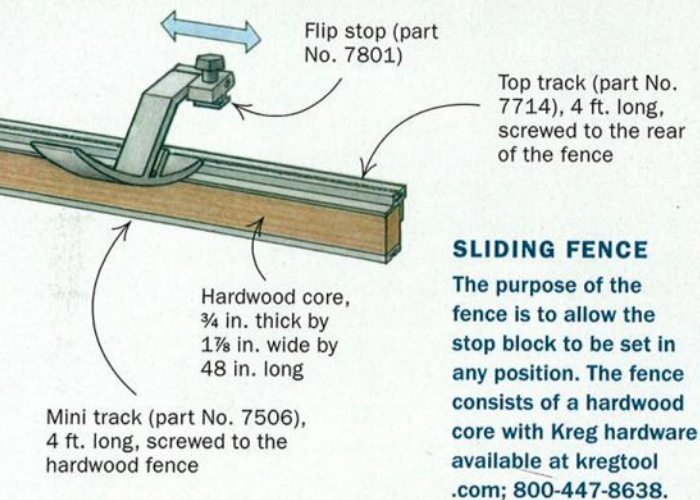
Hardwood track, $\frac{3}{4}$ in. thick by $\frac{3}{8}$ in. wide by 21 in. long, glued into one groove

Height-adjustment slot

OR BUILD IT INTO YOUR BENCH



A built-in miter saw. Putting a miter saw into an existing bench provides support for long pieces and a dust-collection booth.



SLIDING FENCE

The purpose of the fence is to allow the stop block to be set in any position. The fence consists of a hardwood core with Kreg hardware available at kregtool.com; 800-447-8638.

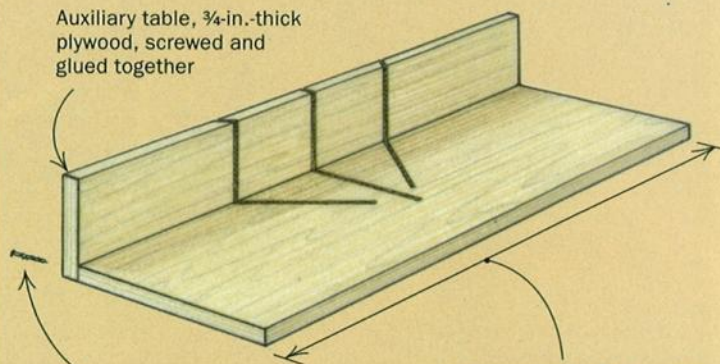


Stop block for miters. Screw a block of wood to the stop block to give mitered ends a larger surface to register against.

Cut small parts safely

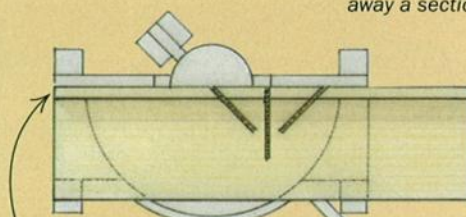
An auxiliary table and fence support small pieces. Aligning one end of the jig with the existing fence aligns the blade with the kerfs.

Auxiliary table, 3/4-in.-thick plywood, screwed and glued together

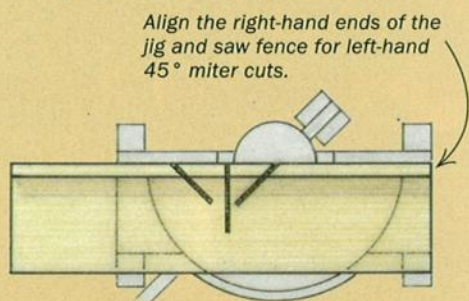


Locate the screws away from the sawkerfs.

Make the jig 6 in. longer than the miter saw's existing fence so that the kerfs don't overlap and cut away a section of the jig.



Align the left-hand ends of the jig and saw fence for right-hand 45° miter cuts.



Align the right-hand ends of the jig and saw fence for left-hand 45° miter cuts.

SAFETY TIP

Clamps replace fingers



When cutting a short piece, don't try to hold it. Instead, clamp it to the auxiliary fence.

How to Troubleshoot a Spray Gun

Learn to handle typical problems and enjoy carefree spray-finishing

BY JEFF JEWITT

As the technical troubleshooter for my business, I've been asked to solve just about every spray-gun problem imaginable, from a new gun that just hisses air to an old gun that used to spray perfectly and now leaves a horrible finish. The good news is that in most cases, you can diagnose the cause of the problem by analyzing the spray pattern. In a few other situations, a slight change in your spraying technique can help. Even if you're just considering taking the leap into spray finishing, knowing how to achieve and maintain a good spray pattern will give you the confidence you need.

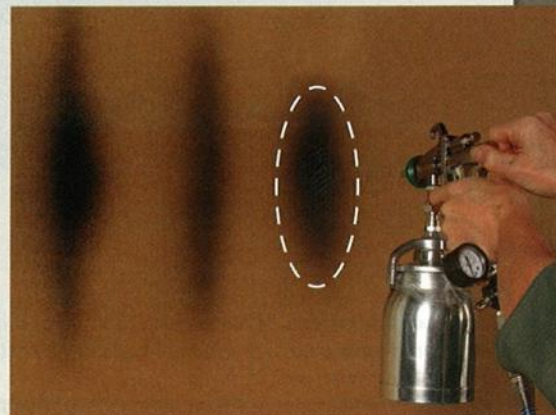
Since all spray guns operate on the same basic principle, it doesn't matter whether you have a high-volume, low-pressure (HVLP) gun or a non-HVLP gun, a turbine-driven system or a compressor-driven system. When differences exist, I'll call them out.

Most of the time some finish comes out of the gun, just not in a manner to give that thin, even coating that makes spraying so worthwhile. You can study the spray pattern with a light shining through it. If you find this difficult, spray some dark finish or stain onto cardboard. If you substitute a dark finish for a clear one just to test the pattern, be sure that it has a comparable viscosity.

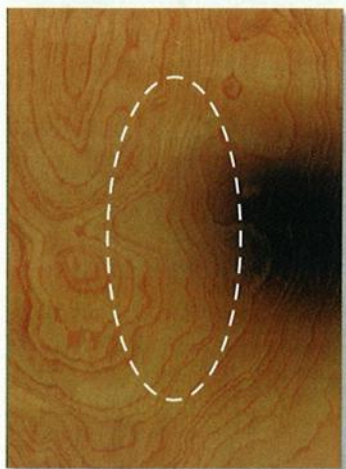
Jeff Jewitt, who runs a finishing-supply company (homesteadfinishingproducts.com), writes frequently about finishing for Fine Woodworking.

Test your gun

You want the gun to spray an elliptical pattern consisting of fine, even-sized droplets (far right). Most of the time, spraying clear finish onto cardboard will give you a legible spray pattern while the finish is wet. For an even clearer pattern, spray black stain or paint onto the cardboard as shown in this article's test panels.



Pattern heavy on one side



The typical culprit for this is a plugged or partially clogged air-cap port. It's easy to diagnose: Just rotate the air cap 180° and if the problem side reverses, then it's the air cap. Remove the air cap and soak it in lacquer thinner. Use micro-brushes to clean the air-cap ports as best you can. The ports meet inside the air cap at a 90° angle, so come in from both sides. A blow gun that has a protective rubber tip can be used to blow out the ports, but wear eye protection in case some thinner splashes out (I speak from painful experience).

If the pattern does not reverse when you rotate the air cap, then it is the fluid nozzle that is clogged, causing the spray to veer to one side as it exits the gun.

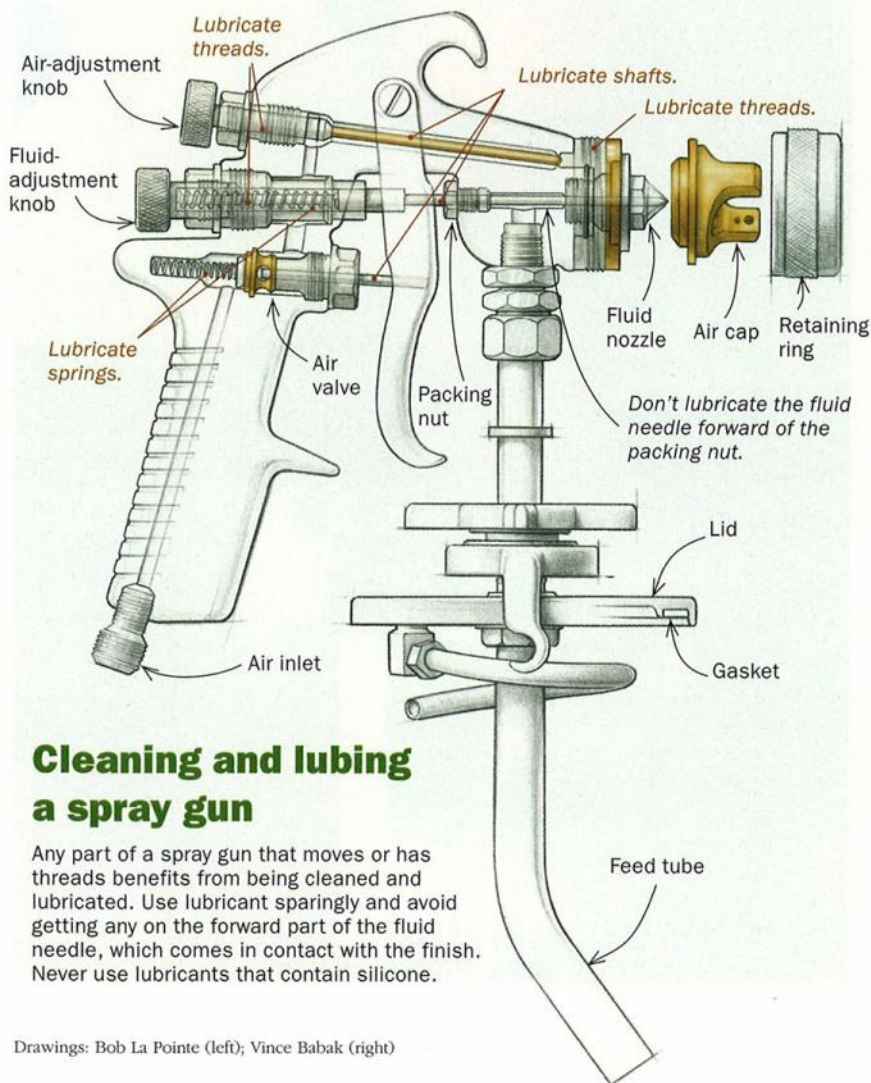
If you have a gravity gun, you can easily diagnose a partially obstructed nozzle by unhooking the air line and pulling the trigger completely back with solvent or finish in the gun. The liquid should come out in a steady stream if the nozzle is clear. If you have a compressor-driven pressure cup and the gun has a cheater valve (an internal air shutoff), simply close the cheater valve and pull the trigger. Again, the finish/solvent should come straight out the front. On suction and turbine-driven pressure cups you can't do this, so you'll just have to see if cleaning the nozzle helps.



One side clogged. To find out if a clogged port on one side of an air cap is causing the spray pattern to be heavy on one side, rotate the air cap 180° and see if the pattern also changes.



Blow out the problem. Air ports have a 90° turn in the air cap, so the easiest way to clean them is to blow them out with compressed air.

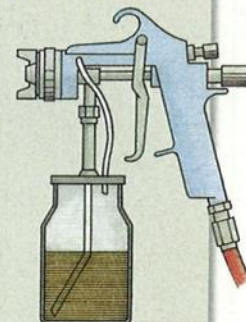


Cleaning and lubing a spray gun

Any part of a spray gun that moves or has threads benefits from being cleaned and lubricated. Use lubricant sparingly and avoid getting any on the forward part of the fluid needle, which comes in contact with the finish. Never use lubricants that contain silicone.

WHICH TYPE OF GUN DO YOU HAVE?

Spray guns come in two basic designs. Siphon cups (also called suction cups) have the storage cup under the spray gun, while gravity guns put it on top. To troubleshoot correctly, you need to know which type you have.

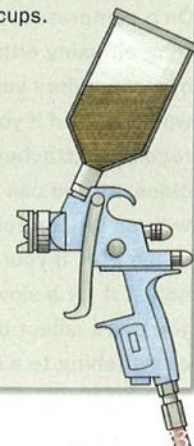


SIPHON CUPS

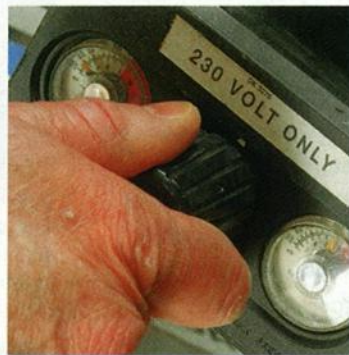
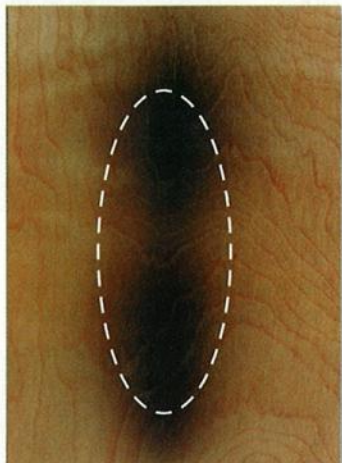
In a standard siphon cup, air exiting the front of the gun creates suction, pulling the finish up into the gun. With a pressurized siphon cup (usually called a pressure cup), the cup is pressurized by an external or internal tube that diverts a small amount of air from the gun. This pushes the finish up into the gun. All turbine systems use pressurized siphon cups.

GRAVITY CUPS

With the cup on top, gravity alone pushes the finish down into the gun. Gravity guns range from full-size cups (about 20 to 25 oz.) to detail guns (about 4 to 5 oz.) used for touchup and small projects. These small gravity guns don't use much air (4 cubic feet per minute) and typically can be run with a small portable compressor.

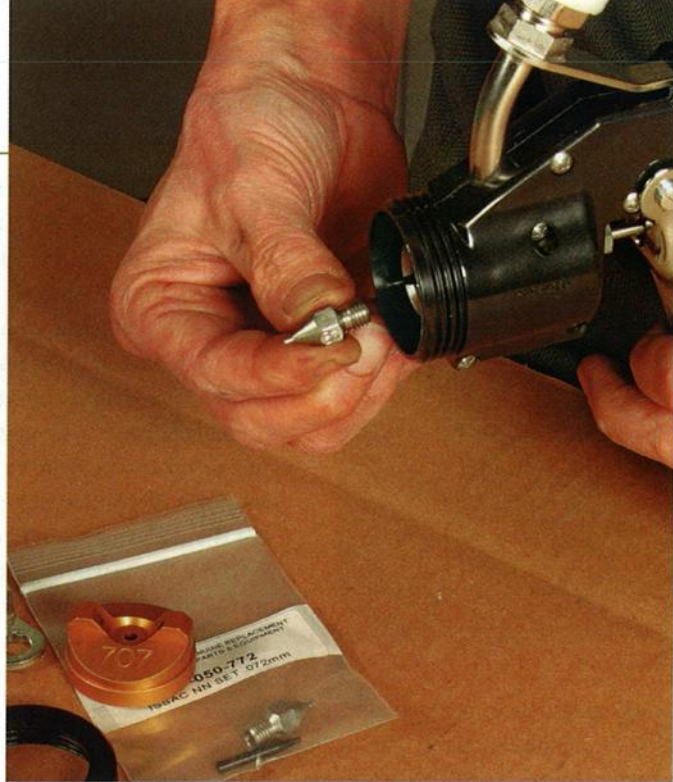


Pattern split in the center



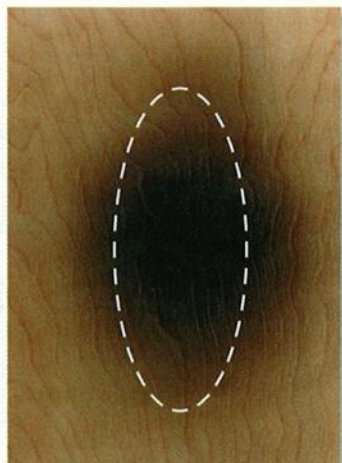
Less pressure. If there is no finish in the center of the spray pattern, try turning down the air pressure on the compressor or turbine.

If there is no finish in the center of the spray pattern, more than likely the air pressure is too high. Lower it and see if the problem gets better. On the few turbine models that lack air regulation, switch to a smaller fluid nozzle.



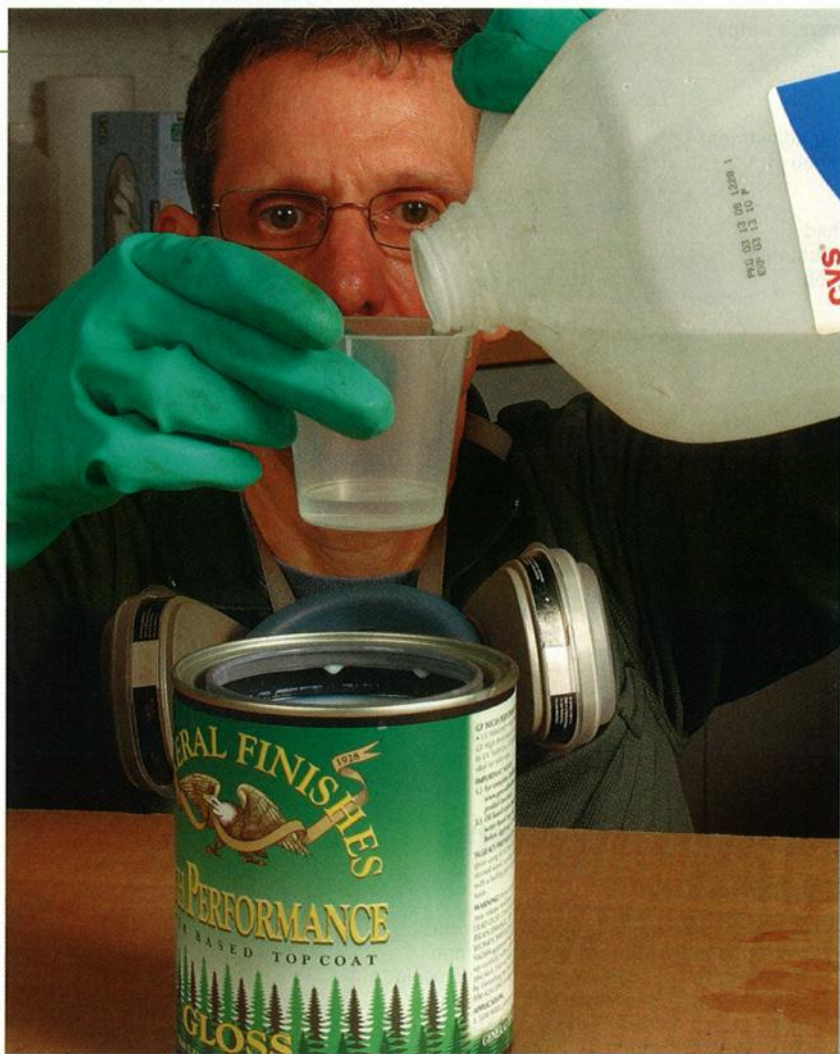
Adjust the nozzle. If adjusting the air pressure doesn't solve the problem, switching to a smaller fluid nozzle may help.

Pattern heavy in the center



Thin the finish. If you can't turn up the pressure, try thinning the finish in 10% increments.

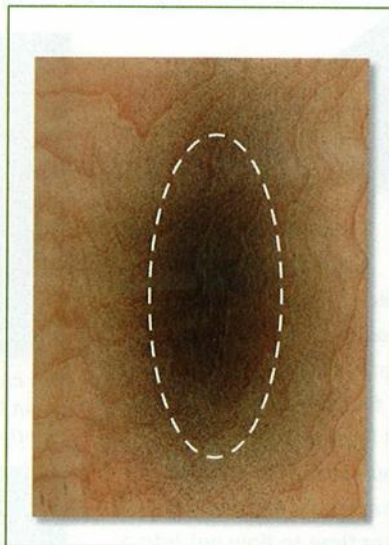
If most of the finish is in the center, the air pressure is too low. If you can adjust the pressure, turn it up. On a compressor-driven system, turn down the atomizing air using either the compressor output regulator or a secondary supply regulator. This regulator can be wall-mounted if you have a metal air pipe, or a mini-regulator attached to the base of the gun. With turbines, all you can do is to turn down the atomizing air with an air-control valve mounted on or near the base of the gun. If your turbine has a speed control, you can adjust it for a slower speed, which reduces the air. If you can't adjust the pressure, try thinning the product or switching to a larger fluid nozzle.



You can't get a wide fan pattern

On a suction-feed gun, try thinning the finish, or even just spraying some solvent to see if you can get a wide pattern. If that doesn't help, try increasing the atomizing pressure. If both these steps fail, then install a larger nozzle.

Though unlikely, both air ports on the aircap may be clogged, so remove and clean them as explained earlier. As a final cause, the fan-width adjustment valve assembly may be damaged or faulty, in which case you should return the gun if it is under warranty or seek out a repair shop. On gravity and pressure-cup guns, follow the same sequence of steps, but don't increase the atomizing pressure.

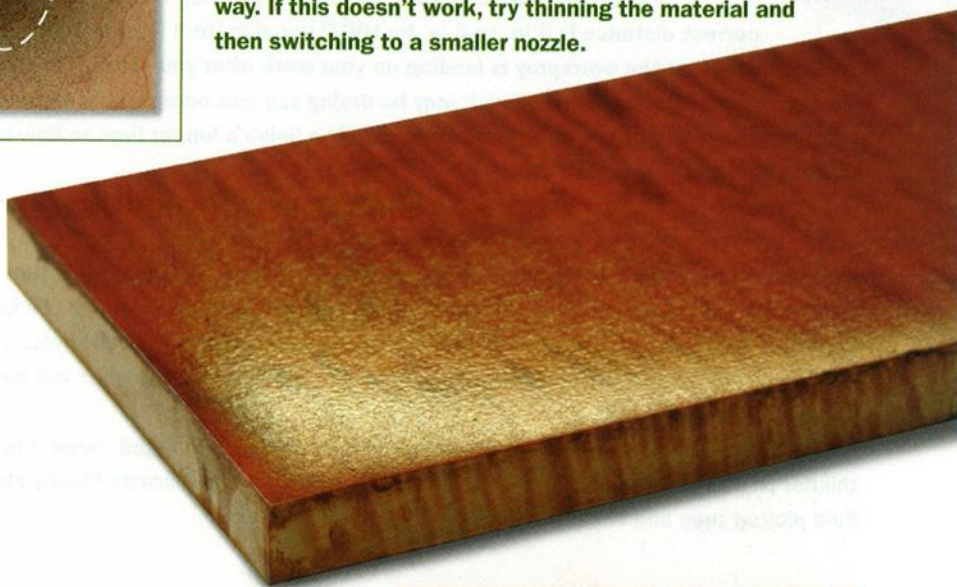


Coarse spray pattern

If your dried finish has little dimples all over it resembling the skin of an orange, you have "orange peel." Poor atomization (large droplets) is the main culprit, and this is often easiest to see if the spray pattern is backlit.

On all compressor-driven guns, try increasing the air pressure and see if the coarse pattern improves. If it doesn't, you can try thinning the product in 10% increments until it improves. If neither works, try a smaller nozzle.

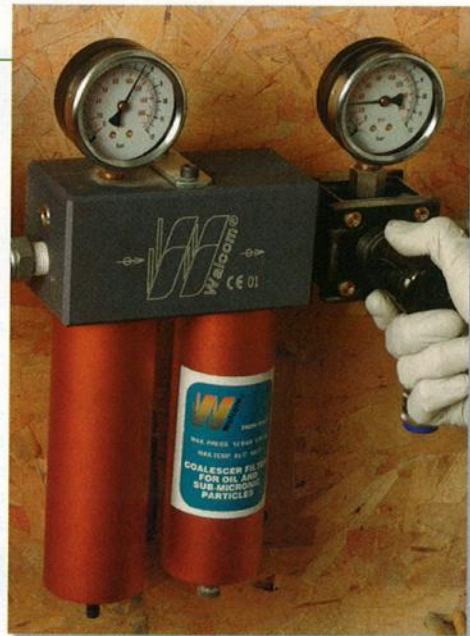
With a turbine gun, make sure the air control (if you have one) or the speed control for the turbine is opened all the way. If this doesn't work, try thinning the material and then switching to a smaller nozzle.



Too much overspray

HVLP systems should limit overspray to 20% to 30% of the finish. If you think you're getting more, you can reduce it by turning down the air pressure. Just keep in mind that when you do this, the finish quality will start to suffer, at some point resulting in the orange-peel effect described above.

Bounce back. Old-fashioned spray guns created large amounts of overspray (right). Modern HVLP guns are designed to avoid this.



Throttle back the air. To reduce overspray, simply reduce the air pressure. If you build a dedicated spray booth, consider installing a combination regulator and air cleaner attached to the wall (above). The cleaner ensures that no contaminants reach the finish.

Dry or rough spray, or no spray at all



If the finish feels rough when it dries, there are some possible causes common to all guns. You may not be depositing enough finish: Try slowing down your motion as you spray to leave more finish on the surface. Likewise, the gun may be too far from the surface. The correct distance is 4 in. to 6 in. for HVLP and 6 in. to 8 in. for non-HVLP.

It could be that the overspray is landing on your work after you spray. Use a fan to remove the overspray. Last, the finish may be drying too fast because it's hot and dry. Use a retarder specified by the manufacturer to give the finish a longer time to flow out into a smooth film.

In extreme circumstances, you may get no finish coming out of the gun. You pull the trigger and hear air coming through the front but no finish comes out, or it sprays a little and then stops. All standard siphon and gravity cups have a small vent hole that allows air to enter the cup to displace the finish volume as it's pulled out through the fluid nozzle. Use a toothpick or micro-brush (see opposite page) to clear the vent hole. If there's a fair amount of hardened finish in the hole, soak the top in lacquer thinner, but be sure to remove any gaskets first.

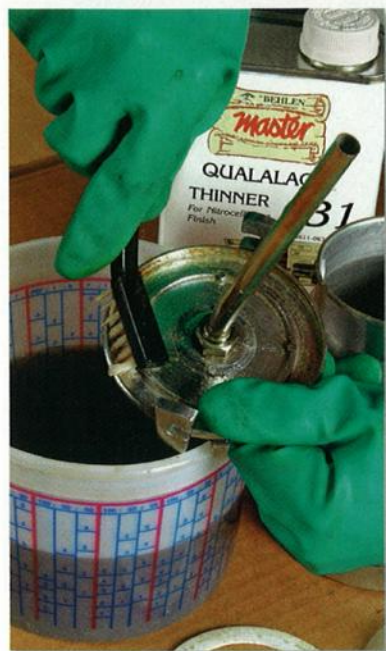
If that doesn't work, remove the fluid nozzle and see if it's clogged. Soak it in lacquer thinner to soften any dried finish and ream it clean with a micro-brush. Finally check the fluid pickup tube and see if it is clogged.



Get closer. If you use an HVLP gun more than about 6 in. from the surface, you run the risk of creating a rough surface.



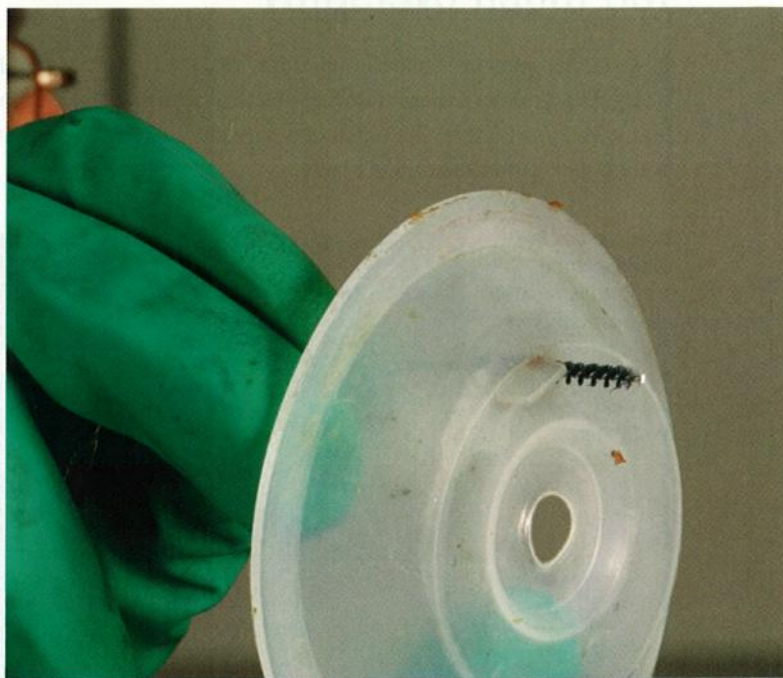
Slow things down. A finish that dries before it can flow out will leave a rough surface. Adding a suitable retarder slows the evaporation and lets the finish dry smooth.



Remove dried-on finish. Soaking gun parts in lacquer thinner is the best way to remove hardened finish, but first remove non-metal parts.



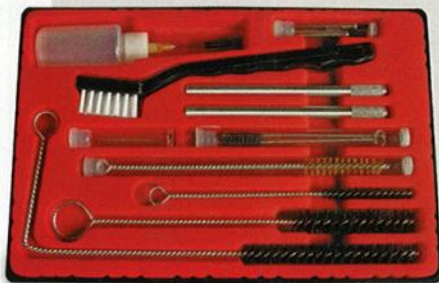
Trouble in the tube. If the tube that pressurizes a pot is clogged, finish will not fully flow to the gun. Remove the tube from the base of the gun and the top of the pot (above), and then blow through the tube to see if the check valve or tube is blocked (below).



Clean the splash guard. The small pressure vent can get plugged with dried finish, interrupting the flow. Use micro-brushes in a spray-gun cleaning kit to clean the hole.

Regular cleaning prevents most problems

If you are spraying a fast-drying finish such as shellac, solvent-based lacquer, or a water-based finish, each coat is likely to be 1 to 2 hours apart, so leaving finish in the gun between coats doesn't cause problems. However, if the finish needs to dry overnight, or if you change to a different finish, you should clean the gun.



Buy a full cleaning kit. To keep spray guns working properly, a cleaning kit should contain special brushes and needles to access the different parts of the gun.

When you use solvent-based lacquer and shellac, any new finish in the gun will re-melt any dried finish, so you typically don't have to clean the gun thoroughly. Just run some lacquer thinner or denatured alcohol through it, depending on the finish.

Finishes that require more diligence in cleaning are water-based and oil-based products (including latex and oil paint) because the cleanup solvent won't remove the dried finish. Therefore you should clean the gun soon after use. When cleaning guns that sprayed paints, remove the air cap, fluid nozzle, and needle so you can clean more thoroughly. The chart below tells you which solvent works best to clean the different finish types, or you can check the finish container for the proper solvent. Note that some products require a different cleaner once they have dried.

FOR CLEANUP, MATCH SOLVENT TO FINISH

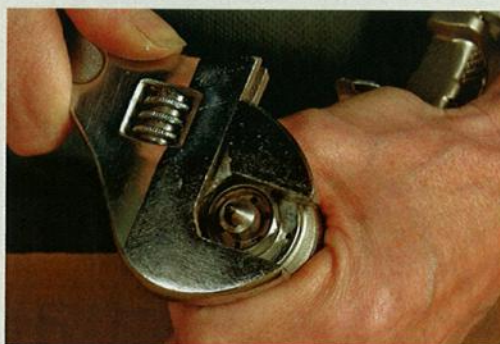
Finish	To rinse/clean	To remove dried finish
Shellac	Denatured alcohol	Denatured alcohol
Solvent lacquer	Lacquer thinner	Lacquer thinner
Waterborne finishes and latex paint	Water followed by denatured alcohol	Acetone/lacquer thinner
Oil-based finishes and oil paint	Mineral spirits/paint thinner/naphtha	Lacquer thinner

Let fluid flow.

Use a large brush to clean the main nozzle in the center of the air cap where finish exits the gun.



Air supply. The small holes on either side of the fluid nozzle supply air that atomizes the finish. Clean them using thin needles.



Don't forget the needle and nozzle. After removing the air cap, unscrew the nozzle (top), and then use a micro-brush to clean inside it.



A thorough going-over. After spraying waterborne or oil-based finishes, guns need to be stripped down and thoroughly cleaned right after use.



HAND TOOLS]

Many woodworkers never discover the pleasure of using hand tools, in part because they've never learned to tune them up. That's a shame, because in their quiet way they often can outperform power tools. Understand hand tools and you'll add a new dimension to your woodworking.

90 Tune Up a Handplane

96 Get Sharp—Fast

102 Block Plane TLC

104 Turn a Cheap Spokeshave
into a Peak Performer

106 Sharpening and Using Card Scrapers

109 Great Carving Requires Sharp Tools

Tune Up a Handplane

Turn a flea-market find into a prince of a plane

Smoothing a board with a handplane is one of the most pleasurable processes in a woodworking shop. I love the feel of a well-tuned plane gliding across the surface, with whisper-thin shavings rising from the tool's throat. And there is no faster way to create a glass-smooth, dead-flat surface for finishing.

A common misconception among many new woodworkers is that you need an expensive plane to get the job done. But you don't need to spend a fortune to catch the hand-tool wave.

Rejuvenating an old Stanley Bailey plane, whether it's a garage-sale find or an eBay purchase, is a great way to get started handplaning without breaking a slim woodworking budget. Tearing a plane down to its bare chassis and building it back to blueprint specs not only creates a great performing plane, but also gives you an insight into how these wonderful bench mates work.

I have rebuilt dozens of Bailey planes for friends and for myself, and I've given more than 100 seminars on the subject. With my step-by-step approach, you'll turn a clunker into a classic. Best of all, you don't need special tools to get the job done.

Why Baileys are a bargain

Stanley was making two styles of bench plane in the late 19th and early 20th centuries: the Bailey and the Bedrock. The

BY ROLAND JOHNSON

Bailey came first. It was considered a working-man's plane, so it was produced in significant numbers and had a lower price point. The more refined Bedrock followed and because there were fewer made, the tool was more expensive than the Bailey. Today, that price differential remains. While you'd be hard-pressed to get a Bedrock for under \$100, you can purchase a restorable Bailey plane for under \$40, including shipping. So with a small investment in labor, you end up with a great tool at a great price.

When a bargain becomes a bummer—A used handplane is a bargain only if it's serviceable. Inspect the plane for obvious flaws. Buying from an online source such as eBay is tricky because you have to rely on photos and the honesty of the seller. Some damaged or missing parts, such as knobs, totes, chipbreakers, and lever caps, can be replaced easily (see "Where to buy," below). A lot of the tools will have some rust, which often is easy to remove and repair. But if it's so bad that parts have seized up or are seriously pockmarked, you may want to pass on the tool.

Take a close look at the castings. If you see cracks in the plane body, especially on the sole in the area around the throat, walk away from the tool; it will be more useful as a paperweight.

You also should be real cautious about buying a plane in which the body has obvious welds or repairs.

Small nicks around the throat are signs of normal aging and wear and are easy to file away. But avoid a tool that has nicks larger than, say, 1/8 in., because the plane body is probably toast.

Start with a cleaning

You can get that used Bailey performing like a star with just a few hours of work. Start

WHERE TO BUY REPLACEMENT PARTS

HIGHLANDWOODWORKING.COM

Blades, chipbreakers, knobs, and totes

ANTIQUED-USED-TOOLS.COM

A wide assortment of original and replacement Stanley parts

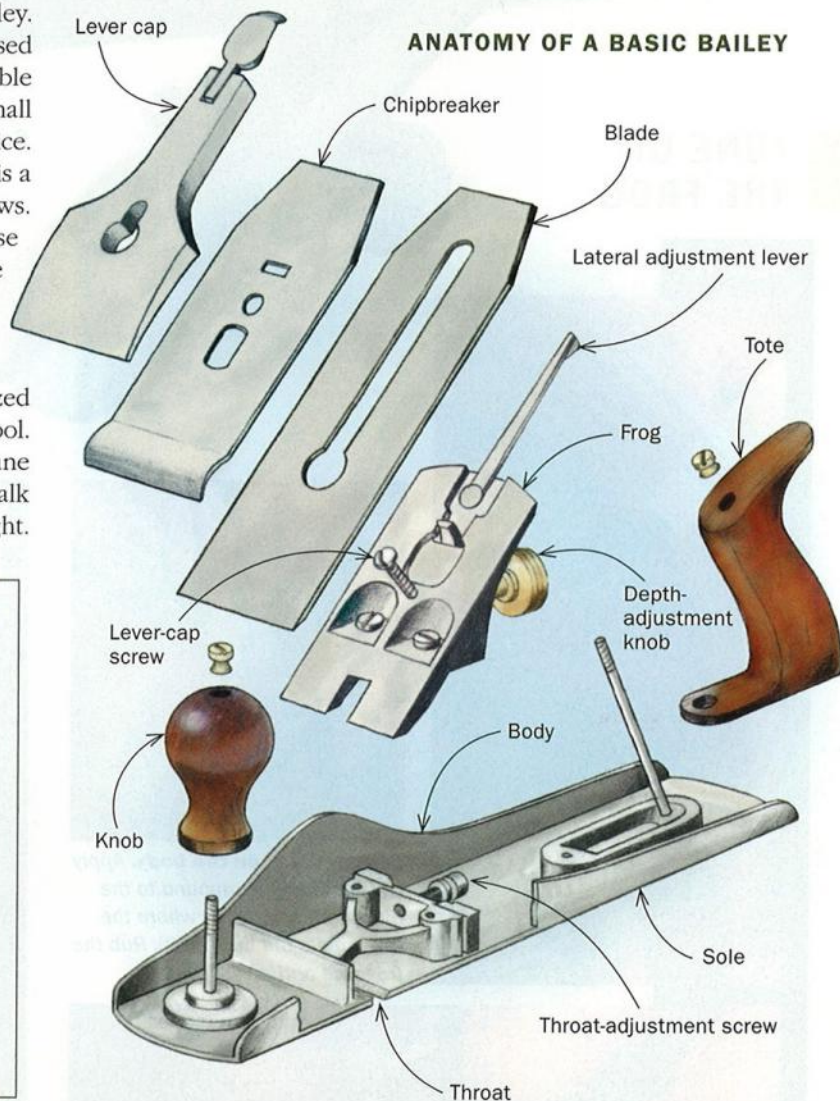
STJAMESBAYTOOLCO.COM/STANLEY.HTML

Reproduction Stanley plane parts

TAKE IT APART AND CLEAN IT UP



Naval jelly sinks rust. Be sure to get it into crevices and even threaded areas. Let it sit for 10 to 15 minutes, then rinse off the parts in water.



Follow with an alcohol bath. Soak and scrub all the parts in denatured alcohol. Dry and then lubricate threaded parts with camellia oil.

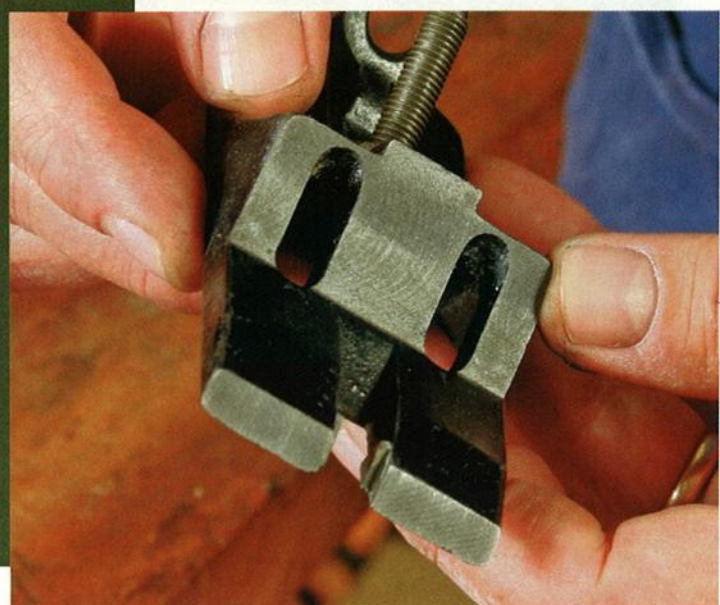


TUNE UP THE FROG

SEAT IT



Seat the frog on the body. Apply valve-grinding compound to the four mating surfaces where the frog meets the body (left). Rub the frog fore and aft (above).



Grind until it shines. Check your progress as you go. You're finished lapping when an even rub pattern shows on all the contact points.

by dismantling the plane. If the plane is rusty, slather on some naval jelly (Amazon.com), a rust-removal product. Then give all the parts a thorough washing and scrubbing in denatured alcohol. Let them dry, and then coat them with a light oil such as camellia oil.

You can refinish the knob and tote, if they are in a bad way. I use shellac, simply because it is easy to repair or refresh and wears well.

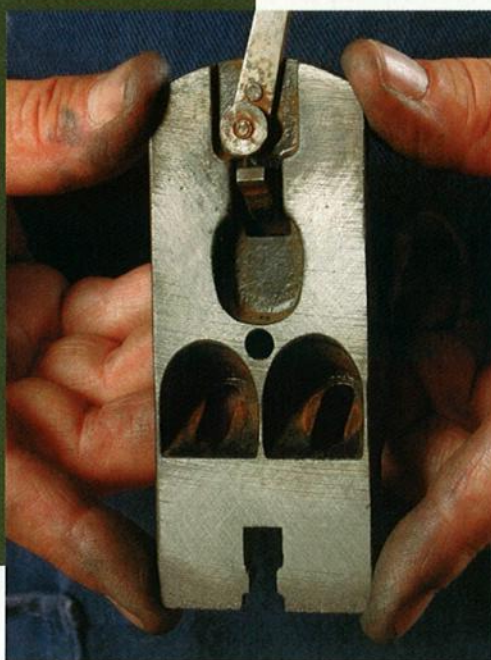
Solid frog makes a solid plane

The frog of a bench plane supports the blade assembly in the plane body. The frog in a Bailey-style plane rests on four points.

If there is any inaccuracy in the machining of the frog or the plane body, the frog, and in turn the blade assembly, will not be fully supported and could move slightly under cutting pressure, which will cause blade chatter.

To seat the frog precisely and firmly to the bed of the plane, first coat the mating surfaces of the frog

FLATTEN THE TOP



A flat frog is a good frog. Flatten the area from the lever-cap screw to the bottom. Johnson starts with 120-grit paper glued to a granite plate with spray adhesive. He works through to 220 grit until all the high spots are removed.

and the plane body with valve-grinding compound (Permatex 80037, available at most automotive-supply stores). Then simply rub the frog fore and aft in the plane body, keeping even, moderate pressure on the frog, until all four points mate evenly and firmly. Clean off the grinding compound using denatured alcohol and a small, stiff brush.

The frog also must be flat across the top. The best approach to flattening it is to rub it on sandpaper adhered to a dead-flat surface, such as a granite block, a piece of plate glass, or a cast-iron tabletop. Begin with 120-grit paper and work through to 220 grit. If needed, you can start with a more aggressive sandpaper and work up through the grits.

Use compressed air to blow out any filings or grit from any threaded holes (do this after you flatten or bed any parts to prevent debris from ruining threads as you reinstall the screws). Coat the fresh surfaces and threaded parts with camellia oil and wipe off the excess. Now you can reinstall the frog on the plane body.

Flatten and sharpen the blade

In my experience, the blades on these planes are good quality steel. Most often you just need to clean them up and sharpen them. But if the blade is really beat up, particularly if it has lots of deep rust pockmarks, forget the salvage job and buy a replacement. Note that a replacement blade may not fit correctly in a Bailey plane, so check with the blade manufacturer for tips on fitting their blade to your plane.

Flatten both sides of the blade and then sharpen it. When flattening the back, or heel side of the blade, you don't need a polished finish. I usually start with 120-grit paper and work up to 320 grit. Concentrate on the area from the keyhole to the bevel. The front, or toe side, of the blade should be polished to as fine a surface as the bevel.

Fine-tune the chipbreaker

The chipbreaker does just what its name implies—it breaks chips. Positioned directly behind the cutting edge, the front of the chipbreaker forces the shavings to break or curl up and away from the throat, preventing them from clogging it. The constant breaking/curling action also works to prevent tearout.

For it to work properly, the chipbreaker must be tuned to meet the back of the blade perfectly. The goal is a knife edge so that the chipbreaker body exerts maximum spring pressure along the entire width of the blade when the chipbreaker and blade are secured together.

Start tuning by sanding the bottom of the front edge flat. I use 220-grit sandpaper on a granite stone. If the bottom is in bad

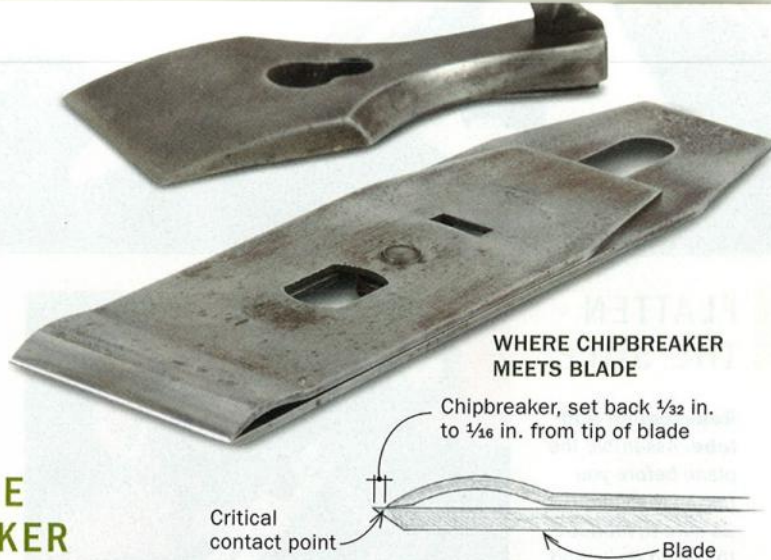
POLISH THE CHIPBREAKER



Mind the gap. Any gaps between the chipbreaker and blade (left) will catch and jam chips. Holding the chipbreaker so that its end is below the tip, rub the bottom of the front edge on 220-grit sandpaper adhered to a flat surface (above). The goal is a knife edge that meets the back of the blade all the way across (right).



Smooth the curve. Polishing the top front of the chipbreaker helps chips slide by smoothly.





FLATTEN THE SOLE

Reassemble and lube. Assemble the plane before you flatten the sole. Be sure to lubricate threaded parts and the lever cap as you go.



Rub-a-dub-dub. Retract the blade so it doesn't protrude, then run the sole of the plane over sandpaper glued to a flat substrate. Skew the plane both ways as you work.



shape, you may have to start with coarser paper. To check your progress, put the blade and chipbreaker together and hold the assembly in front of a white sheet of paper or light background. Look for any gaps between the blade and chipbreaker; keep working until they are gone.

Once you're finished working the bottom, polish the top front of the chipbreaker, which will help the curls of wood glide over the curved surface.

Tweak the lever-cap screw

Make sure the bottom surface of the head on the lever-cap screw is smooth. Often a pair of pliers has been used on the screw sometime during its life, creating a rough edge. Remove any small burrs; otherwise, the lever cap won't slide easily past the screw nor will the head hold the lever cap accurately. After smoothing out the burrs, lubricate the parts with camellia oil.

Tension the plane before truing the sole

The final steps are to flatten and fix up the sole of the plane. At this point the plane should be completely assembled; be sure the blade is backed off inside the body. Cast iron is slightly flexible and can move a bit from pressure exerted on it, so having the plane assembled and "tensioned" will ensure accuracy during this step.

Get the sole flat by running the plane over sandpaper glued to a flat substrate. If the bottom is scarred and badly out of flat, start with 80 grit. Otherwise, begin with 120 grit, then move up through the grits to 400.

Once you have the sole flat, ease all of the edges with a mill bastard file.



Progress is easy to see. Work the sole until all high spots (above) are removed. When you're finished (below), lubricate it with a light oil, such as camellia oil.



Rough throat? Smooth it with a file

The throat area must be flat with a crisp, straight edge to help hold down the grain of the board in front of the blade while making a pass. If the plane has small nicks or a wear curve at the front edge of the throat, the blade could lever up the grain, causing tearout.

Use a mill bastard file to dress the edge flat, carefully holding the file perpendicular to the bottom of the plane body (sole).

Once that's done, add a light coat of camellia oil on the sole, which will keep the new surface slick and free of rust.

Some tips on setup

After you've finished rehabbing the plane, hone the blade

REFINE THE ROUGH SPOTS



Soften the edges. After flattening the sole, ease the corners with a mill bastard file.



Remedy for a rough throat. If the throat has small nicks, dress the edges carefully with a mill bastard file. Be sure to hold the file perpendicular to the sole.

READY FOR TAKEOFF

Dial in the throat opening. When reassembling the plane, adjust the frog to create a tight opening between the blade and the front of the throat. For most work, $\frac{3}{32}$ in. is plenty.



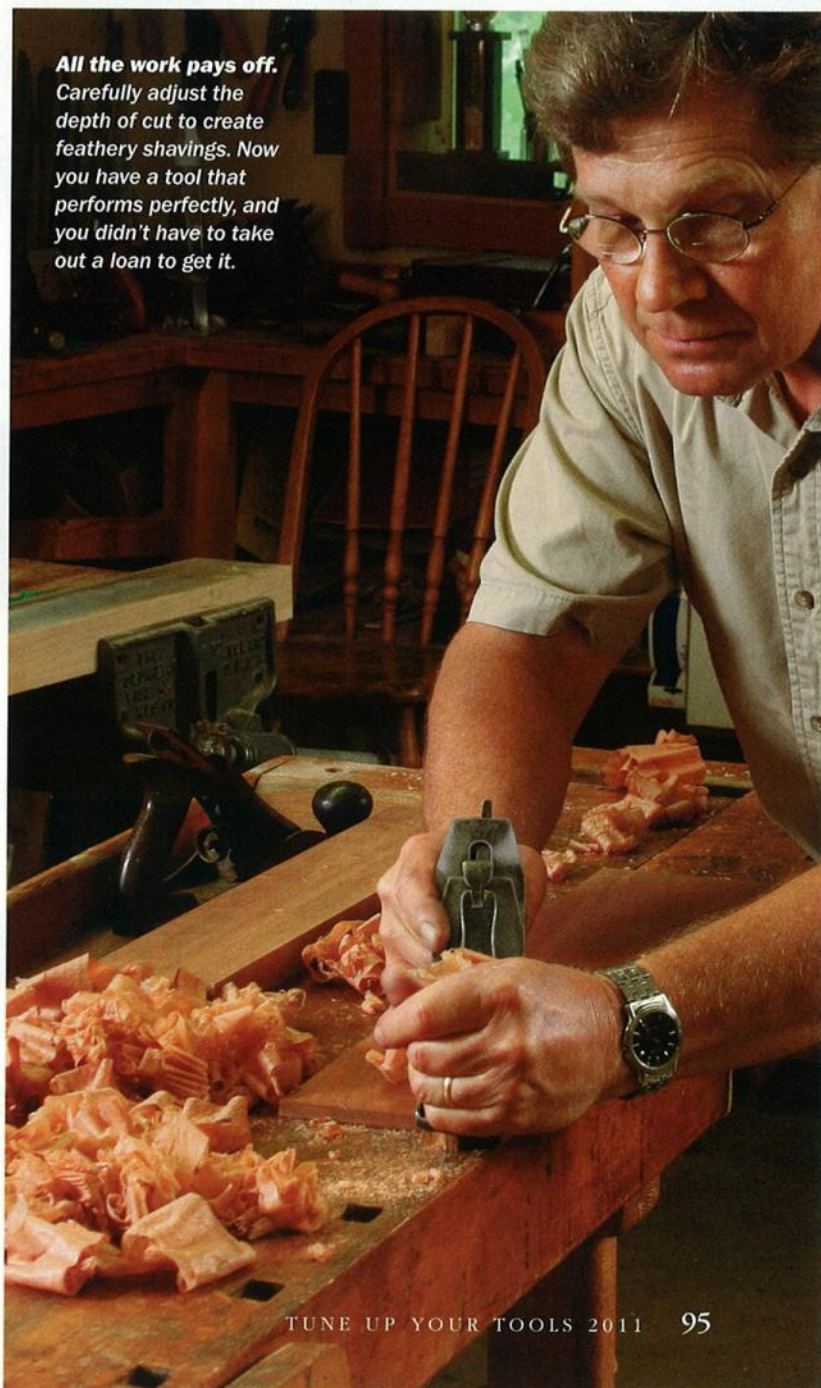
to perfection. When reassembling the blade and the chipbreaker, set the chipbreaker about $\frac{1}{16}$ in. or less from the tip of the blade.

Now adjust the throat opening. First, just break the screws loose so that the frog can move. Place the blade assembly on the frog, and add the lever cap with the lever in the down position. Tighten the lever-cap screw until it just touches the lever cap, and then give it about a quarter turn more. The lever should be easy to open and close but will still offer sufficient pressure to keep the blade assembly in place.

Now turn the frog-adjustment screw, which is located behind the frog, to move it forward or backward. For most work, a throat opening of about $\frac{3}{32}$ in. between the tip of the blade and the front of the throat will be sufficient. A narrower opening will help you tackle more difficult woods. When the desired opening is reached, remove the lever cap and blade assembly and tighten the frog-holding screws just enough to hold the frog securely in place.

Now, with a carefully restored plane and a razor-sharp blade, you're ready to tackle any wood like a pro. And you'll have a reliable tool for life. □

All the work pays off. Carefully adjust the depth of cut to create feathery shavings. Now you have a tool that performs perfectly, and you didn't have to take out a loan to get it.





HAND TOOLS]

Get Sharp—*Fast*

Learn how to sharpen, and stop struggling with hand tools

BY DENEK PUCHALSKI



For many woodworkers, sharpening plane irons and chisels is an intimidating and frustrating task. I've traveled the country teaching and demonstrating sharpening and hand-tool techniques for Lie-Nielsen Toolworks for the past nine years, and I've met plenty of woodworkers who struggle to get a consistently sharp edge on their tools and are convinced that sharpening is beyond their reach.

Sharpening doesn't have to be difficult and mysterious. The method I'll show you combines ideas I've picked up over 25 years of working with hand tools. I've demonstrated it countless times.

The heart of this approach is a collection of simple tools: a \$15 side-clamping honing guide, a supply of sandpaper in several grits, 1,000- and 8,000-grit waterstones (or a combination stone if you like), a thin metal ruler, and a shopmade stop board that will help you quickly and reliably set the correct honing angle every time. With these tools, you can handle the most common sharpening tasks—honing, grinding, and repairs—for every kind of blade.

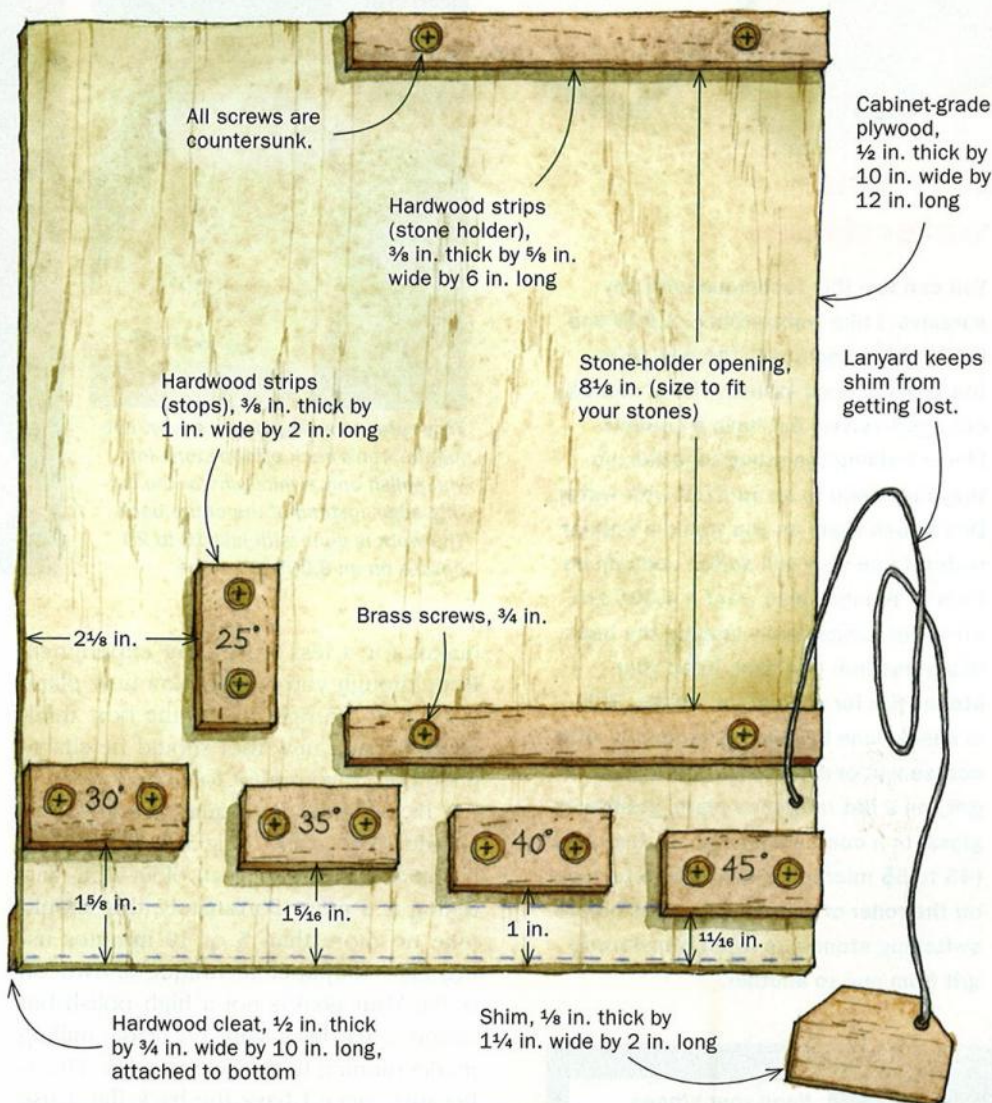
Using this method, you'll get a truly sharp edge, allowing your tools to cut more cleanly and efficiently with less effort.

Start with a time-saver: The ruler trick

Many woodworkers buy a high-end hand plane with the idea that their woodworking will get better. It's true that a better tool

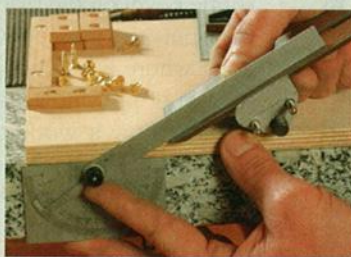
AN ALL-IN-ONE HONING STATION

A board with multiple reference stops is a great way to set honing angles reliably. This compact jig also supports your sharpening stones. The measurements shown give approximate angles for most side-clamping honing guides. For best results, set your own stop distances as shown below.



SET YOUR OWN ANGLES

To locate a stop at the correct distance for a given angle, place an iron in the honing guide and use a protractor to set the angle. Then, butt the guide against the board and place the stop against the iron's edge. Use brass screws to secure the stop parallel to the edge.



Shim adjusts angles. The 1/8-in.-thick shim adds about 2° to shallower angles and up to 5° to steeper ones.

A new blade only needs honing

HONE JUST THE TIP OF THE BACK

Why I like waterstones

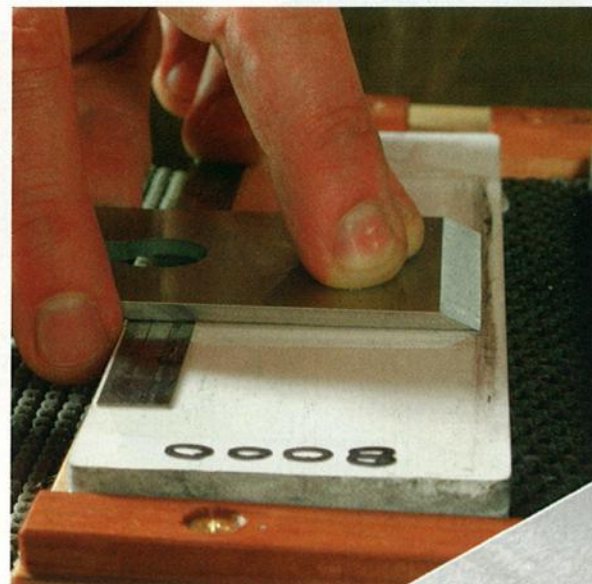
You can use this technique with any abrasive. I like waterstones, 1,000 and 8,000 grit, specifically the new Shapton glass-backed stones. These stones cut aggressively but have a ceramic binder holding the stone together, so they only need to be spritzed with water. Don't soak them as you would a regular waterstone; they will soften and can be ruined. You may also want a 4,000-grit stone for occasionally lapping the back of a plane iron or chisel. Keep your stones flat for consistent results. This is easily done by lapping frequently with coarse wet-or-dry paper (150 to 220 grit) on a flat reference plate, granite or glass, or a coarse diamond lapping plate (45 to 55 micron). Also, be sure to wipe off the roller of your honing guide before switching stones, to avoid transferring grit from one to another.



Keep your stones flat. Lap your sharpening stones often with a diamond plate or coarse wet/dry sandpaper on a flat surface. Do this often and it will be less work each time.



Tiny ruler is a huge time saver. Lifting the iron's back off the stone lets you polish only a thin band at the cutting edge, instead of the entire back. The work is done with just 10 to 20 passes on an 8,000-grit stone.



makes for a less frustrating experience. But although you may think a new plane is ready to go right out of the box, think again. Even a new tool should be sharpened before you put it to wood.

A brand new, high-quality plane iron should have a flat back. If it doesn't, or if you're working with an older iron, flattening is a must. Fortunately, this should take no more than 5 or 10 minutes using the sandpaper technique shown on p. 94. Your goal is not a high polish but simply a flat back with no heavy milling marks running to the cutting edge. This is because, once I have the back flat, I use David Charlesworth's ruler trick to create a subtle bevel on the blade's back. The ruler trick puts the honed surface at the cutting edge where it belongs and eliminates the tedium of polishing the entire back.

Here's how it works: Place a thin metal ruler (0.020 in. thick or less) on one side of the 8,000-grit stone. Now place the back of the blade on the ruler and lower the blade's tip onto the stone. Work it up and down until you can see an even mirror polish about $\frac{1}{32}$ in. wide, from corner to corner, at the edge of the blade. Now you're ready to hone the bevel.

The typical bevel-down smoothing plane blade comes with a primary bevel of about 25°. There's no need to hone the entire primary bevel to get a sharp edge, though.



It's more efficient to create a small, steeper secondary bevel right at the cutting edge. For the most common primary bevel of 25°, a secondary bevel of 30° works well.

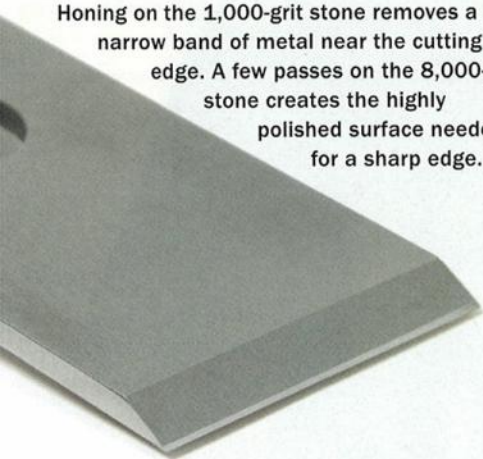
I use steeper angles with scraper planes, as well as bevel-up tools for working in hard, highly figured woods. The harder the wood, the higher the angle.

How to find and hold the right angle

To hone the secondary bevel, I use a honing guide. Some woodworkers call this cheating. As someone who learned long ago to sharpen freehand, I say it's not. A honing guide holds the blade at a consistent angle as you work the edge and move from stone to stone. The secondary bevel remains flat, and each successive grit reaches all the way to the tip of the edge.

SAME GOES FOR THE BEVEL

Honing on the 1,000-grit stone removes a narrow band of metal near the cutting edge. A few passes on the 8,000-grit stone creates the highly polished surface needed for a sharp edge.



I use a simple, side-clamping honing guide. To set the angle consistently, I constructed a stop board (see drawing, p. 91), which consists of a plywood base and several stops to set the blade a certain distance from the front of the guide. The shorter the distance, the steeper the honing angle. My board has stops for five common angles: 25°, 30°, 35°, 40°, and 45°. I also use a 1/8-in. shim to increase an angle at any of the stops. With a long projection like 25° to 30°, 1/8 in. represents roughly a 2° increase in angle. With a short projection like 45°, the same 1/8 in. represents about 5°.

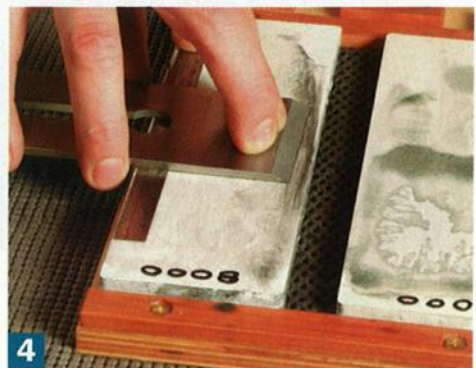
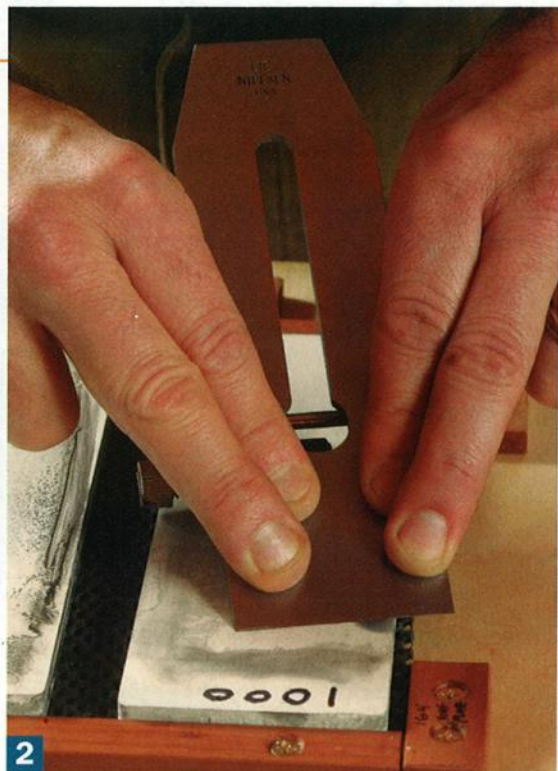
Honing takes less than a minute

Set the blade to the correct angle and tighten the guide so the blade won't shift. Begin with the 1,000-grit stone, working back and forth and applying even pressure. After four or five passes, you should be able to see and feel a burr or "wire edge" on the back of the blade. This burr indicates that you have removed the dulled edge and it's time to change stones.

Before sharpening on the 8,000-grit stone, wipe off the roller wheel of the honing guide so that you don't transfer grit from stone to stone. To ease off some of the burr, take one pass on the blade's back, drawing the blade toward you. Now work the bevel side, taking another four or five passes. When you see a clean and brightly polished parallel line right at the blade's tip, you are done. However, if you applied uneven pressure on the blade, the polish line will be wider at one corner than the other. This can be corrected



1 *This should take only a minute. Use the 30° stop on the board to set the iron in the honing guide (1). Four or five passes on the 1,000-grit stone should be enough to raise a burr on the iron's back (2). Take a handful of passes on the 8,000-grit stone to create a highly polished narrow band at the tip (3). Finally, repeat the ruler trick to remove any remaining burr on the back (4).*

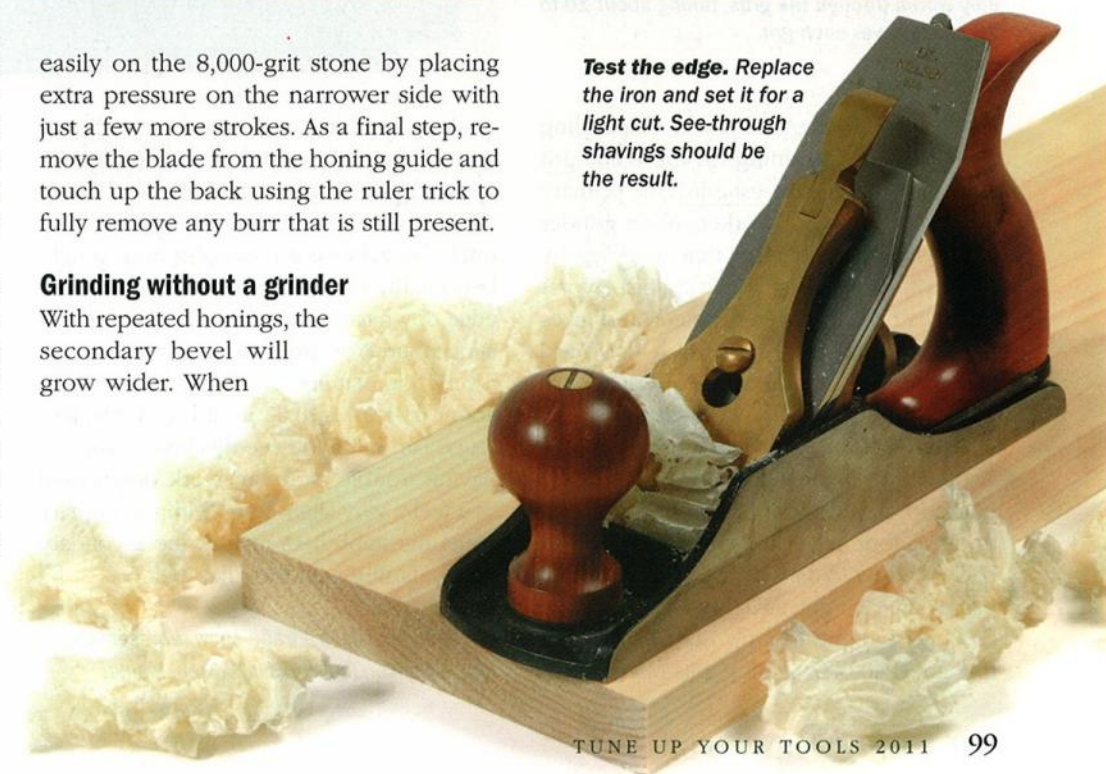


easily on the 8,000-grit stone by placing extra pressure on the narrower side with just a few more strokes. As a final step, remove the blade from the honing guide and touch up the back using the ruler trick to fully remove any burr that is still present.

Grinding without a grinder

With repeated honings, the secondary bevel will grow wider. When

Test the edge. Replace the iron and set it for a light cut. See-through shavings should be the result.



Ready to regrind? Sandpaper is safer

Repeated honings will eventually widen the secondary bevel to the point (as seen below) that it's no longer quick and convenient to hone. Before you reach that point, regrind the entire surface back to the original bevel angle and then re-establish the narrow secondary bevel.



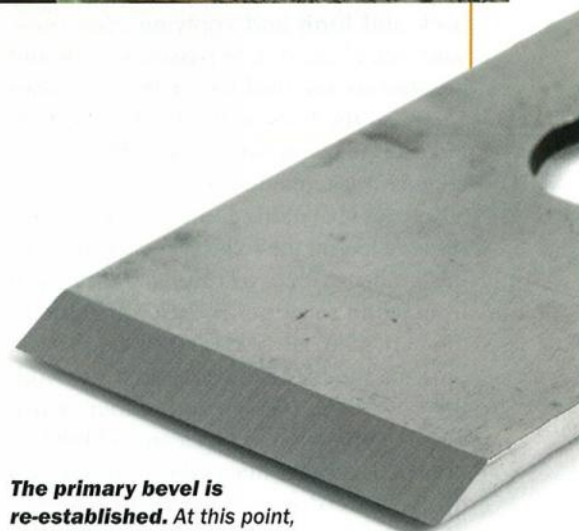
Set the angle. Most primary bevels are ground at or near 25°. Puchalski uses sandpaper in grits ranging from P80 to P400. He attaches the paper to a flat slab of granite and repeatedly works through the grits, taking about 10 to 15 passes over each grit.

it becomes too large, and you're spending 20 to 30 passes honing on the 8,000-grit stone, you need to re-establish the primary bevel. A lot of woodworkers use a grinder for this, but I've found that working by hand on sandpaper is just as fast, won't burn the tip and soften the steel, and gives me more control. You need a flat, hard substrate to attach the sandpaper to. I use granite, but plate glass works too.

Re-establishing the primary bevel—Use the stop board to set the blade in the guide to the correct primary bevel. Attach three or four grits of 3-in.-wide adhesive-backed paper to the substrate. Take 10 to 15 passes on each grit, switching from a coarse (P80 to P180 grit) to a medium (P220), to a fine grit (P400). Switching grits often avoids

working too long in the same scratch pattern. It also helps prevent unintentionally crowning the blade, which makes honing difficult. Continue cycling through the grits until you achieve a consistent and straight bevel at the desired angle. Do not work the edge down to a point. Stop just short of creating a burr. You are done when you can see a very thin, flat line on the tip of the blade, about 0.01 in. or 0.02 in. thick. A jeweler's loupe can help you see this line. If you are having trouble, you can work down until you feel a very slight burr. With the primary bevel re-established, rework the secondary bevel, starting with the ruler trick. □

Deneb Puchalski is a trade-show representative for Lie-Nielsen Toolworks in Warren, Maine.



The primary bevel is re-established. At this point, you're ready to hone the back using the ruler trick and then hone the bevel.

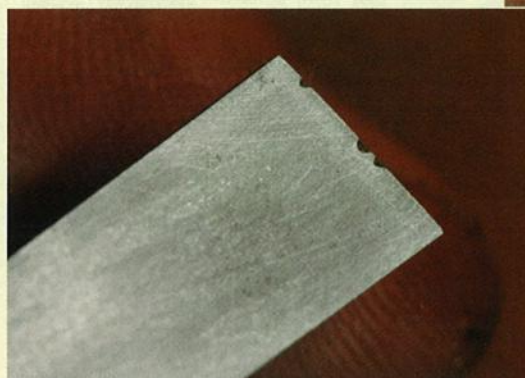
Same method for chisels, with a few tweaks



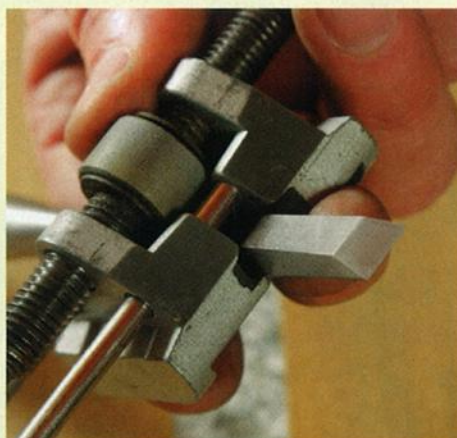
Like new plane blades, chisels aren't ready to go right out of the box. The good news is that this sharpening method works for chisels, too. The bad news is that the ruler trick won't work. You need to flatten (on sandpaper) and polish (on stones) the entire back because it serves as a reference for paring and other fine work.

Once the back is flat, mount the chisel in the honing guide. Its lower position in the guide creates a honing angle that is about 5° shallower than the marked angles on your board. So your 30° stop becomes 25° and so on.

Because I can control the angle and am not removing much material, I work the entire face of the primary bevel on the 1,000-grit stone, then hone a secondary bevel a few degrees steeper on the 8,000-grit stone. Use the 1/8-in. shim to increase the angle. I avoid sandpaper grinding unless I get a heavy nick in the edge.



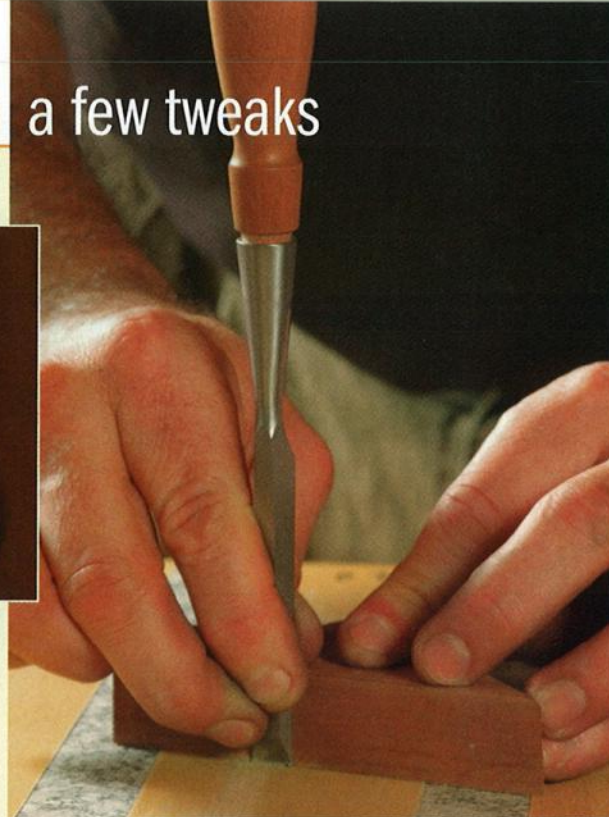
Fix the nicks first. There's no point in honing this edge until the nicks have been removed. Puchalski uses a block of wood to hold the chisel perpendicular to the sandpaper as he grinds the edge back to remove the nicks. Then he regrinds the primary bevel with the chisel in a honing guide. The same method works for plane blades.



Fitting the chisel in the honing guide. The chisel rides in the lower set of jaws. The lower jaws also hold narrow plane blades.

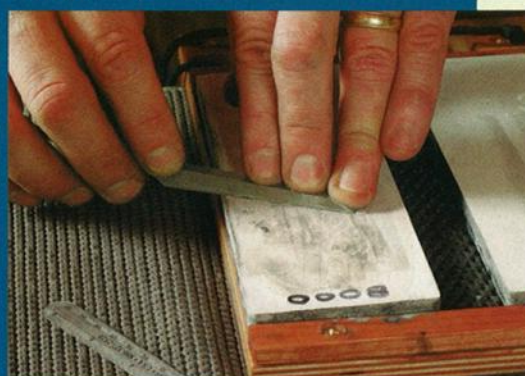


Honing in two steps. Puchalski works the entire face of the bevel on the 1,000-grit stone, then hones a secondary bevel a few degrees steeper on the 8,000-grit stone.



The angles are different. Chisels ride lower in the honing guide and project farther out of it. To compensate, choose a stop that is 5° steeper than your desired angle.

IMPORTANT NOTE!

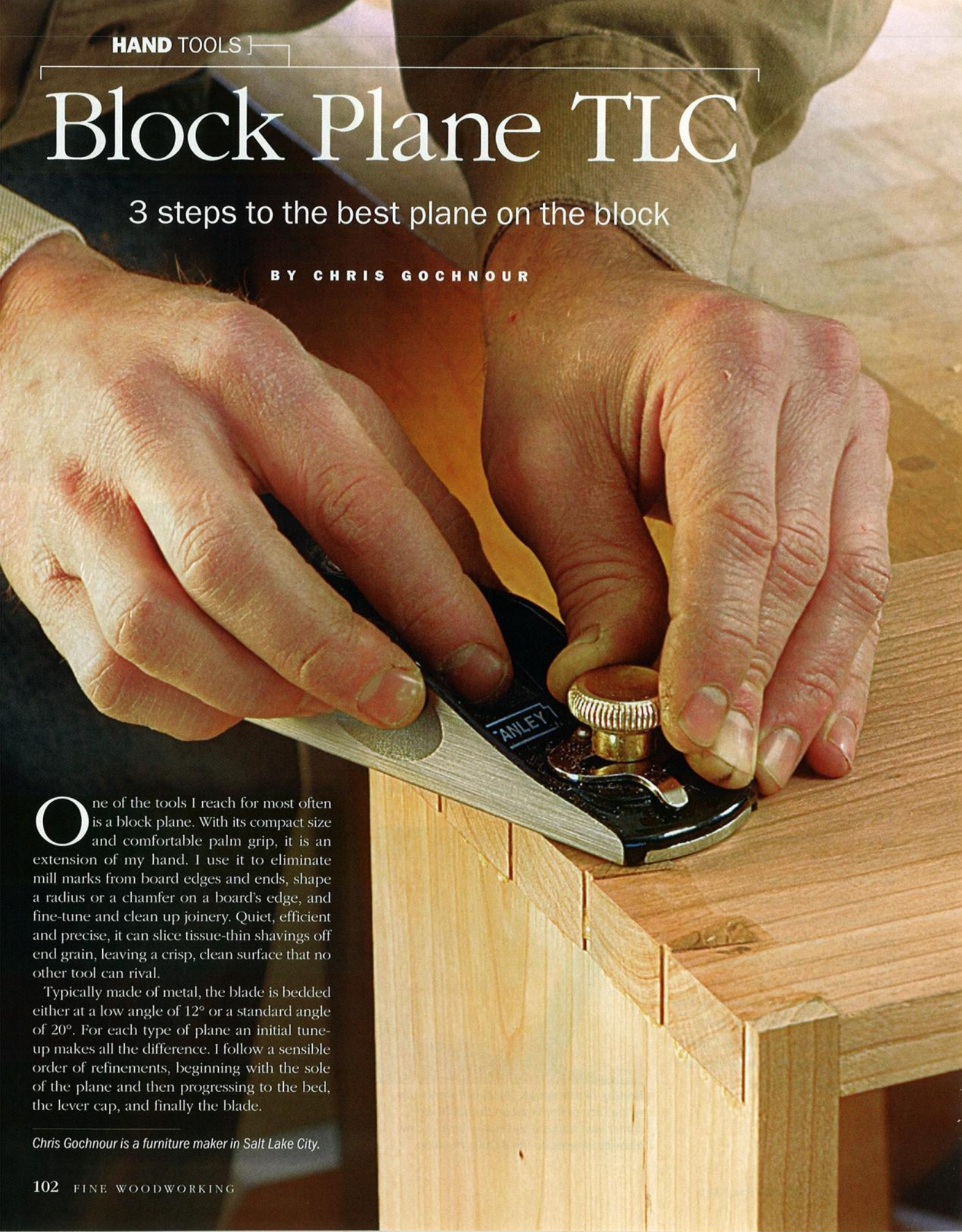


Avoid the ruler trick with chisels. Once you're done honing, take a couple of passes on the back to remove the burr. Keep the back flat on the stone.

Block Plane TLC

3 steps to the best plane on the block

BY CHRIS GOCHNOUR



One of the tools I reach for most often is a block plane. With its compact size and comfortable palm grip, it is an extension of my hand. I use it to eliminate mill marks from board edges and ends, shape a radius or a chamfer on a board's edge, and fine-tune and clean up joinery. Quiet, efficient and precise, it can slice tissue-thin shavings off end grain, leaving a crisp, clean surface that no other tool can rival.

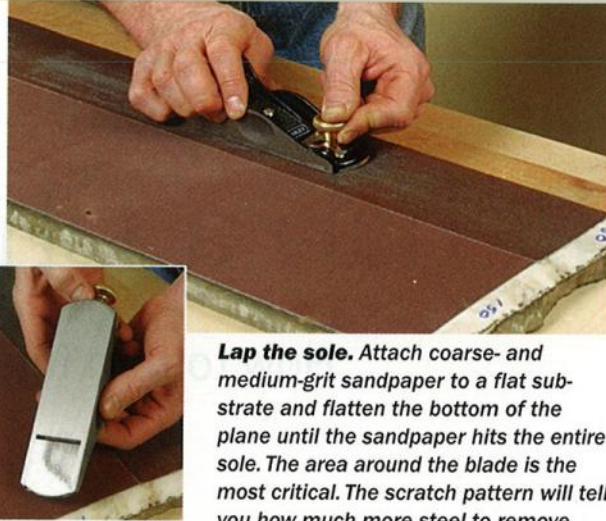
Typically made of metal, the blade is bedded either at a low angle of 12° or a standard angle of 20°. For each type of plane an initial tune-up makes all the difference. I follow a sensible order of refinements, beginning with the sole of the plane and then progressing to the bed, the lever cap, and finally the blade.

Chris Gochmour is a furniture maker in Salt Lake City.

1. FLATTEN THE SOLE

A convex or concave sole will leave the cut unsupported, causing unpredictable results, so I always check to see whether the sole is flat. Before lapping the sole flat, I also check that the adjustable throat seats well in the plane body. Remove the throat plate and check for any burrs or debris and then use a file to eliminate any trouble spots. Reassemble the plane, making certain the throat plate seats properly and moves freely.

I flatten planes by putting abrasive paper on a flat surface (plate glass, a slab of granite, or a jointer bed) and lapping the bottom of the plane. I always keep the blade in the tool, properly tensioned but raised above the sole. Begin with 80 grit and then follow with 150 and 220. You can stop there and let actual use further polish the sole, or go one step further to 320 grit.



Lap the sole. Attach coarse- and medium-grit sandpaper to a flat substrate and flatten the bottom of the plane until the sandpaper hits the entire sole. The area around the blade is the most critical. The scratch pattern will tell you how much more steel to remove.

2. TUNE THE LEVER CAP AND BED

The blade must have a snug fit with the lever cap and the bed of the plane. First remove any rough burrs or sizable drips of japaning (black paint) that prevent a stable fit between the cap and blade. Then check that the bed of the plane is free from rust, paint globs, grime, or coarse machining. The blade must have a solid footing to remain still under pressure.

Eliminate any imperfections with careful filing, being cautious not to make matters worse by being reckless with the file.



Tune the lever cap. While protecting the back of the cap assembly with a piece of paper, sand the paint off the front edge for a snug fit with the blade.

Level the bed.

Insert a small wood block into the back of the plane body as shown (right), to raise the file to the blade angle. Don't over-file.



3. LUBRICATE THE PARTS AND HONE THE BLADE

The plane's vertical adjuster and adjustable throat will work more smoothly with a light drop of machine oil on each part. A little paste wax on the sole of the plane will keep it gliding freely and prevent rust.

Sharpen the blade as you would any other, remembering that the sharpening angle of a block plane impacts performance. Because a block plane has its bevel up, its cutting angle is the sum of the bed and the sharpening angle. I sharpen my standard (20° bed) and low-angle (12° bed) planes with a 25° bevel, producing 45° and 37° cutting angles, respectively.

I use a honing guide because it helps maintain the desired bevel angle. There are two sides to a sharp edge: the bevel and the blade's back. I take both surfaces to 6,000 grit on my waterstones.



Adjust the throat. A small gap in front of the blade supports the finest cuts; a larger gap is required for heavier cuts.



Wax the sole. This protects the plane from rust and makes for smooth sliding action.

Rehab a Cheap Spokeshave

How to turn this tool into a peak performer

BY ALFRED SHARP





A quick tune-up is all you need

You'll never regret spending the money for a quality spokeshave. But if you already have an inexpensive one or you can't resist a flea-market bargain, there are a couple of ways to tune them up to perform like their costlier cousins. Start by buying a thicker, aftermarket blade in high-carbon steel, and spend some time sharpening it until both surfaces making the edge are fairly polished.

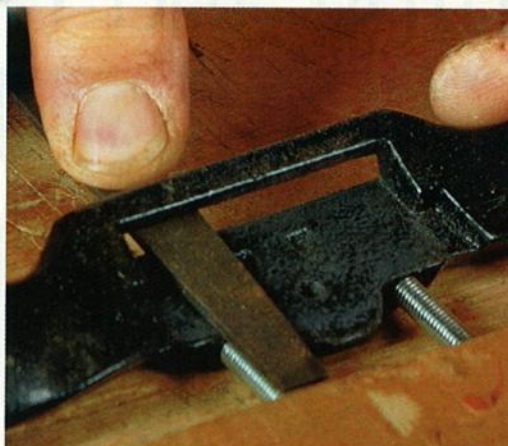
The typical lower-priced metal shave has a wide throat that looks ready to take a chunk worthy of a drawknife. To correct this, you'll need to make a hardwood shim that fits between the frog and blade and closes the throat.

If your shave has the two blade-adjusting screws, the shim shouldn't be so thick that the blade no longer engages these screws. A maximum throat opening of 0.020 in. (four pieces of copier paper) allows for a reasonably thick shaving while still cutting cleanly and without chatter.

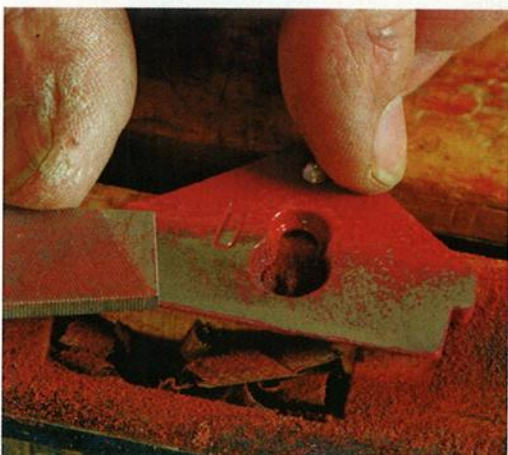
While you are working on the throat clearance, inspect the frog and correct any problems you find there. Often the paint used on the body of the shave has gotten onto the frog's surface, even collecting in a fat sag. Carefully scrape down to the metal and then check the surface for flatness. A little judicious filing may be in order. Careful: Don't nick the front edge of the throat or you'll be left with an irregular mouth opening.

If the frog doesn't register the blade square to the sole, correct that too by filing. Then you can calculate the thickness of shim needed to create the proper throat. □

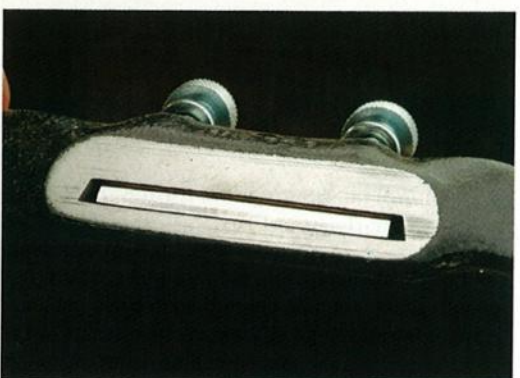
Alf Sharp (alfredsharp.com) is a period and contemporary furniture maker near Nashville, Tenn.



Body and sole. Scrape away any surplus paint and then check the surface for flatness and whether the blade registers square to the sole. A little judicious filing (left) will correct either problem, but be careful not to nick the front edge of the throat. Budget spokeshaves often come with coarse scratches on the sole. Use a file to remove these and flatten the sole at the same time (right).



Smooth the chipbreaker. Rough casting and paint prevent many chipbreakers from making good contact with the blade. File down to flat metal (left). Bevel the leading edge (right) to create a tight joint with the blade, which keeps shavings from getting caught under the chipbreaker.



Close the throat. Make a dense hardwood shim (left) that fits between the frog and blade. The shim shouldn't be so thick that the blade no longer engages the adjustment screws. The tighter throat (right) makes for much smoother cuts.

Sharpening and Using Card Scrapers



Reach for this tool on difficult wood

BY BRIAN BOGGS

Card scrapers are ideal for lightly cleaning up areas of torn or gnarly wood that no other tool can deal with. This is not to say that scrapers cut better than planes; they seldom do. On really difficult grain, though, a scraper can finish a surface where almost any smoothing plane will struggle.

How a card scraper works

As the shaving forms, it immediately encounters the near vertical face of the scraper. Before the shaving can lift off the workpiece, it is compressed between the uncut wood ahead of the tool and the face of the scraper. The angle of the face of the scraper determines how compressive the force is. It also determines how

deeply the burr will bite into the wood. Therefore, as the scraper is angled forward, it takes a more aggressive cut yet works extra hard to compress the larger shaving and minimize tearout. The downside is that the extra downward force actually crushes the pores as the scraper moves along, leaving a slightly fuzzy surface behind. The solution is to follow with a lighter cut, made with the scraper more upright, which will exert less downward force and leave a cleaner surface. A good way to maintain this higher angle and take a lighter cut is by pulling the scraper toward you.

The most common mistake when using a card scraper is to try to remove too much material. Beginners tend to create an enormous burr on the scraper and then angle the blade forward, hogging

off vast shavings. Not surprisingly, their thumbs get hot from the friction, and they find it difficult to maintain the flat plane of the surface of the workpiece.

You can use all four edges of a card scraper, so as soon as you feel the blade getting warm, turn it over and use another edge. The burr will last longer if it is kept from overheating.

Preparing a scraper

Sharpening card scrapers is one of the tasks that frustrates even experienced woodworkers, but I use a couple of jigs that get rid of the guesswork.

Most if not all scrapers need a lot of honing when new. Cheaper scrapers need initial work on a medium (325-grit) stone, but a fine (600-grit) stone is good for better scrapers. Just put all of your fingers right over the edge and hone away until the sides and edges of the scraper are smooth and meet at 90°. Now it's time to form the four cutting burrs. Lay the scraper on a piece of wood about 1¾ in. from the edge. With an oiled burnishing rod resting on, and at about a 45° angle to the edges of the scraper and the wood, stroke the scraper a couple of times. This stretches out the corner of the scraper so that a longer burr can be turned.

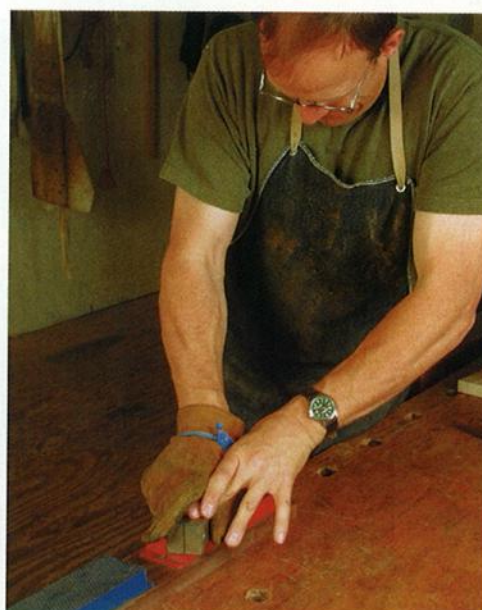
The burr on a well-tuned scraper is so small that I can't tell what angle it actually is, but I think it is less than the 5° normally recommended. To help create the perfect burr on a scraper, I use a wooden guide block, which also is used for honing (right). Place the scraper in the guide block so that the top edge protrudes between ½ in. and ⅙ in. (see the bottom drawing on p. 108). With the guide block locked in a vise, slide the burnishing rod across an edge of the scraper with the rod angled forward so that it rolls

SHARPENING A SCRAPER

STEP ONE: SMOOTH THE FACE AND EDGES



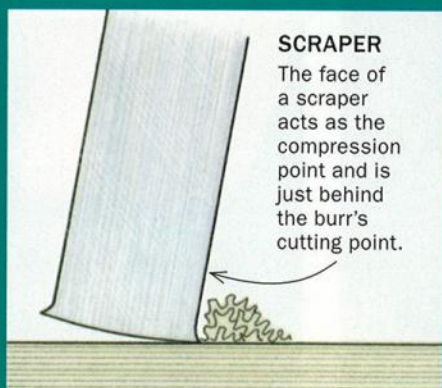
Hone the sides of the scraper. Polish the sides of the scraper on a fine diamond plate or sharpening stone.



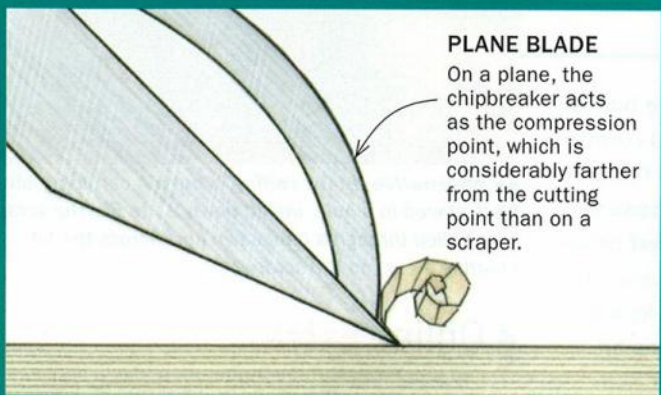
Hone the edges. A guide block helps hone the edges of the scraper 90° to the sides. The scraper should fit loosely enough that it can be pushed onto the sharpening stone.

SCRAPER VS. PLANE

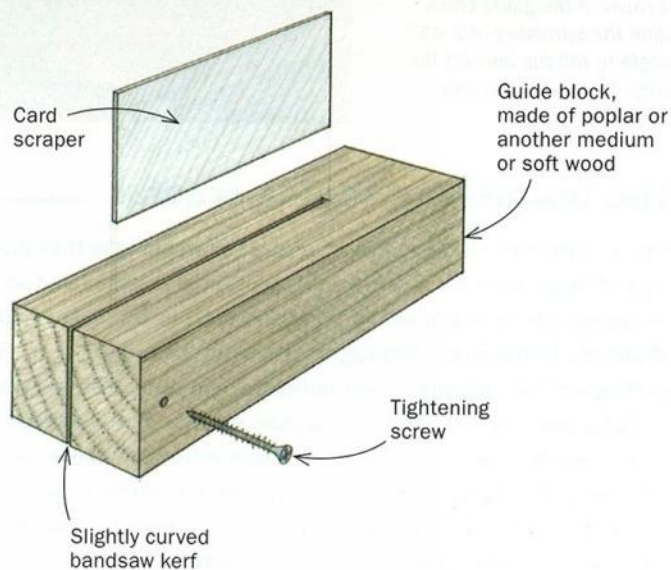
Both the scraper and the plane blade slice wood and then compress the shaving before it can lift and cause tearout. The scraper compresses the shaving while it is still short, so it is less prone to cause tearout on difficult woods.



SCRAPER
The face of a scraper acts as the compression point and is just behind the burr's cutting point.

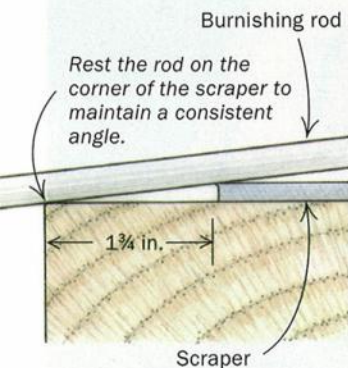


PLANE BLADE
On a plane, the chipbreaker acts as the compression point, which is considerably farther from the cutting point than on a scraper.

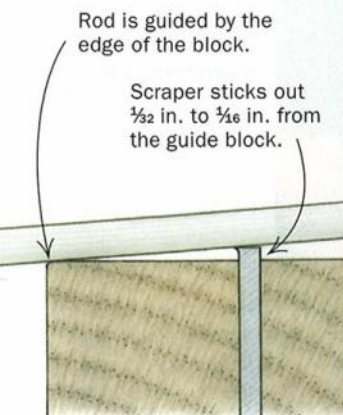


SHARPENING A SCRAPER (continued)

STEP TWO: CREATE A BURR ALONG THE EDGES



Stretch the edge. Push the burnisher along the side of the scraper to draw out a burr.



Roll the burr. With the scraper in the guide block, slide the burnisher at a 45° angle to roll the burr off the edge. It should take only one or two passes.



The burnishing tool is crucial

As important as anything else in scraper sharpening is the condition of the burnishing rod. It needs to be a very hard steel that is polished and scratch-free. I rounded the edges and polished an old triangular file, but Lee Valley makes a good teardrop-shaped burnishing rod. The slightest nick in the rod will tear off a burr instead of putting one on, so protect your burnisher and treat it as you would your best chisel.

I also have used the shank of a solid carbide router bit with very good results. You either can use it with the guide block described above, or you can make a jig and insert the bit into the angled hole (see the photo at right). Because the bit should be oiled when used as a router bit, it is best to choose an old bit or remove all of the oil before using it in a router again.

the burr off the edge. With a well-honed scraper edge, the weight of your hand and forearm should generate enough pressure to turn the burr. The rod has only a small area in contact with the scraper, which translates into a lot of pressure per square inch. The more passes you take, the more you will roll the burr, thus changing the cutting angle, so try to get the job done with one or two passes.

Renewing a scraper—You can repeat the stretching and rolling steps two to six times without rehoning, depending on the type of wood and the amount of material you are removing. Eventually, the edges of the scraper will become hardened from the burnisher, preventing a new burr from being rolled. Before this used scraper can be rehoned, the work-hardened metal must be filed away. Lay a single-cut bastard file on the bench and stroke the blade over it, perpendicular to the file. You'll feel the file start to cut easily as soon as the work-hardened surface of the scraper is removed.

To remove the file marks and to square the edge, place the scraper in the wooden guide block. Apply even pressure on both the blade and the block to keep the scraper square to the diamond plate (see the bottom photo on p. 107). As you do this, keep checking the edge until it develops a uniform shine. Remove the scraper from the block and repeat the face honing with very light pressure until the wire edge is removed. Now you can stretch and roll new burrs using the burnishing tool.

It may take you a few tries before mastering your card scrapers, but stay with it. You will be rewarded with greater efficiency and a more enjoyable finishing process on all your projects. □

Brian Boggs makes furniture near Asheville, N.C.



An alternative jig for rolling a burr. A carbide router bit is placed in a hole angled down 2° to 5°. The scraper is pulled through a bandsawn kerf across the bit, creating a burr on the scraper.

Online Extra

To see a video of the author preparing a card scraper, go to FineWoodworking.com/tuneup.



HAND TOOLS]

Great Carving Requires Sharp Tools

Learn to sharpen a curved gouge and you'll be able to sharpen its cousins

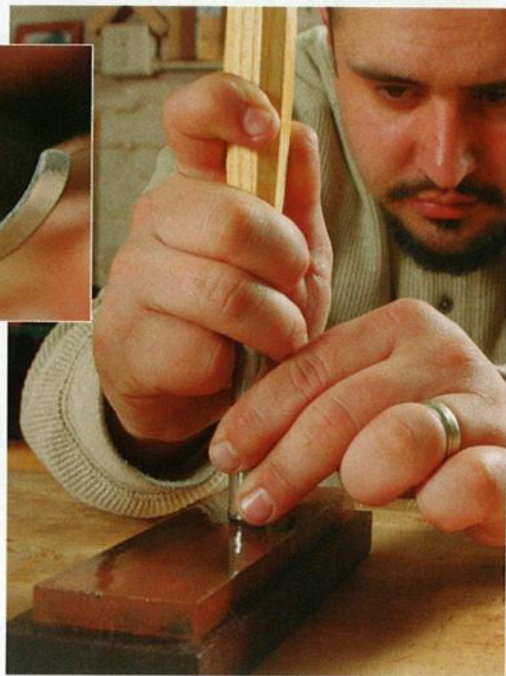
BY DAN FAIA

It is not the artistic side of carving that keeps some woodworkers from trying it, but the mechanics of how to sharpen the multitude of carving tools. This article will teach you how to sharpen a curved gouge, one of carving's most basic and useful tools. Gouges of various widths and curvature (sweep) are used throughout the carving process: the initial roughing out, the "setting in" of the carving's primary outlines, and the final details and finished

GRINDING A SMOOTH BEVEL



Joint the edge flat. Faia rests his forearms on the benchtop to help keep the tool perpendicular to the stone. The goal is a flat that's no more than $\frac{1}{64}$ in. or so wide.



Grind with a light touch. Steadily rotate the handle to work the entire edge. Also slide the tool from side to side to use the wheel's whole width. When you're done, the jointed surface should be almost gone.

Get the hang of honing



Center to side. Place the stone on the bench so its long axis crosses your body. Tilt the handle upward until the blade is seated on its bevel.

surfaces. Some of the techniques you'll learn also apply to other types of carving tools. On FineWoodworking.com/tuneup, I'll show how I sharpen two others.

Gather your equipment

To sharpen a gouge or any other carving tool, you need sharpening stones (one coarse stone, like an India stone, and one fine Arkansas). I use oilstones because they wear more slowly than other types of stones. If you plan to carve a lot, get a separate set of stones for your carving tools. Otherwise, you'll spend too much time keeping the stones flat for your straight-edge tools.

You'll also need a fine, profiled slipstone, a leather strop, and a bench grinder with a tool rest. A slow-speed grinder is best, but a high-speed one with a white or pink wheel is fine, too.

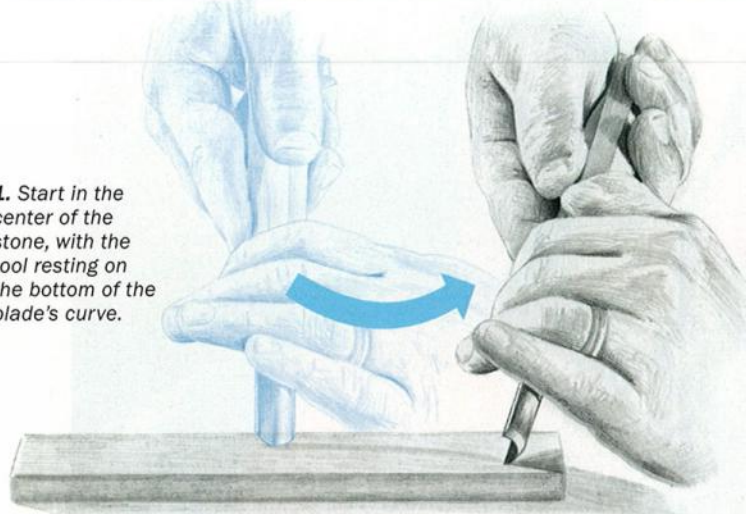
Start by jointing the edge

The first thing to do with a new gouge is to joint the edge. Jointing flattens and trues the edge and creates a narrow, flat surface on the tip. This flat serves as a visual reference to aim for when grinding the bevel, helping you to keep the edge consistent. Jointing is also important in repairing a damaged edge or if you need to grind the edge again to re-establish the bevel angle. I joint the edge on a fine India stone. Using a two-handed grip, hold the edge perpendicular to the stone and take six to 10 strokes, drawing the tool toward you. Your goal is a flat that's no wider than $\frac{1}{64}$ in. or so.

The next step is to grind the bevel. First, consider whether to bevel both sides of the edge or only one. Some carvers bevel both sides, but I find it easier to maintain the tool with a bevel only on the outside of the flute. Then consider the angle of the bevel itself. In general, a shallower bevel cuts more easily while a steeper bevel creates a longer-lasting edge. I like a 30° bevel because it gives you a durable edge that cuts effectively in all but the hardest woods. The steepness of the bevel also means that the tool's handle sits high enough when I'm cutting that my knuckles can ride underneath without bumping the work.

Setting the tool rest is easy. Most new tools come with the bevel set between 24° and 26° , and with a little experience you'll be able to use this angle as a reference to set the tool rest by eye. You also can set the angle using a protractor or angle gauge. The diameter of the wheel is not critical (because all of the hollow will be honed away). There's also no need to dress the wheel with a

1. Start in the center of the stone, with the tool resting on the bottom of the blade's curve.



2. Then work the gouge from side to side, rotating the tool as you go. End each stroke as the tool's corner touches the stone.



Move to the finer stone. Continue honing in the same pattern, switching to the Arkansas stone to polish the bevel.



Push back the burr. Use a slipstone, working the edge with short strokes along the tool's long axis. Return to the Arkansas stone and repeat the process until the burr is gone and the bevel fully polished.

Stropping is the secret



Pull and roll. Faia starts with the edge on one corner and pulls the tool toward him, rotating it onto the opposite corner as he goes.

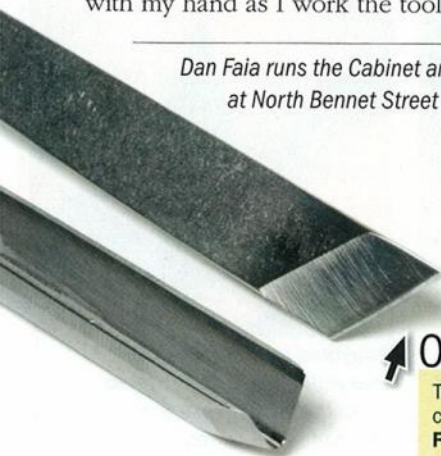
special shape—a flat grinding edge is what you want. To grind the bevel, hold the gouge flat to the tool rest and lightly touch the edge to the wheel. Steadily rotate the handle to ensure even grinding, and move the tool from side to side, using the whole width of the stone. Check your progress often. You'll know you're done when the jointed surface on the edge is almost gone.

Honing refines the edge

I start honing on the India stone. Orient the stone with its long side facing you. Start in the middle of the stone, with the middle of the flute facing down. As you move the tool toward the side, rotate the handle so that the stroke ends with the trailing wing in contact with the abrasive. The next step is to bring the tool all the way back across the stone, rotating as you go, so the opposite wing is touching when you reach the other end. But first, I back up just a little and work the same wing once more. This helps ensure even wear between the wings and the bottom of the flute.

Work until you raise a burr on the inside of the flute. Then use the translucent white Arkansas slipstone to push the burr back, holding the slipstone dead flat against the inside of the flute. Move on to the finer stone, repeating the process to polish out the scratches from the India stone. Using the stones, chase the burr from bevel to flute until the hollow is flattened, the bevel is polished, and you can no longer feel the burr. Finish by lightly stropping the bevel and flute to polish away any rough spots and create a highly sharpened edge. I charge the suede side of a piece of leather with honing compound (I like Herb's Yellowstone), and hold the strop flat on the bench with my hand as I work the tool across it. □

Dan Faia runs the Cabinet and Furniture Making program at North Bennet Street School in Boston.

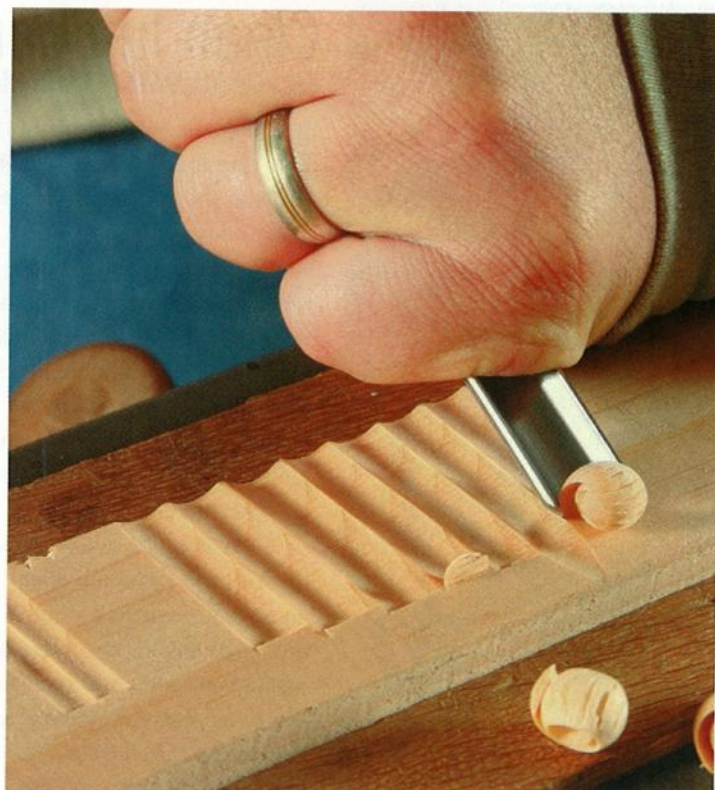


Online Extra

To see how Faia sharpens a skew chisel and a V-parting tool, go to FineWoodworking.com/tuneup.



Put a curl in it. Faia simply folds the strop over to work the inside of the gouge.



Do your carving tools cut like this? A series of clean cross-grain cuts with clearly defined ridges and no tearout indicates a sharp gouge.



Keeping tools sharp

AVOID DIRT AND DAMAGE TO ADD MILEAGE TO BITS, BLADES, AND CHISELS

BY ROLAND JOHNSON

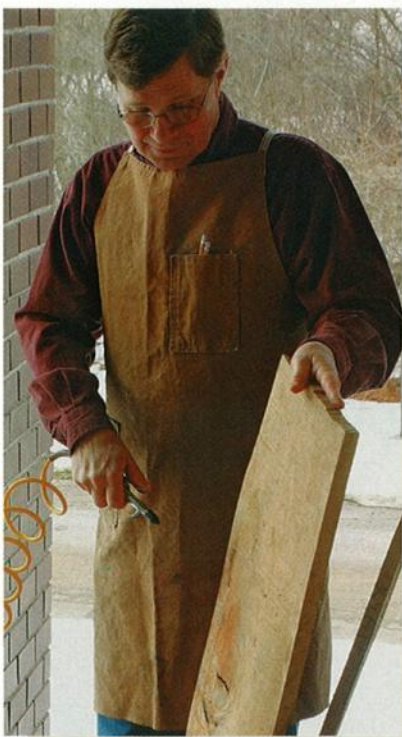
One of the most time-consuming tasks in a woodworking shop is sharpening, whether that means grinding and honing chisels, running to the store for a new cutter, or sending planer blades out to be sharpened. Although it's a chore that can't be avoided, it can be delayed. A variety of hazards will dull cutting edges prematurely. Steering clear of them will let you work more and sharpen less.

Among the worst of these is dirt. Cleaning debris off rough lumber before machining can help maintain a sharp edge on jointer and planer knives and sawblades. Removing pitch and sawdust to prevent buildup helps prevent cutters from dulling too soon. It's also important to protect your tools from collisions with other metal or hard surfaces that can mar a sharp edge.

Clean lumber before milling

Roughsawn lumber holds lots of dust and debris, which can act like sandpaper on cutting tools. A light brushing will not always get it out of the surface pores. The best way to clean the surface is to use compressed air and a wire brush. A quick blast will remove the bulk of dirt and debris, and a good brushing will dislodge the remaining grit. It's best to clean lumber outdoors so as not to spread dust on nearby material, tools, or workbenches. Although it cleans a bit more slowly than compressed air, a good shop vacuum can be used indoors because it will not spread dust around the shop. Used lumber poses different hazards. I use a metal detector to find embedded nails or screws that can dull or damage tool edges and remove them before proceeding with the cut.

Hand-scraping or chemical removal will take care of old paint, which will dull a cutting edge quickly and leave a residue on tools. But the wood has to be pretty valuable to go through all that hassle. The best bet is to avoid painted lumber altogether.



Compressed air removes the bulk of surface dirt. Clean boards outside, away from machinery, tools, and workbenches.



Use a wire brush to dislodge the rest. Scrub in the direction of the grain to remove debris.



Recycled lumber may contain nails. Use a metal detector to find hidden fasteners that can ruin a cutter.

Scrub and lubricate cutters

Toothed cutting blades on bandsaws, tablesaws, and chopsaws rely on clearance immediately alongside the sawteeth to help eliminate drag, and on gullets behind the cutter to remove the freshly cut wood fibers. If the teeth have pitch baked on their sides or if the gullets have crud built up on their edges, the blade will heat up and dull quickly. I clean my tablesaw blade frequently with a blade cleaner such as CMT Formula 2050 Blade and Bit Cleaner, or Easy-Off oven cleaner. I am careful to keep the gullets clean on my bandsaw blade, especially when resawing—a brass brush can clear blocked bandsaw gullets quickly without dulling the edges. In addition, a regular waxing or dry lubricant coating on the blade will minimize buildup and reduce friction in the cut. I find that paraffin wax or DriCote works well. Before applying DriCote, clean the blade with a solvent because this product needs to adhere to bare metal.

Drill bits, especially twist bits, suffer when chips build up in the flutes and can't be extracted from the bore hole. This is an especially big problem with bits used in hollow-chisel mortisers. The friction from the compacted chips can create enough heat to turn the metal of the chisel and the bit blue, effectively ruining the temper, or hardness, in both. Once steel loses its hardness, the cutting edge won't stay sharp for long. To improve the ability of bits to eject chips, I coat bits with DriCote.

Specialized lubricants can significantly enhance the operation of tools that rely on metal tables to support work being sawn, edged, or molded. Products such as Empire's TopSaver will keep a steel or cast-iron top slick, so less effort is needed to push material past a blade or cutter. Constant feed rates, essential to producing a consistent knife-mark pattern on molded edges, are easier to maintain when the table's friction is low.

REMOVE PITCH AND SAWDUST



Use a cleaner on tablesaw blades. Spray it on the buildup and let it sit before scrubbing with a brass brush.



Clean bandsaw gullets. With the machine turned off, rotate the upper wheel by hand as you pass a brass brush over the blade.

LUBRICATION SLOWS DULLING, RUST



Apply a dry lubricant on chisel mortisers.

The lubricant helps prevent buildup and keeps bits from dulling prematurely.



Wax bandsaw blades to reduce friction.

With the blade running, hold a piece of paraffin wax on the table and against the blade.

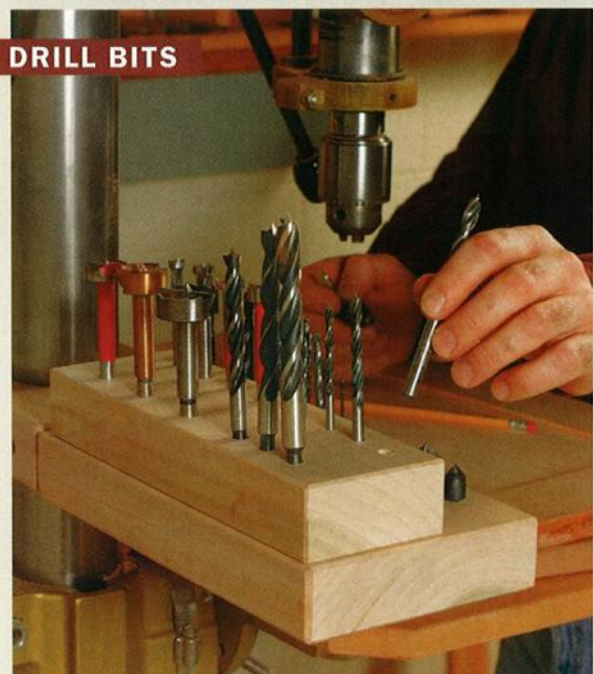
Protect sharp tool edges from hard knocks

I have an ongoing debate with a friend about the proper way to set a sharp handplane on a benchtop. I always set mine on the sole with the blade resting on a fairly clean wooden benchtop surface. I reason that there is less chance of damaging the blade, or myself, when the blade is covered. Resting the plane on its side exposes the blade, increasing the chances that I'll get a flesh wound or my plane will be damaged by another metallic tool.

Chisels laid on a benchtop should always point away from the woodworker, the project, and the other tools on the bench. Be careful to avoid clutter on a workbench; it is too easy to bump sharp cutting edges against metal.

Debris in tool trays, and the trays themselves, can nick and dull cutting edges. Keep trays clean and organized. Put a divider between each tool in a toolbox and if the toolbox is metal, line the interior with wood or heavy card stock.

Provide a safe haven for all cutting edges. I have a rack for my chisels; dowels on the wall for my files, rasps, and planes; trays for my router and drill bits that keep the sharp sides up and separated from one another; individual shelves for my tablesaw blades; and a separate dowel for hanging each of my bandsaw blades.



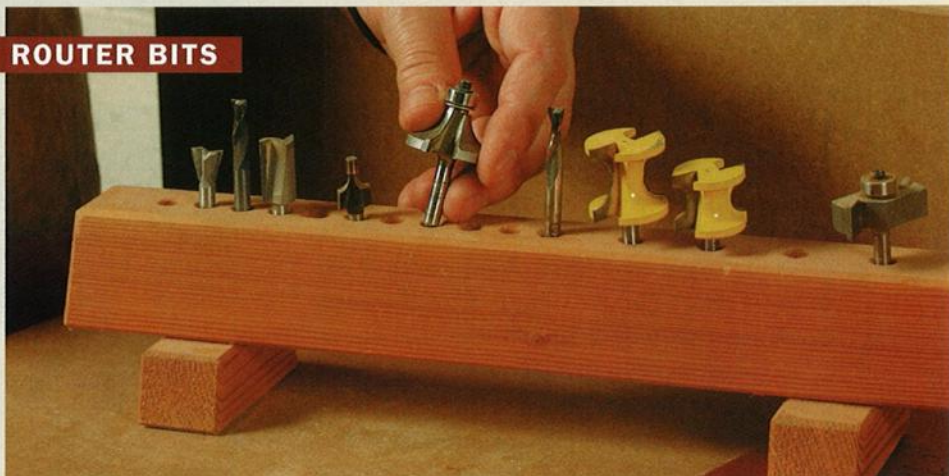
Bit rack clamps directly to drill press. This two-tiered rack easily holds most commonly used bits.

CARVING TOOLS



Lesser-used tools can be stored in drawers. Custom-made drawer dividers will help keep carving tools sharp.

ROUTER BITS

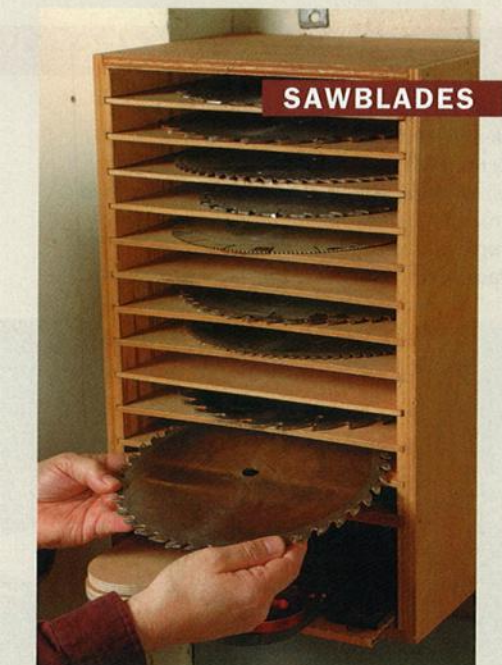


Make portable racks for your router bits. A small rack is portable and easy to make from scrap lumber.



CHISELS

Build racks for your chisels. Wall-mounted tools protect edges and allow for quick access.



SAWBLADES

Keep tablesaw blades separated. Cut dados into a simple case to accommodate 1/4-in. plywood shelves, set 1 in. apart. Leave the shelves loose so they can slide out for easy blade access.

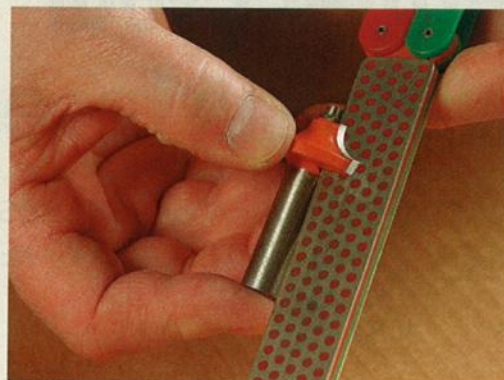
Touch up that edge before it's gone

It is faster and easier to hone a slightly dull tool than to regrind a really dull tool. As soon as the performance drops in any cutting device, it is time to give it a touch-up. Sometimes honing is as simple as running the flat face of a bit over the edge of a diamond stone to restore full performance.

Steel cutters such as plane blades and chisels also should be honed frequently during use and ground only occasionally. Carvers are seldom far from their honing system, whether it is a leather strop and diamond paste or a buffing system.

The same goes for scrapers. The burr that does the cutting on a scraper is relatively fragile and can start to lose its sharpness within a few strokes. But a quick once-over with a burnishing tool will restore the edge.

There's nothing like seeing fine shavings roll off the cutting edge of a tool. Protecting those edges and touching them up often will extend your working time between full sharpenings.



Sharpen router bits with a small diamond stone. Run the flat face of a bit over the stone, using the same number of strokes for each edge.



Hone plane irons regularly. Diamond paste on a piece of leather quickly renews an edge.

SOURCES OF SUPPLY

SOLVENTS

CMT Formula 2050 Blade & Bit Cleaner
tool-corral.com

Easy-Off oven cleaner
Widely available in stores

HONING ACCESSORIES

Diamond paste
japanwoodworker.com

Diamond stones
leevalley.com

LUBRICANTS

DriCote
woodworker.com

LPS1 Greaseless Lubricant
marvgolden.com

Kurobara Camellia Oil
japanwoodworker.com

Empire Top Saver and other dry tool lubricants
woodcraft.com

continuing care

Protect your shop surfaces

MACHINES, JIGS, AND BENCHES ALL BENEFIT FROM BEING SEALED AND WAXED

BY CHRIS A. MINICK

We go to great lengths to protect the projects that leave our workshops from the rigors of everyday use, yet we often neglect our jigs, fixtures, shop cabinets, workbenches, and tools—the very objects that allow us to create fine furniture in the first place. There's no need to French-polish your crosscut sled, but there are treatments that will make your jigs, benches, and machine tops work better and last longer.

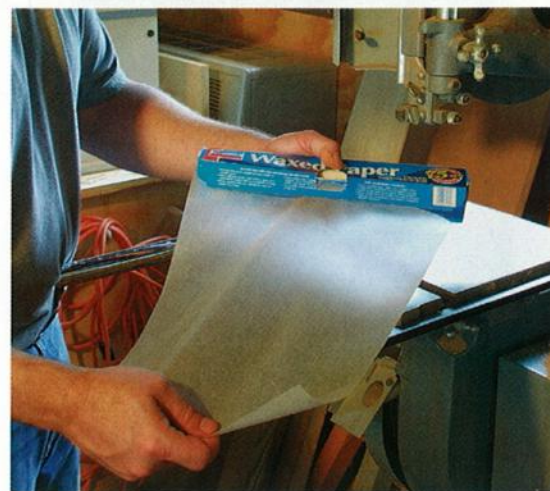
Prevent rust on machine surfaces

Bare metal will rust if not protected or used constantly. There are myriad products that purport to be the last word on metal protection. Each product claims to prevent rust and to leave a slick surface that will not contaminate wood. The ones I've tried have done neither, and I'm leery of applying oil to my saw top or jointer bed. As a consequence, I've adopted my own system for cleaning and protecting metal that works and doesn't require much effort.

I remove the rust by buffing the surface with a green pot-scrubbing pad. Small

WAX FOR MACHINE SURFACES

A green pot-scrubbing pad mounted to the hook-and-loop base of a random-orbit sander (left) removes rust and tarnish from machine beds. Kitchen waxed paper (below) can be used to protect and lubricate a machine bed. Simply crumple up the paper and rub it over the surface (right) to lay on a thin layer of wax.



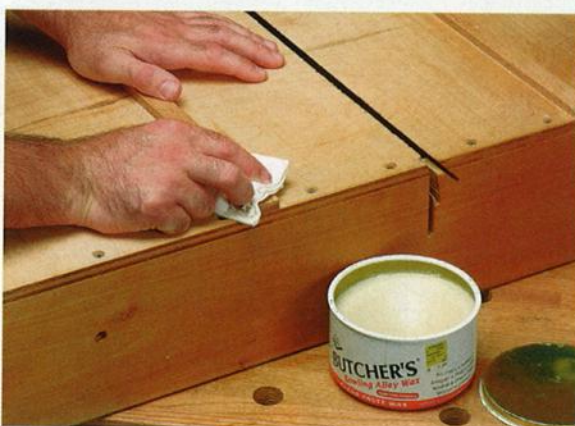
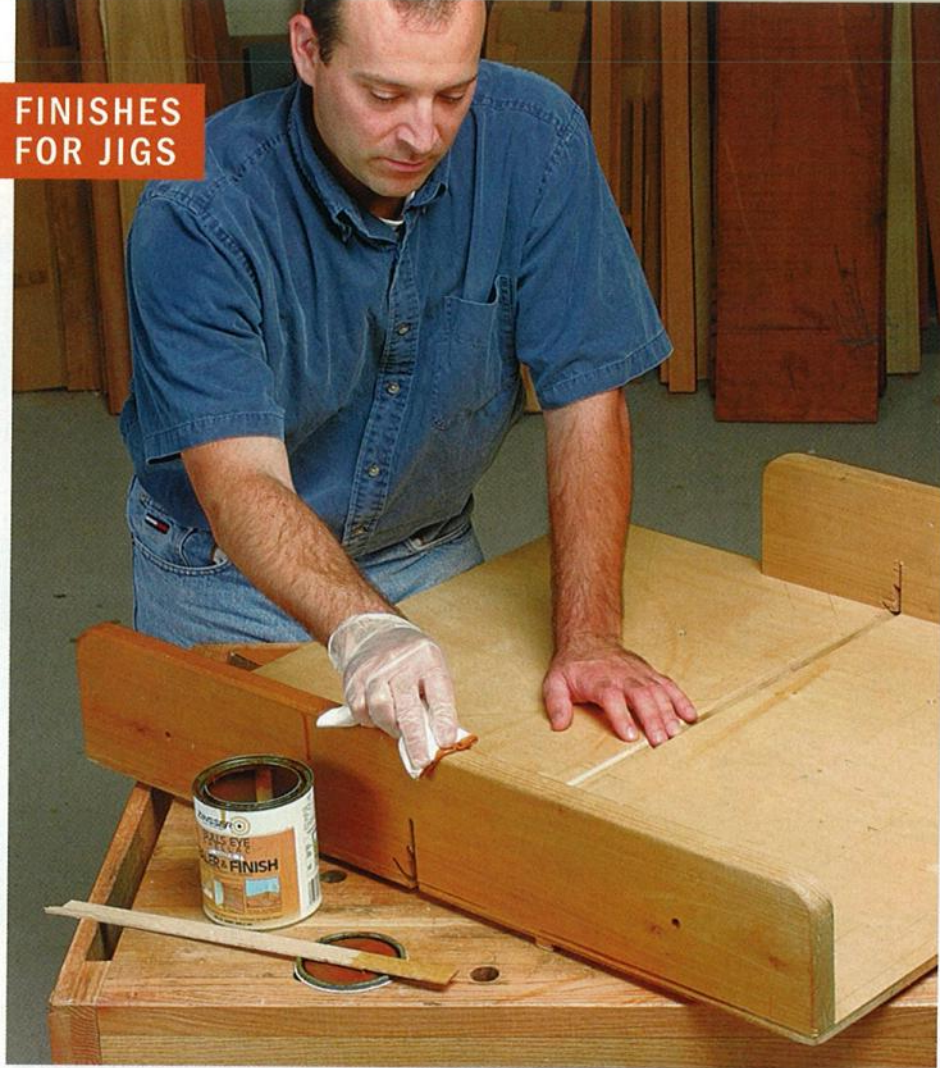
FINISHES FOR JIGS

items such as planes, chisels, or scrapers are buffed by hand, but large surfaces like my tablesaw or jointer get power-buffed with a 5-in. random-orbit sander. The hook-and-loop sanding pad holds the scrubber firmly while I guide it around the metal surface. Once it's rust-free, I polish the surface with a wadded-up piece of waxed paper. Just enough wax (carnauba, I've been told) transfers to the metal surface to protect it from rusting and to lubricate it simultaneously. Boards glide across the saw or the jointer as if they are floating on air.

High-pressure laminate requires virtually no maintenance and is the ideal surface for router tables, shop-cabinet tops, chopsaw extensions, and the like. Dried glue and finish easily scrape off, and a quick rubdown with waxed paper keeps the laminate slick.

Finishes help jigs last longer

There are several good reasons to finish jigs. Even simple jigs help us hold, saw, or bore wood precisely. The usefulness of most jigs depends on their accuracy, and they require a fair amount of time and effort to construct, so it makes sense to

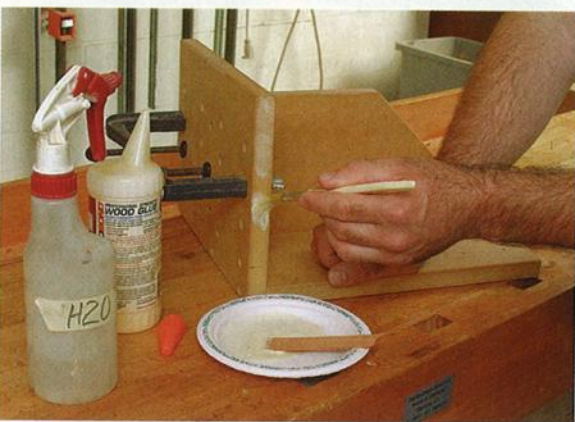


▲ SHELLAC

Shellac not only seals and lubricates, but it's also the best finish for reducing seasonal movement in solid wood.

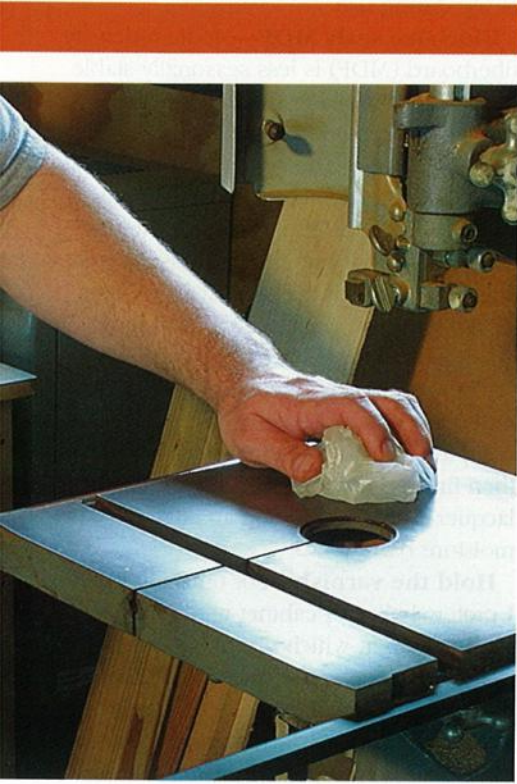
◀ WAX

The plywood parts of jigs need only a coat of paste wax to protect them from dirt and glue drips. The wax also helps jigs slide during use.



◀ GLUE SIZE

The edges of MDF are far more absorbent than the compressed faces. PVA glue diluted with water (called glue size) seals the edges, after which the whole jig can receive a coat of shellac.



TWO WAYS TO PROTECT BENCHTOPS

SACRIFICIAL SURFACE

Benchtops made from sheet goods are best protected with a sacrificial top of hardboard, which can be replaced easily when it gets worn out (left). Use the old surface as a template to mark the outline on the new top (below).



protect them properly. The type of finish depends on how the jig is used and the material it is made from.

Shellac on solid wood—Finishing jigs with shellac virtually eliminates dimensional changes in solid wood caused by seasonal humidity. That means the moisture content of wood finished with a few coats of shellac will barely change, even if the humidity level in the shop does.

I prefer dewaxed shellac to finish furniture, but for jigs I use the hardware-

store variety of premixed orange shellac. That cloudy stuff in the can is natural shellac wax, which lubricates the sliding surfaces of the jig and allows it to glide across a tablesaw easily.

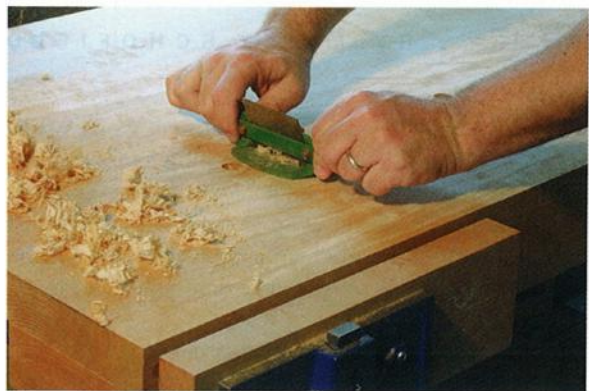
Paste wax for plywood—Plywood and tempered hardboard remain dimensionally stable over wide humidity swings, so they are ideal materials for your most critical jigs. Often a coat of furniture paste wax is all the protection needed for jigs made from these stable materials. The

paste wax also helps the jig slide more easily during use.

Glue size seals MDF—Medium-density fiberboard (MDF) is less seasonally stable than other manmade sheet goods, but it still can be used for jig construction if properly sealed. The edges of an MDF sheet are considerably more absorbent than the faces. If left unfinished, the unprotected edges can absorb moisture and significantly swell the MDF sheet. A coat or two of finish will not seal the edges adequately, so instead I use glue size—a 50-50 mixture of polyvinyl-acetate (PVA) glue and water. Allow the glue size to dry completely, lightly sand the rough surface, then finish the whole jig with shellac or lacquer. This will provide an effective moisture barrier.

Hold the varnish—For finishing jigs, I prefer shellac or cabinet-grade nitrocellulose lacquer, which dry much faster than oil-based varnish and are available in convenient aerosol cans. More important, shellac and lacquer form harder surface films than varnish, which means that jigs

A RENEWABLE FINISH THAT SEALS AND PROTECTS



Scrape first. On a used bench, scrape away any dried glue before applying a new coat of the wipe-on finish.



Mix the finish. Minick's mixture of oil, varnish, and paint thinner contains a higher proportion of resin than most Danish oils to give the bench greater protection. Each coat dries to the touch in about an hour.



Lay it on heavy. Apply the oil-varnish mixture liberally and allow it to soak in for 10 minutes before wiping off the surplus with a clean cloth.

coated with these finishes slide more easily over a tablesaw or router table than their varnish-coated cousins.

Benchtops need protection, too

When it comes to finishing a workbench, I find that woodworkers fall into two camps: Some lavish as much attention on finishing their bench as they would a dining-room table, while others consider any finish to be a waste of time. I fall somewhere in the middle, applying a finish more for protection than for the look it imparts.

Benchtops take plenty of abuse, so an easily renewable finish is in order. My

home-brewed wipe-on finish dries fast and gives plenty of protection. Mix 1 cup oil-based polyurethane brushing varnish with $\frac{1}{2}$ cup mineral spirits, then add about 2 oz. boiled linseed oil. Adjust the mixture with mineral spirits for proper wiping consistency, and then apply it like any other wipe-on finish.

Three coats on a new workbench will resist water better than standard Danish oil; it's a good idea to apply an additional coat or two once a year to maintain this protection.

My shop cabinets are varnished inside and out, so they don't need much attention; however, they still get dings

and scratches. Every couple of years, I vacuum off the dust and wipe on my home brew, which makes them look almost as good as new.

If your benchtop is made from layers of plywood or MDF, a better form of protection is to use a sacrificial surface. My benchtop is covered with $\frac{1}{8}$ -in.-thick hardboard held in place with double-faced carpet tape. When the top gets too dinged to be usable, I pry up the old piece and replace it with fresh hardboard. □

Chris A. Minick is a former consulting editor for Fine Woodworking.

How to clean brushes

IT'S EASIER TO TAKE CARE OF A BRUSH THAN TO REPLACE IT

BY MARK SCHOFIELD

One painter I know claims that most amateurs (and quite a few professionals) would rather wash their cat than clean their brushes. However, there are several good reasons for learning to do this job correctly and efficiently.

First, a good brush is a considerable investment: a 2-in. synthetic filament brush suitable for water-based finishes is around \$15, while a top-of-the-line ox-hair brush for applying

varnish will set you back \$40. Second, a dirty brush won't work well. Dried finish prevents the brush from holding as much finish and makes the filaments and bristles less flexible. Don't wrap a dirty brush in foil or plastic wrap and expect it to be just as good the next morning. Instead clean it each time you finish using it and then it will be good to go next time you need it.

Mark Schofield is the managing editor of Fine Woodworking.

CLEANING STARTS BEFORE YOU BEGIN

So you're anxious to see how your new brush works. Before you dip it in the finish, though, there are a couple of steps to take. First, even the best brush may have one or two loose filaments (cheap brushes will have many), so rather than pick hairs out of a wet finish, bend the filaments back and forth with your hand a few times, pulling gently on them. Hold the tip up to the light and remove any filaments protruding above the rest. Now dip the brush into a solvent that matches the finish you'll be using and then squeeze out the solvent onto a paper towel. This coats the filaments with solvent and makes cleaning the brush much easier when you've finished using it.

In use, don't overload the brush with finish. If you are brushing vertical surfaces, periodically squeeze out as much finish as possible back into the can. These steps will prevent finish pooling around the base of the filaments and flowing all over the ferrule or running down the handle.



SHELLAC, LACQUER, AND WATER-BASED FINISHES CLEAN UP EASILY

**SHELLAC
AND LACQUER:
LET IT DRY**



Brushes used for lacquer and shellac don't need to be cleaned thoroughly. Give it a swish in lacquer thinner or denatured alcohol, shake it out, and let it dry hard. When you need it again, just stand it in solvent. It will be soft and ready to use within 30 minutes.

**USE SOAP AND WATER
FOR WATER-SOLUBLE
FINISHES**



Use hot water and dish soap to remove water-based finishes from brushes. Lather, rinse, and repeat two or three times.

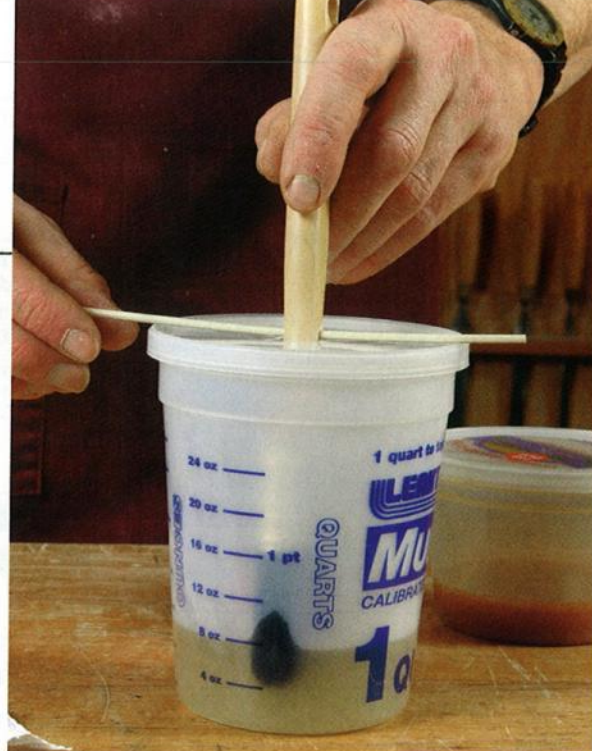




OIL-BASED FINISHES ARE HARDEST TO CLEAN

Let's start with the good news: You don't need to clean the brush if you plan to use it again within 24 hours. Instead, suspend the brush in mineral spirits that have previously been used for cleaning a brush. Keep the tips of the filaments off the bottom of the container so they don't get bent or contaminated with residue.

When you're done with the brush, rinse it a couple of times in used mineral spirits, then pure mineral spirits, removing the bulk of the solvent on newspaper each time. Now rinse the brush in hot soapy water several times before giving it a final cleaning using either citrus cleaner or household ammonia. If you can't smell any mineral spirits on the filaments, the brush is clean and can be wrapped in paper and put away.



LET IT SOAK BETWEEN COATS

If they are going to be reused within 24 hours, brushes containing an oil-based finish can be suspended in mineral spirits. Use a kebab skewer through the handle to avoid bending the bristles.



Solvent, then soap. Rinse the brush two or three times in mineral spirits, then remove the solvent on newspaper before cleaning the brush with hot water and soap.

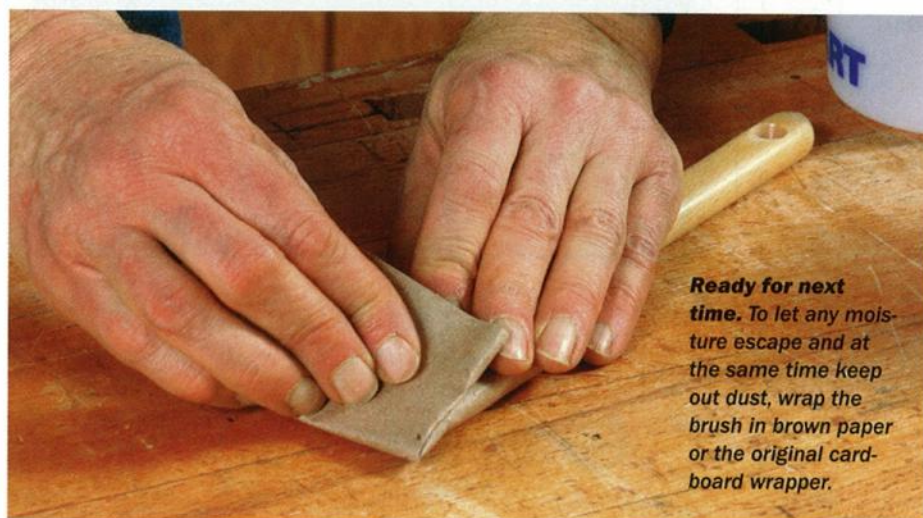


Final cleaning. To remove any last traces of mineral spirits, rinse the brush in either a citrus cleaner or household ammonia.

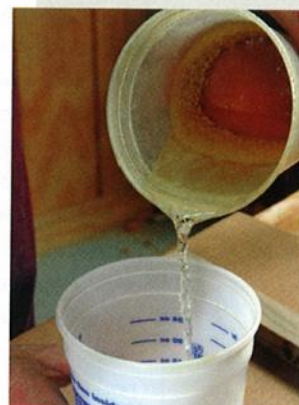
TIP Reuse your mineral spirits



Don't toss it. After you have cleaned a brush, pour the contaminated mineral spirits into a sealable container.



Ready for next time. To let any moisture escape and at the same time keep out dust, wrap the brush in brown paper or the original cardboard wrapper.



Clearly better. After a few weeks, the residue will sink to the bottom of the container and you can pour off clean mineral spirits for reuse.

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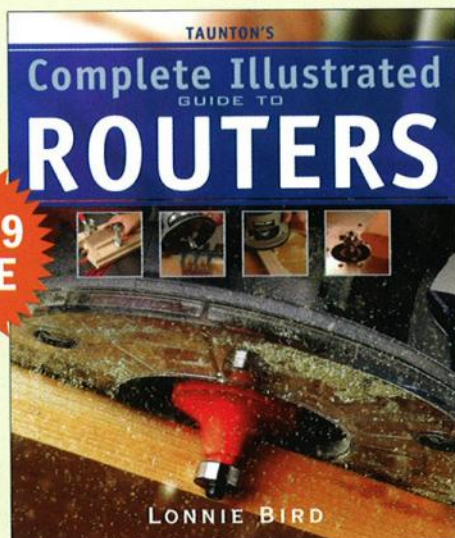
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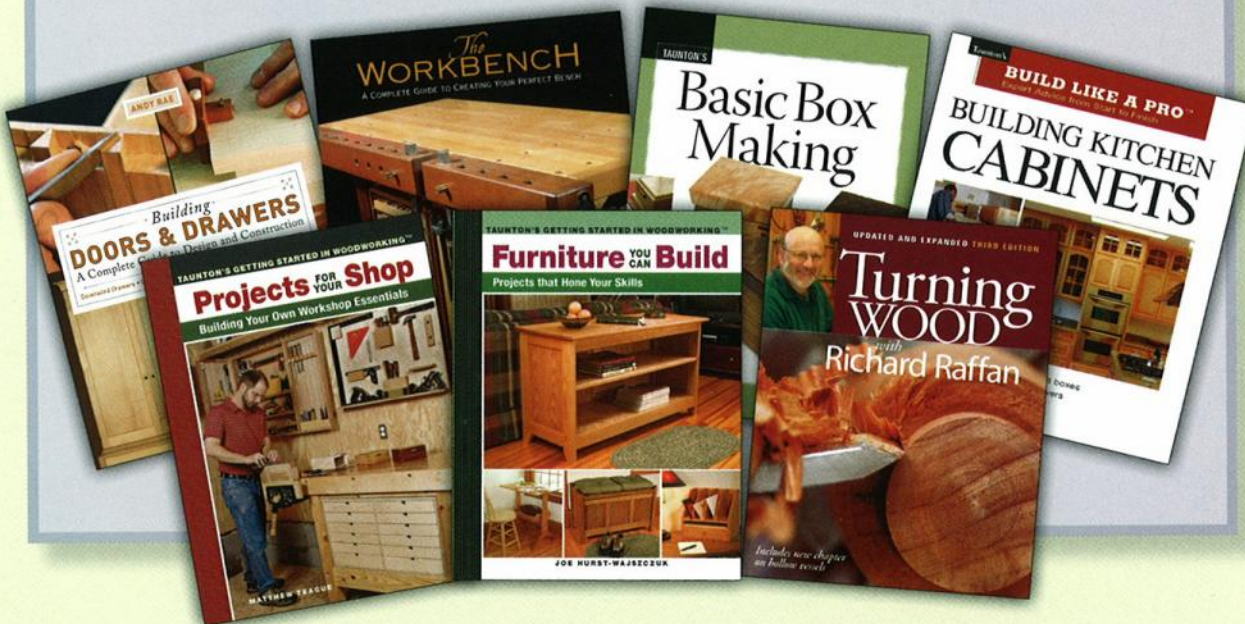


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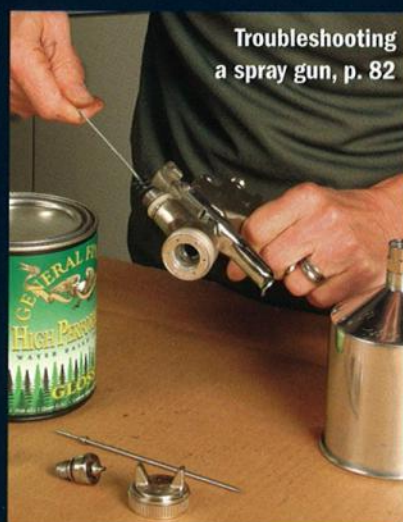
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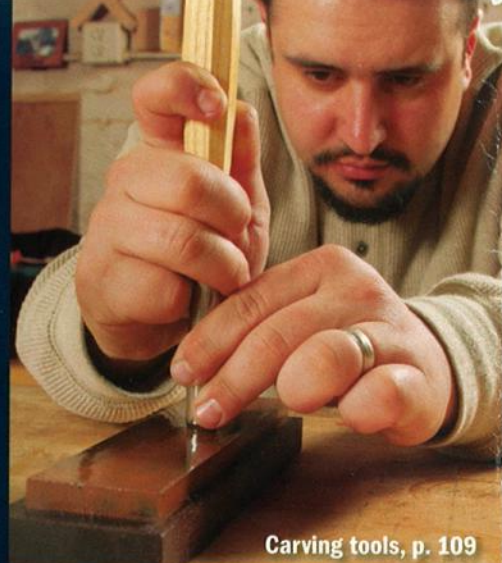
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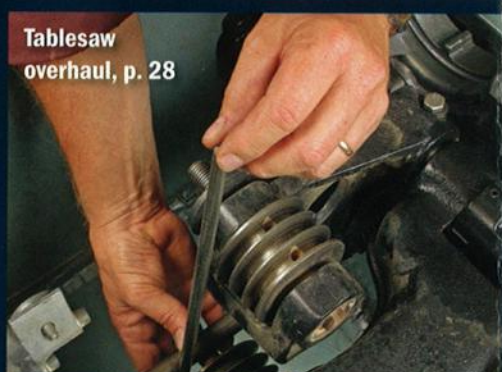
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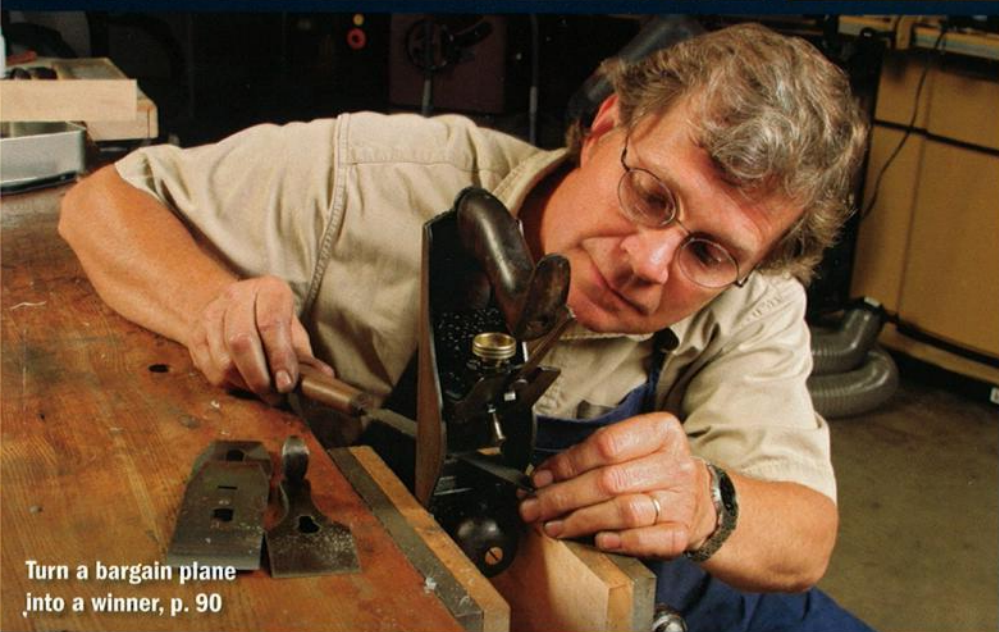
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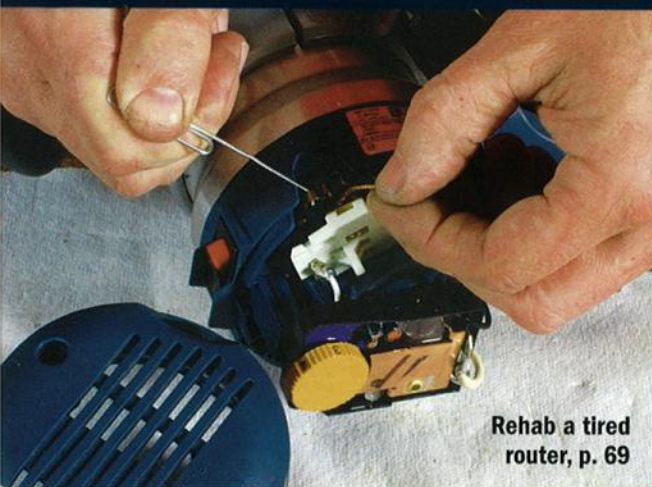
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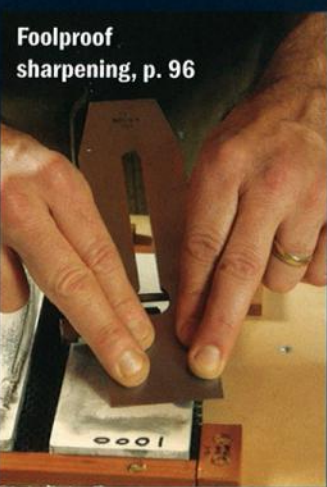
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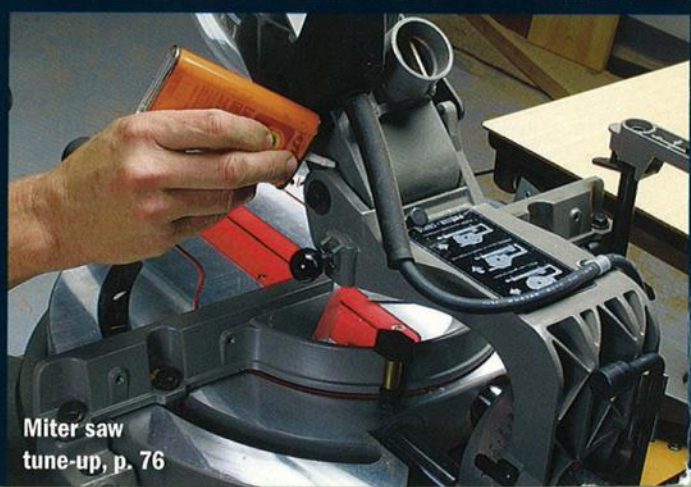
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