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June 2001 #122

Popular Woodworking

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- The best biscuits

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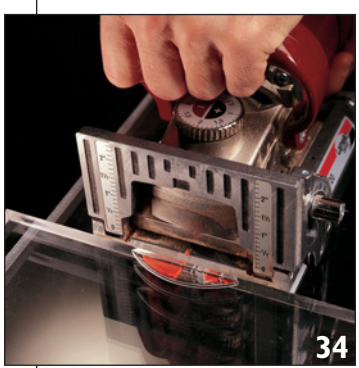

TOOLS & TECHNIQUES

continued on page 4

On the Cover

Limbert furniture merged European styling with quality American construction. When this bookcase appeared in Limbert's 1905 catalog, it sold for $18; surviving examples now sell for more than $2,500. Thanks to Scott Phillips for the use of his shop for the cover photo.

Cover photo by Al Parrish

In Every Issue

Projects

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Getting It Right

Weighing in once again on woodworking's little miracle joint-making machine.

We've devoted several pages of reviews and techniques in this issue to the oft-maligned biscuit joiner. Yes, you can conclude that this magazine is on the biscuit joiner bandwagon. There's nothing new about that. We've been an advocate of these clever machines for years.

If you aren't aware, there's a vocal group of woodworkers who trash this tool at the drop of a chisel. Generally, these woodworkers hold to more traditional techniques. Their argument is like this: the biscuit joint is a substitute for the mortise and tenon, and the usually thinner biscuit can't be as strong as the thicker tenon. The mortise and tenon has been used for centuries, and fine antiques have survived hundreds of years using the joint. (We won't get into how many pieces of old furniture *didn't* stand the test of time.)

Now, I'm not harping on traditional joinery. Like Rodney Dangerfield, I'd simply like to see biscuits get a little respect. They deserve it. They are fast, easy to use and the joint produced is strong.

How strong? Six years ago a respected woodworking magazine published an article on just this subject. In the article, the authors tested different types of joints used in door-making on a hydraulic ram. One tester builds custom doors; the other is a structural engineer who wrote his doctoral dissertation on timber joint strength. The test measured the deflection in each joint before a gap appeared and at what pressure the gap appeared. Then they measured how much pressure it took before the joint failed. And the winner was? Well, from my reading of the article all the joints won, with the exception of the one using two lag bolts. For all the other joints, the wood failed before the joint failed. As to how much pressure it took before the joint failed, the statistics show the biscuit joint outperformed the rival joints. Yet the article concluded the loose tenon was best, closely followed by the traditional mortise and tenon. Huh?

Why didn't the biscuit joint get its due? The article cites the ill-effect freeze/thaw, wet/dry cycles would have on the joint and that when it failed, it failed completely.

So let me get this straight — I shouldn't use biscuit joints for cabinets and furniture that go outdoors, on entry doors for my house or if I'm timber framing a building? Otherwise they are stronger, deflect less and gap only under considerably more pressure than traditional joints? I can live with that. Heck, I can continue using them with confidence for the dozens of everyday applications for which they were always intended in the first place.

This article has always stuck in my craw because those involved appear to be prosecutor, judge and jury. And what the article really proved is what we've always known, that modern adhesives and properly made joints will always be stronger than the wood it's holding together.

And so I say, once again, "Pass the biscuits. And this time, with a little respect."

PW

Joint Strength

Joint	Size of Joint	Gap Pressure	Deflection*	Failure Pressure
3 biscuits	#20	1,700 lbs.	1/64"-	3,000 lbs.
2 biscuits	#20	1,700	1/64"+	2,800
Loose tenon	1/2" x 3 x 5	1,200	7/16"	2,700
Mortise & tenon	1/2" x 2 1/2" x 2 1/2"	1,200	7/8"	2,700
2 dowels	1/2" x 5 9/16"	1,200	not given	1,800
Tongue & groove	1/2" x 5/8"	not given	not given	1,300
2 lag bolts	1/4" x 1 3/4"	not given	not given	300

** Deflection is the amount the rail and stile had moved as a gap appeared in the joint. Source: Fine Woodworking, April 1995*

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Safety Note

Safety is your responsibility.
Manufacturers place safety devices on their equipment for a reason. In many photos you see in *Popular Woodworking*, these have been removed to provide clarity. In some cases we'll use an awkward body position so you can better see what's being demonstrated. Don't copy us. Think about each procedure you're going to perform beforehand. **Safety First!**

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Woodworker's Book Club: 1507 Dana Ave., Cincinnati, OH 45207; (513) 531-8250

Build the $175 workbench without a planer or jointer

Tricks and Tips to Building the Bench With Just a Few Tools

I just finished reading your article on the $175 Workbench in the February 2001 issue, and I really like what you have done. My first thought is: I don't have a planer or jointer, so how do I get the stock flat and square? I am just getting into the hobby, and I need a good first bench. I was thinking I might try a hand power planer. Do you think this would work until I can afford the jointer?

Tom Holbrook
Arroyo Grande, California

Editor's note: You don't have to have a jointer or planer to build this bench. In fact, you can build this bench with just a few tools.

One good option for the top is to buy two or three sheets of birch plywood or MDF (medium-density fiberboard), cut them to size and glue them into a thick 1½" or 2¼" sandwich. That will make a good first top, and you'll be done in a day. Use bricks (or anything that's heavy) for clamping the center. Use a lot of bricks and a lot of glue.

If you want to make the top using 2 x 4s, I recommend you first rip off the rounded edges of the 2 x 4s using your table saw and then glue up several sections as described in the article. If you have a biscuit joiner, you can use that to help align the 2 x 4s during glue-up. Another way to align the boards would be to cut a spline in each one. Then glue the sections together. Throw the top up on some sawhorses and see how flat it is using winding sticks. You can then flatten any high spots with a jointer plane or a belt sander.

— Christopher Schwarz

Block Planes Aren't the Only Planes With Adjustable Mouths

You mention that block planes have adjustable throats and you should tighten them down until you get a good shaving (February 2001, issue #120). You failed to mention that many bench planes also have an adjustment for the mouth. It's the "frog," which is the cast piece that sits above the sole body and holds the iron in place. Adjustments vary by brand and model, but look either under the iron for screws or around the back next to the depth-adjusting wheel (or both). Sliding the frog forward will adjust down the mouth opening. It's not as easy or convenient as the adjustable mouth block plane, but it's there, nonetheless.

Keith Mealy
Cincinnati, Ohio

Is Wax a Good Enough Finish for a Maple Coffee Table?

My question is: I have stained a maple coffee table that I just made and would like to know if I can apply a wax finish over the oil stain and leave it as a finished table?

Charles Weech
Ancaster, Ontario

Editor's Note: As a finish, wax is a poor substitute for almost any other type. It offers virtually no protection from scratches, heat, moisture, alcohol or other stains. Because your table will have to stand up to all these, you should apply a finish that builds a protective film over the wood. Your choices are water-based finishes, varnish, polyurethane, shellac or lacquer. You have invested time and money

WE WANT TO HEAR FROM YOU

Popular Woodworking **welcomes letters from readers with questions or comments about the magazine or woodworking in general. We try to respond to all correspondence. Published letters may be edited for length or style. All letters become the property of** ***Popular Woodworking*****.**

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Letters

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in building the table; spend an afternoon to protect your investment with the finish it deserves.

Dust Collection Manufacturer Explains the Science of Microns

After more than 10 years of perusing woodworking magazines I am always amazed at the unscientific conjecture in the letters and articles on dust collection. I see advertisements touting "5 micron bags" (as if this is a good thing) while not mentioning how much of the 5-micron material is actually filtered — 10 percent or less would be my guess.

Industrial hygienists consider the health threat range to be mostly between 1 and 10 microns. The most common misunderstanding is that somehow it makes sense to blow dirty air out of a chip collector into the shop air and then try to pick it up with a piece of equipment that hangs on the ceiling. Forget that you are in the shop, breathing the air. It makes a lot more sense to put a good filter on the dust collector and stop the lung-damaging dust from entering your shop air in the first place. This is more cost-effective as well. I hear the argument that some material escapes the hood. Yes it does, but if the system is designed correctly, 99 percent of the fine dust is captured, on average, lowering the dust level by a factor of 5 to 20 times.

Generally, 20 years of exposure with good dust collection is equivalent to one year without dust collection or bad dust collection. Bad dust collection can create more airborne respirable particulate than no dust collection at all. The object is to minimize exposure to the point where the health threat is eliminated. Proper dust collection is accomplished when dust is collected at the source and filtered to the smallest particle. Recently, scientists at The School of Public Health and Community Medicine at the University of Washington did a before-and-after source dust collection study on a one-man wood shop. They found good source collection brought the dust level from an unhealthy, out-of-compliance condition to a level of three times cleaner than ACIH recommended levels. Get the facts. Protect your health. **PW**

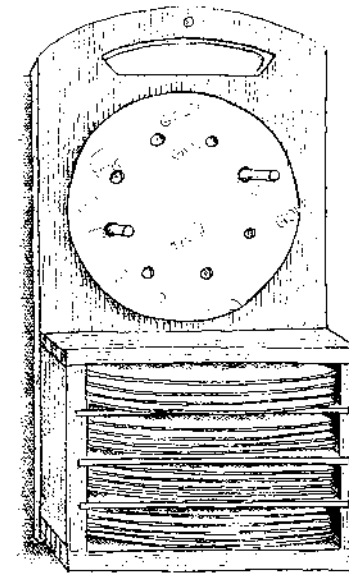
Robert Witter
Oneida Air Systems Inc.

Illustrations: John McCormick

Two pegs place sandpaper on a sander in a second

THE WINNER:

Easy-On ROS Sandpaper



I really like my random-orbit sander that uses hook-and-loop disks because I can quickly go through three or four grades of paper while finishing a project. The problem I had was keeping the disks in order, convenient and clean. This holder hangs on the wall when not in use, and when laid down flat it has two little pegs that locate the disk on the sander's hook pad. These gadgets now being sold with eight pegs are nonsense. Two pegs is all you need, and one should be longer than the other so you can engage them one peg at a time. Too long a peg will get up into the fan blades and cause problems.

Don Dickens
Vancouver, Washington

TRICKS OF THE TRADE FROM THE AMERICAN WOODSHOP

The American Woodshop

GREETINGS FROM 'THE AMERICAN WOODSHOP'

As host of "The American Woodshop" I've collected a lot of tips, tricks and great woodworking ideas over the years. Some are basic helpful hints, while others are just good common-sense solutions to everyday problems. I'm happy to share these with you here. In addition to my ideas, we pick the best tip or trick sent in by a reader and publish it on these pages as well. Delta Woodworking Machinery is the sponsor for the Tricks of the Trade column, and the company is giving away a model 46-250 Midi Lathe (shown at left) to the best "trickster."

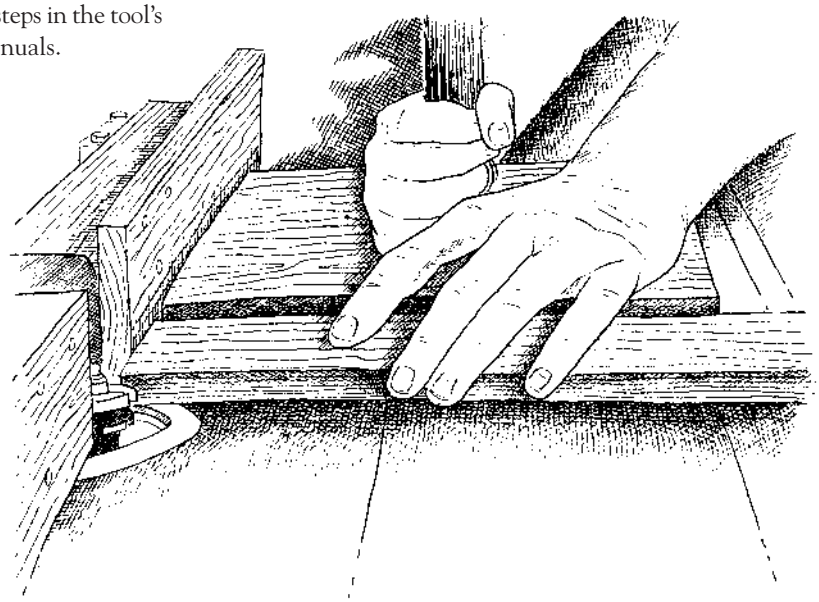
To submit your tip or trick, e-mail it along with a daytime phone number to DavidT@FWPubs.com or mail it to: Tricks of the Trade • *Popular Woodworking* • 1507 Dana Ave. • Cincinnati, OH 45207.

- Scott Phillips

DELTA MACHINERY

Stop Tear-out When Coping Your Rails

For the home woodworker, I think the router table is the perfect machine to make cope-and-stick doors. But not everyone has a high-end router table with a miter slot to make perfect cope cuts on the ends of both rails (rails are like rungs on the ladder – they are horizontal). A simple homemade jig is the solution. Make what looks like the mother of all push blocks. It should be 1" thick, 10" x 10" square and have a handle in the middle. Set the router so the depth of cut is a perfect match for the stick cuts that were made first and lock everything in place. Place the jig so one edge is secure and tight against the router fence and keep all parts well away from the router bit at this time. Next, place the rail workpiece secure to the front edge of jig. This will keep the cope cut square as you make the cut and eliminate tear-out because the jig supports the wood at the end of the profiling process. Remember to follow all safety steps in the tool's manuals.



If You Could Have Only One Finish, What Would it Be?

One viewer of "The American Woodshop" really pinned me down recently. He asked what finish would I use if I could use only one. It's simple: I would dilute a satin polyurethane by 25 percent with mineral spirits and wipe it on with clean cotton rags. It takes three applications to end up with a perfect and durable finish. This technique virtually eliminates drips and runs, plus there are no brushes to clean up. Remember to always wear good finishing gloves and work in a well-ventilated area. Better yet, work outside when the temperature is between 70 and 85 degrees and the humidity is between 40 and 60 percent. Also remember to dispose of the used rags appropriately.

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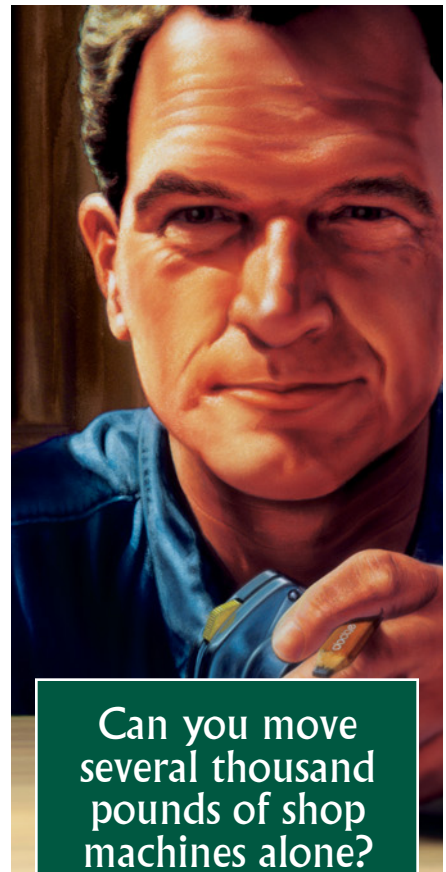
Circle #104 on Resource Directory Coupon



Circle #106 on Resource Directory Coupon

Tricks of the Trade

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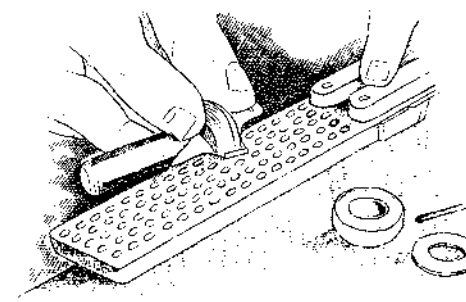
Cut one Type of Hole in Your Entertainment Center for Wires and for Removing Heat

If you are planning an entertainment center, remember to allow space for venting the heat that electrical components generate. The easiest solution is to build a case with fixed shelves and a back that is securely screwed to the fixed shelves. This is necessary because most TVs weigh in on the heavy side. Next use a 3" hole saw chucked into a corded drill to cut access holes through the back (and where you cannot see them from the front) for all your wiring. You will never see the holes when the components are in place, and the 3" hole gives you more than enough access for cords and is still large enough to safely vent the heat away from the components.

Sharpening Dull Router Bits

Most shops have two types of router bits — dull and sharp ones. It's easy to tell the difference because the sharp bits ease through the wood while the dull bits labor. Sometimes a good cleaning is all the bit needs. Any good blade solvent will rid bits of pitch and resin. Once the bit is clean I like to use a fine monocrystalline diamond stone with a couple of drops of water to hone the flats of the carbide. Count the number of strokes taken on each flat, then repeat this process with the other carbide surface on the bit. Diamond stones will sharpen carbide or high-speed steel. I only use carbide cutters because they stay sharp longer. Don't attempt to sharpen spiral router bits — send these to the sharpening shop. **PW**



Powermatic's Revamped Mortiser: Near Perfect, But Pricey for DIY

Powermatic souped up its benchtop hollow chisel mortiser this year to create a machine that is everything a home woodworker could ever need, and is an inexpensive alternative for the professional shop.

Unlike benchtop mortisers that sell for less than $250, the Powermatic 719A floor-model mortiser is loaded with features that make cutting square holes as simple as possible. If you've ever used a benchtop mortiser, you know they're plagued by two problems: wimpy hold-down clamps and inaccuracies due to chips building up between the fence and your work.

The 719A has solved both these problems with a sliding table (borrowed from metal milling machines) that moves using hand wheels, plus a heavy-duty acme-thread screw clamp that holds your work firmly in place. A series of adjustable stops control where each mortise begins and ends, so you can cut exactly the same mortise as many times as you want — no more eyeballing your layout lines.

Powermatic hasn't just put its previous benchtop mortiser on a stand. This is an entirely new machine inside and out. Improvements include: the capacity to handle work up to 7¼" thick with a ⅜" chisel installed; a slow-speed induction motor that spins at 1,720 rpm; and the addition of a cabinet with a padded shelf with holes in it for storing all the auger bits, chisels and bushings a commercial shop could want.

The chisel depth limiter has also been redesigned and improved to work like the depth stop on the JBM-5 mortiser from Powermatic's sister company, Jet. One of the small disappointments of the 719A is that Powermatic uses the same chuck key as on the JBM-5. The key is longer, so it's easier to maneuver to the chuck, but the teeth don't mesh up just right.

At first I thought the 719A's table was too low (about 31" from the floor) and the table movements seemed stiff. But after a couple of easy table adjustments and a few mortises, I changed my opinion. The table moved smoothly and the adjustable handle felt really good where it was; I never had to contort my body to plunge to the full depth.

Like most Powermatic equipment, the 719A is designed for years of use. The gibs in the dovetailed ways can be adjusted or replaced when they're worn. All of the handles are beefier than those on the company's previous model, and many of the castings on this Taiwanese-made machine are simply massive.

Of course, the most important question is whether the machine is right for your shop. As an Arts & Crafts nut, just about every project I do seems to need a boatload of mortises. The sliding table makes mortising at least twice as fast as it is on a benchtop model. And because there's virtually none of the frustration you get with a benchtop mortiser, cutting mortises seems almost as fast as cutting biscuit slots. I'll be saving my pennies.

— Christopher Schwarz

For more information, circle #150 on the Resource Directory Coupon.

SPECIFICATIONS:

Powermatic 719A

Street price: $770
Max stock under ⅜" chisel: 7¼"
Max stock, chisel to fence: 4"
Motor: 1hp, 115/230v, 1,720 rpm
Chisel capacity: ¼" to 1"
Table movement L/R: 16"
Table movement F/B: 4½"
Shipping weight: 182 lbs.

Performance: ●●●●○
Value: ●●●●○

Powermatic 800-248-0144, or www.powermatic.com

How We Rate Tools

At *Popular Woodworking* we test new tools and products with an honest, real-world workout. We check for ease of assembly and determine how clear and complete the manuals are. Then we use the tool in our shop to build projects that appear in the magazine. Each issue, the magazine's editorial staff shares its results and experiences with the tools, rating each for performance and value.

We use a one-to-five scale, with "five" in performance indicating that we consider it to be the leader in its category. For value, "five" means the tool is a great deal for the money, while "one" means we consider it pricey. However, a tool with a low value rating may be worth the high price.

If our tool reviews don't answer all your questions, e-mail me at DavidT@FWPubs.com or call me at 513-531-2690, ext. 255. If we haven't reviewed the tool you're considering, there's a good chance I've used the tool, but simply haven't had a chance to write a review. Give me a call and see if I can help. You can also visit our website www.popwood.com to check out our past published tool reviews and sign up for our free e-mail newsletter (focussing on tools) that's sent out every other week. —*David Thiel, senior editor*

Toolbox Dozuki Affordable and Handy, if a Bit Rough Around the Edges

Lee Valley offered this tool more than 15 years ago, and it's back by popular demand. A Japanese pull saw is desirable for many applications, but the improved performance usually means a somewhat fragile tool that requires special care. With this folding version, the blade is folded inside the handle to protect the teeth from the jostling encountered in a toolbox. The blade is sturdier than normal, and while the cut isn't as perfect as a high-end dozuki costing $100 or more, it's rugged and performs well in anything from a pine 2 x 4 to figured white oak.

We were intrigued to notice that the handle on our test saw was made from highly figured curly maple, but was covered by a dark stain and a poor-quality finish. With a little lacquer thinner and some elbow grease the figured wood shone through as nicely as any piece of finished furniture. For the luxury of having a fine-cutting dozuki handy at all times (without having to baby the tool) this is a great buy for the toolbox at $19.95.

— Jim Stuard

For more information, circle #151 on the Resource Directory Coupon.

SPECIFICATIONS:

Model 60T56.01
Folding Dozuki Saw
Street price: $19.95
Teeth per inch: 16
Blade depth: 2½"
Blade thickness: 0.01"
Length open/closed: 21¾"/12"
Performance: ●●●●○
Value: ●●●●○
Lee Valley: 800-871-8158, or www.leevalley.com

New Clifton Bench Planes Designed for Years of Hard Use and to Compete with Lie-Nielsen

After many cross-country phone calls and trans-Atlantic faxes, we had the privilege to shop test one of the brand-new Clifton bench planes from Clico Tooling Ltd. in Great Britain. These well-made beauties are aimed to compete with the expensive-but-worth-it planes from Tom Lie-Nielsen in Warren, Maine. After a few weeks with the Clifton #3, all we can say is: Watch out Lie-Nielsen. At its core, the Clifton #3 is a lot like the Lie-Nielsen bench planes. Both have a frog that seats on a fully machined section of the base casting. This feature, which was pioneered on the Stanley Bed Rock series of planes (1898 -1943), was expensive to pull off (and it still is), but the results have always been worth it. Like the Lie-Nielsen's, the Clifton's frog can be adjusted forward and back to tighten the throat without dismantling the frog, something you have to do on most Bailey-style planes. Instead, you merely loosen two screws at the back and turn the center frog-adjusting screw. Check your depth of cut, and you're good to go.

OK, so how did this thing do out of the box? The sole looked a bit bowed when checked with a straightedge, so I lapped it. To my surprise, however, the sole needed very little attention to become perfectly true. The blade is a ⅛"-thick hand-forged job that comes with Clifton's two-piece Stay-Set cap. Clifton sells these blades with the cap for more than $80 in some catalogs, so getting one on this plane is a nice bonus. The face of the blade was perfectly flat out of the wrapper — something I have never seen. The primary bevel was also ground true. I honed a secondary bevel on the edge and put her back together and got out a cherry board. Yes, the plane is nice. Yes, you need one. Yes, you can afford it if you start saving your money right now. It's worth every bit of the $200. In fact, the Cliftons are a bargain because some of them are priced significantly less than the comparable Lie-Nielsen models. Supply of Clifton planes is limited now; good luck if you want one tomorrow. To buy one, we recommend you contact the Robert Larson Co. for a supplier in your area.

— Christopher Schwarz

SPECIFICATIONS:

Clifton Bench Planes
Street price: #3, #4 and #5: $200, #6: $280, #7: $300
Blade: ⅛" thick, hand forged
Blade hardness: Rc 60-62
Handles: bubinga
Performance: ●●●●●
Value: ●●●●○
Robert Larson: 800-356-2195, or www.rlarson.com

For more information, circle #152 on the Resource Directory Coupon.

Hitachi FDS10DVA Cordless Drill Kit

I first wrote nice things about this drill/flashlight set in our very first e-mail newsletter in May 1999 (visit www.popularwoodworking.com to subscribe for free). I've been using the tool since November 1998, and it still deserves a place of honor in my shop. It's not the most powerful 9.6v drill on the market, but I paid $85 for it two years ago, and the darn thing is great.

The model FDS10DVA has plenty of power for any household chore and everything but the most demanding workshop applications. It has all the features of a much more expensive tool, and it comes with an adjustable-head flashlight that is better than many stand-alone flashlights.

After two years of use the set is holding up well. Even after hundreds of charges, the batteries still take and hold a good charge, and the gears still perform well on all the clutch and speed settings. I've dropped the thing I don't know how many times, and I've finally managed to crack one of the battery casings, though the battery still functions fine. Though I've not had any problems with it, the forward/reverse switch seems a little fragile, and the plastic skin of the drill can be slippery in the cold or when wet. And lastly, the battery's footprint is a little small, which makes this drill tricky to balance on your bench when you set it down. Save yourself some frustration and learn to set it down on its side instead of on the battery. In all, however, these are minor quibbles that shouldn't stop you from purchasing this set.

What should stop you from purchasing this drill is if you have unrealistic expectations. I recently read a review of this tool on the Internet by a guy who was pleased with his purchase but was disappointed with the drill's performance when using a masonry bit. Let me clear this up. *No* 9.6-volt cordless drill should be used with a masonry bit. To expect that of this or any other low-voltage cordless drill is just silly. However, if you're looking for a drill up to the task of drilling up to ½" holes in wood, driving home a good number of 2" x #8 screws, or just putting together a piece of knockdown furniture from the store, a 9.6-volt drill is a fine choice. And as 9.6-volt drills go, the Hitachi FDS10DVA is a great performer at an amazing price.

At press time, I went online and found this drill/driver kit for sale at Coastal Tool (www.coastaltool.com) for $75 plus $5 shipping — the lowest price we've seen. **PW**

— David Thiel

Photo by Al Parrish

SPECIFICATIONS:

Model FDS10DVA
Drill/Driver & Flashlight
Street Price: $75 - $85
Battery: 9.6 volt, 1.2 amp hour (2)
RPM: 0-280/0-850
Max. torque: 130 inch-lbs.
Clutch settings: 5
Charger time: 1 hour
Weight: 3.3 lbs.
Chuck: ⅜" keyless
Brake: Yes

NICE FEATURES:
- **Great price, flashlight, two batteries, two speeds, electronic brake, quality construction, only five clutch settings**

RECOMMENDED MODIFICATIONS:
- **Add a soft skin for improved grip**
- **Beef-up the forward/reverse switch**

Hitachi: 800-706-7337, or www.hitachi.com

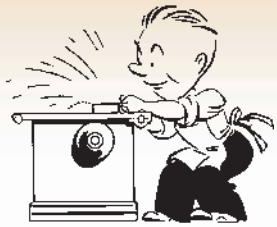
ABOUT OUR ENDURANCE TESTS

It's nice to know how a new tool performs, but most woodworkers also want to know how long the tool will last. Each issue we tell you about tools that have stood up to regular use in our shop for at least a year. We tell you how the tools have fared, any recommendations we have and if the tools have passed the *Popular Woodworking* Endurance Test. *— David Thiel, senior editor*

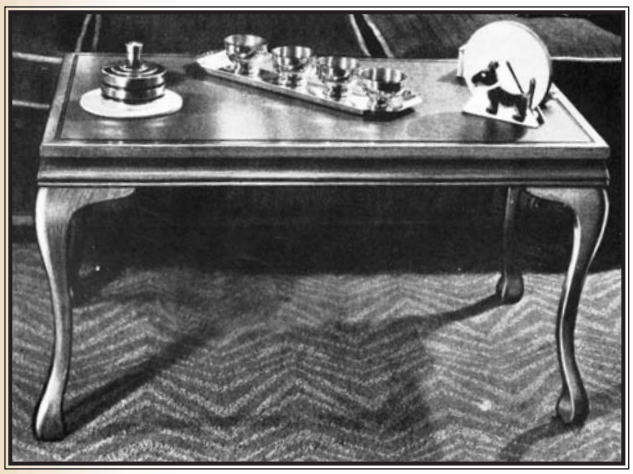
The Deltagram

A nostalgic look back at plans published by Delta Machinery during the World War II era.

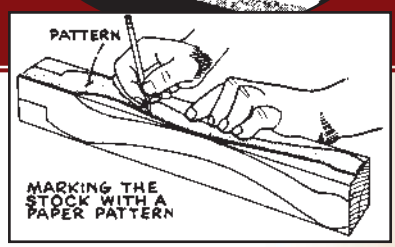
From Vol. 6, Issue No. 6, 1937

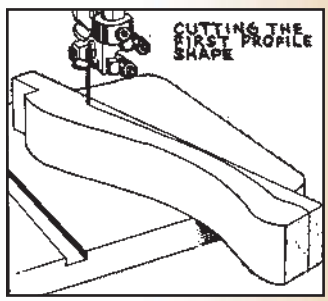


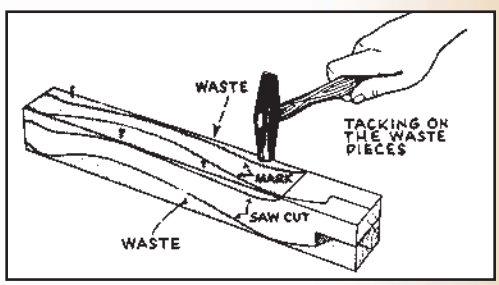
Queen Anne Coffee Table

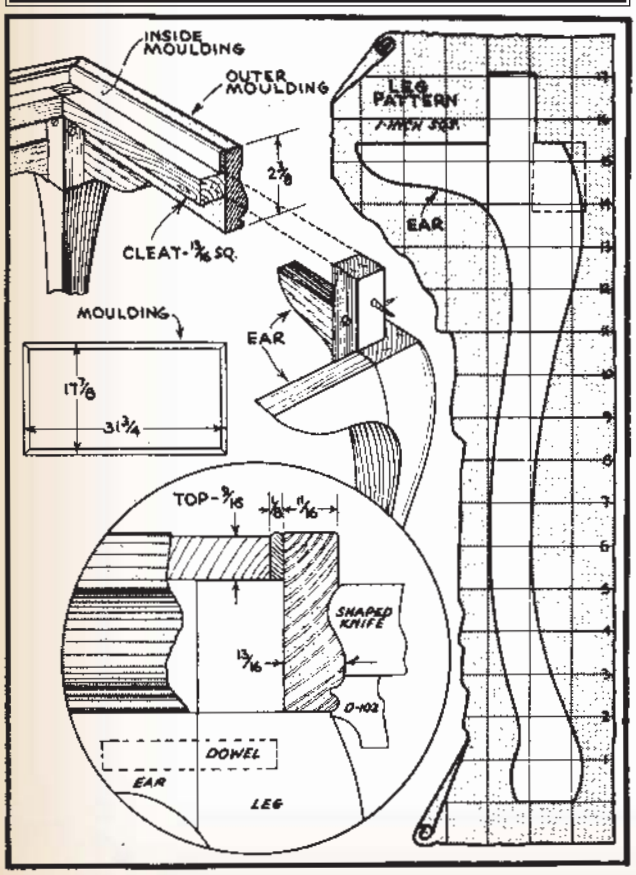


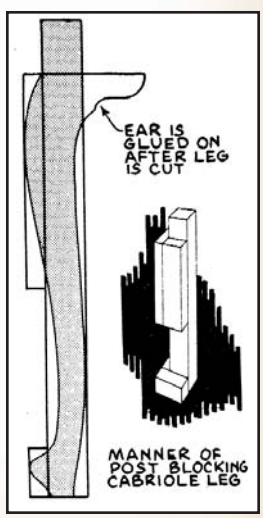
The construction of this graceful table is largely concerned with the legs. The four leg blanks should be 2¼" square. The leg pattern is laid out on two sides of the stock, and the compound cut is made on the band saw, tacking on the scrap cuttings from the first cut to furnish a foundation for making the second cut. Each leg is then shaped on the outer and inside edges. The front edge is shaped to about a full quarter-round, and this part of the work is best done with a spokeshave. The two ears on each leg are doweled and glued in place. Stock 1½" thick is used. Cut the profile on the band saw. Fit the ear to the leg, as can be seen by the line on the leg pattern, and round it off to the same curve as the leg. The manner of making the whole assembly is apparent from the drawing, each leg being screw-fastened and glued to the outer moulding. **PW**











Microadjustable Finger Joint Jig

What a difference a machine screw makes.

by Nick Engler

Nick is a contributing editor to Popular Woodworking, the author of 52 books on woodworking, and a builder of pioneer airplanes.

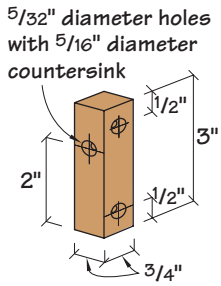
You find them lurking in bins in hardware stores, hanging out in plastic bags in home centers, rusting in baby food jars in garages and basements all across America: flathead machine screws with 32 threads per inch. Few of us ever suspect that these unpretentious bits of hardware could be so incredibly helpful, particularly to those of us who still use the ancient and venerable English system of measurements. These tiny bolts are a cure for many troubles that afflict our accuracy. They can eliminate the error from a trial-and-error method and turn a homemade jig into precision equipment.

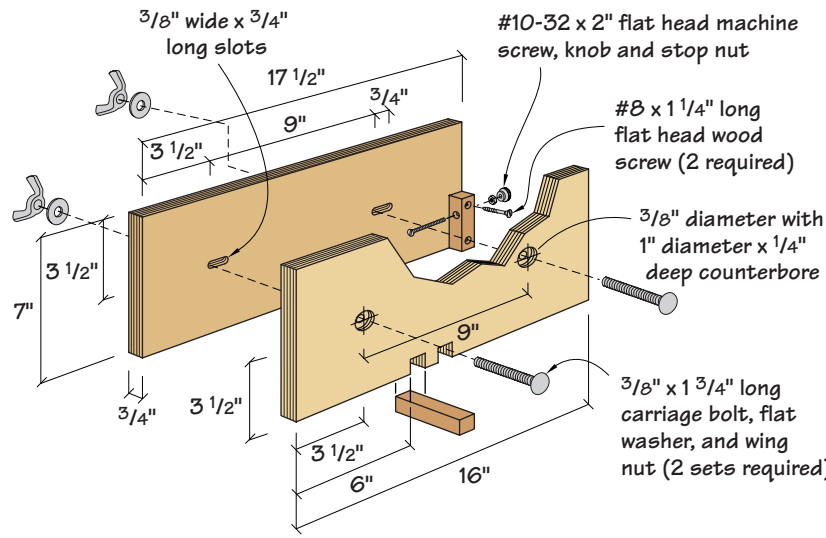
Consider the traditional finger joint jig. It's designed to make evenly spaced square notches in the ends of adjoining boards, leaving multiple tenons that interlock to form a finger joint. The standard finger joint jig has just three parts: a back that you attach to your miter gauge, a movable face that feeds the wood into a dado blade to cut the notches, and a tenon that aligns the wood for each cut. To set up this jig, you must move the face right or left, adjusting the space between the tenon and the dado blade, so the fingers will be properly spaced. If the fingers are too close together, the joint will be loose. If too far apart and they will be too tight to assemble easily.

Positioning the face properly is often a frustrating loop of trials and errors. Cut a finger joint, test the fit, move the face, cut another joint, and so on. But if you add one more part to this jig — a small wooden block that mounts a #10-32 machine screw and serves as an adjustable stop — you can escape this frustration.

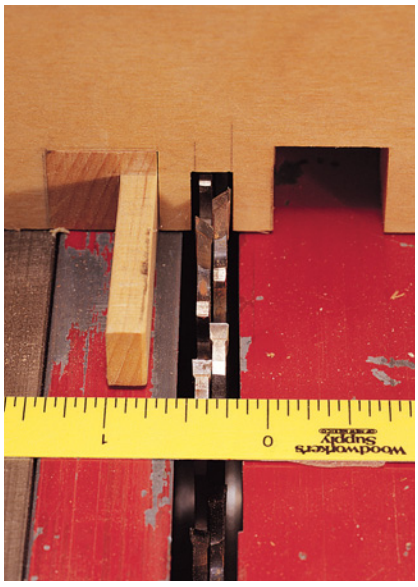
Because the machine screw has 32 threads per inch, one turn will move it precisely 1/32", one half turn moves it 1/64"; one quarter turn, 1/128". When the flat head is resting against the face, the face will move a precise amount. No guesswork!

continued on page 26

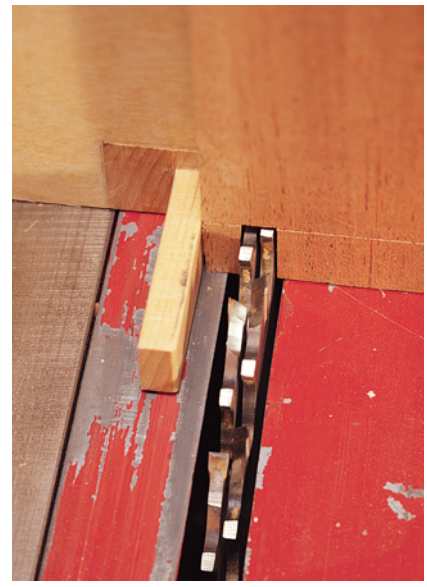




Making a Finger Joint



Initially, set up the finger joint jig by making a few rough measurements with a ruler. The tenon, the dado blade, and the distance between them should all be the same width, in this case, 1/4".



Make a test cut. Butt the edge of the board against the tenon and feed the wood forward, cutting a notch. The resulting tenon should be exactly 1/4" wide.

To cut multiple fingers, move the board sideways, fit the notch over the tenon, and cut again. Continue until you have cut all the fingers. Note that the last finger on this trial board is not as thick as the others.

Photos by Al Parrish

Since the board is 4" wide and the fingers are supposed to be 1/4" wide, the fingers should have come out evenly. Checking with a micrometer, I find they are 1/64" too narrow— the tenon needs to be 1/64" further away from the dado blade. I loosen the face and turn the machine screw 1/2 turn.

When the jig is properly adjusted, it's time to cut the good stuff. Make a single finger in one of the adjoining boards as you did in Step 2. Turn the board edge for edge and fit the notch over the tenon. Use the first board as a spacer to make the initial cut in the second board.

Place the notches in the boards over the tenon and cut more notches. Continue, cutting both adjoining boards at once. Note: If the fingers are spaced properly and the joint is still too tight or too loose, adjust the width of the dado blade. I invested in a set of thin brass dado shims just for this purpose.

Ingenious Jigs

continued from page 24

When constructing this finger joint jig remember that the tenon must be precisely the same width as the fingers you wish to cut. I made several faces for my jig, each with different sized tenons.

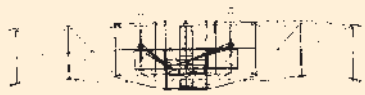
Make the tenon and stop from hardwood such as oak or maple. Drill a 5/32"-diameter hole for the machine screw, then cut threads in the hole with a tap. (You can purchase a #10-32 tap at most hardware stores.) Oak and maple are hard enough to hold the fine threads, but soft enough that they spring back and hold the machine screw in position. To make it easier to turn the machine screw, install a knurled nut on the end and tighten a stop nut against it.

These stops have many other applications besides finger joints. I use them as fence stops on my router table and drill press. I've incorporated them in cut-off boxes, tenoning fixtures, and other applications where a small adjustment can make the difference between good craftsmanship and great craftsmanship.

Tip: To keep the dado blade from splintering the wood where it exits the cuts, scribe the length of the fingers on the board. Make the fingers about 1/32" longer than the width of the board so they protrude slightly when you assemble them. Later you can sand the ends and faces flush. **PW**

Kids Build a Wright Airplane!

Update: In the February 2001 edition of *Popular Woodworking*, I explained the Centennial Flyer Project ("Help Kids Build a Wright Flyer," page 28) and asked if any of our readers would help run workshops, teach a little woodworking, explain a little aerodynamics, and help a group of kids build the rib for a 1903 Wright Flyer. The kids sign the rib and send it to the Wright Brothers Aeroplane Company in Dayton, Ohio, where we incorporate it in a full-size airplane. So far, almost 40 generous souls have signed up to run these workshops, and I am deeply grateful. If you'd still like to get involved, there's room; we need 74 ribs in all.



THE CENTENNIAL FLYER

At this writing, I'm up to my eyeballs in ash and spruce as I put together the materials for the workshop leaders. By the time you read this, we should have our first ribs back and I'll show them to you in the next issues.

If you would like to enroll your kids in one of our rib workshops, check out the Waypoints section of our web site at www.wright-brothers.org. This lists the schools and air shows where we'll be showing our Wright aircraft, and we'll conduct a workshop at each location.

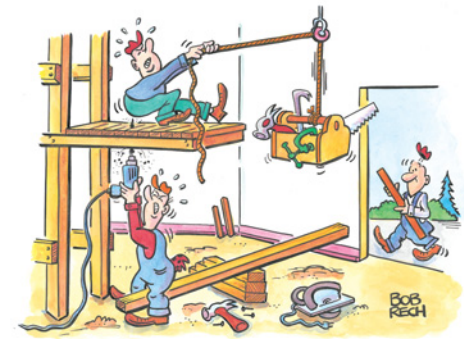
While we're waiting for our ribs, we've begun work on a 1901 Wright Glider that we will fly at Kitty Hawk, N.C., later this year. You're all invited to come help us fly; watch the web site for details.

— Nick

Cartoon

Illustrated by Bob Rech
bobrech@juno.com

#49



Submit your caption(s) for this issue's cartoon on a postcard to *Popular Woodworking*, Cartoon Caption #49, 1507 Dana Ave., Cincinnati, OH 45207 by **June 18**. Winners will be chosen by the editorial staff.

The winner will receive a four-piece router bit set from Freud, including a flush trim bit, straight bit, roman ogee and beading bit, plus a bearing to convert the beading bit into a 5/8" roundover bit. The runners-up each win a one-year subscription to *Popular Woodworking*.

Sponsored by freud®

#47

"With this entertainment unit you can get a laugh without turning on the TV."

Stan Haw, of Walton Hills, Ohio, is the winner of our Cartoon Contest from the February issue and recipient of a fine set of Freud router bits. The following runners-up each receive a one-year subscription to *Popular Woodworking*:

"And to think that cable TV man wanted to drill a hole in my wall."
Bill Clifford, Southbury, Connecticut

"What style of furniture is this, Modern Redneck?"
John Isenhower, Seaford, Delaware

"Biff's idea didn't get a good 'reception.' "
Dave Nelson, Camp Hill, Pennsylvania

BISCUIT JOINER Sh

We dissect 10 models to find out what's important, and skim the grease from the gravy.

Biscuit joinery is one of the newest concepts in woodworking, but the tools themselves are actually descendants of the angle grinder. In many ways a biscuit joiner is a simple tool: a 4" blade spins on the end of a basic universal motor. The feature that tends to divide the tools is the fence. But even there, the principle is still the same. Though the fences can make the process more convenient and offer a variety of angles to make the slot, they all exist to perform the same fundamental function: locating the slot.

Body Styles and the Fence

Biscuit joiners are available in two body styles, in-line (where the motor is directly over the blade) or right angle (with the motor essentially behind the blade). All but two of the joiners currently sold are the right-angle variety. The two in-line models are both manufactured by Ryobi (one under license to Sears). It's fair to say the right-angle type is the more popular design, and rightly so. While the in-line version is less complicated mechanically and makes a less jarring noise (no transverse gearing), the high center of gravity makes it more awkward to use. The right-angle orientation allows the user to put the energy directly behind the blade during the plunge cut.

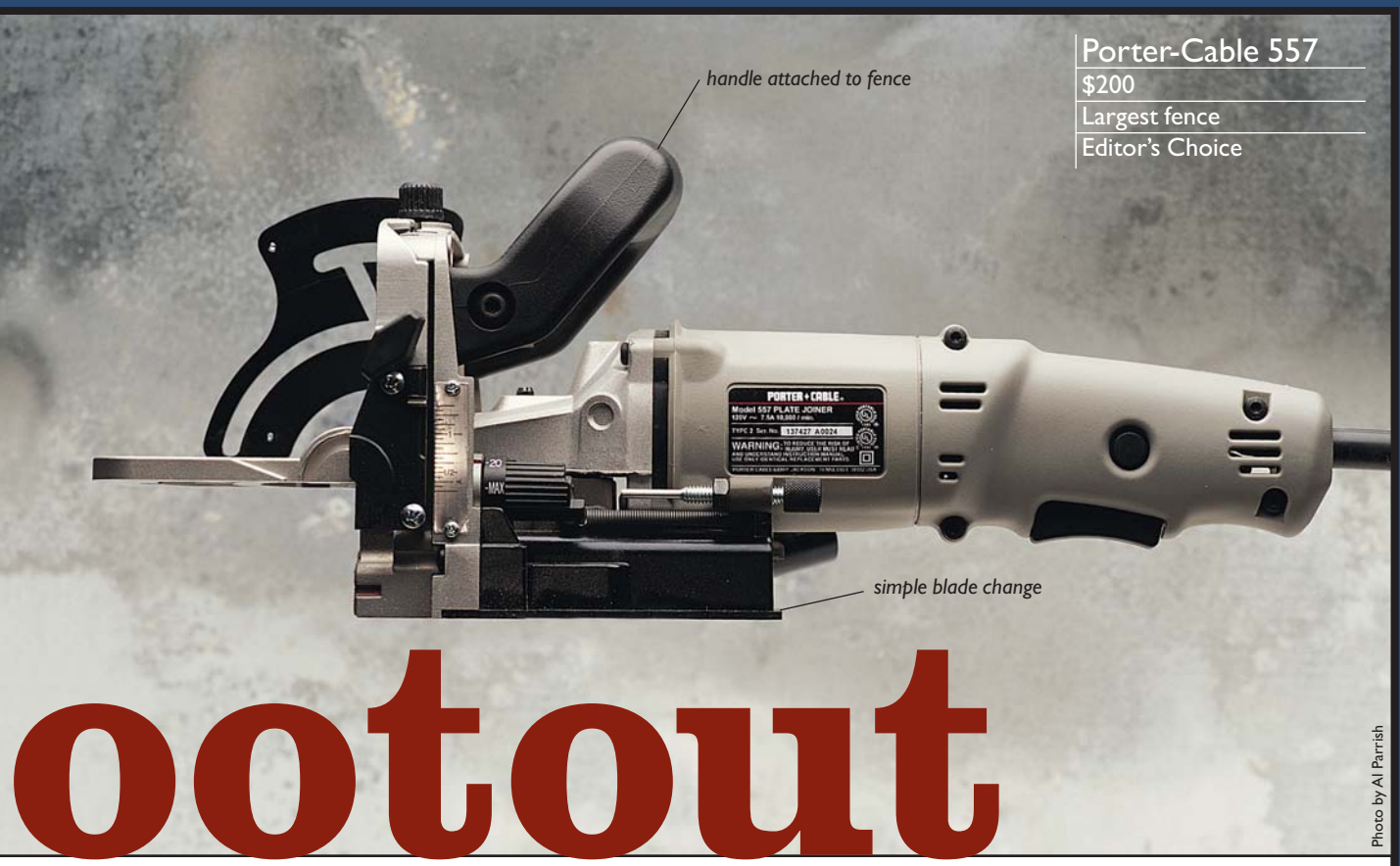
Fences also come in two basic designs. The first style has a removable fence that's used for right-angle cuts. When you want to cut at an angle other than 90°, you remove this fence and flip down a second fence to the desired angle. The second type of fence has one single fence that can flip down to cut at 90° and at other angles. The method of adjusting the fence can be significant in the performance and convenience of the tool. Fences can be made of steel or plastic, but the great majority are made of cast aluminum (Ryobi's products are again the exception). The Porter-Cable 557's fence is the best in our minds because it offers continuous adjustment to 135° with no loose parts to lose. However, the two-piece fences are certainly serviceable. The difference in fence designs doesn't appear to affect price.

Some fences offer detents at commonly used angles, while others offer a simple graduated scale to determine the angle. All the joiners tested are capable of cutting biscuit slots at zero and 90° to the wood surface. Most will adjust to angles between 0° and 90° as well, while seven of the 10 will adjust to make slots at up to 135° to the wood surface.

Another variable with fences is the method used to keep the joiner face from

by David Thiel

Comments or questions? Contact David at 513-531-2690 ext. 255 or DavidT@FWPubs.com.



Porter-Cable 557
$200
Largest fence
Editor's Choice

ootout

Photo by Al Parrish

sliding across the wood surface during the cut. The rotation of the blade tends to make the joiner pull to the left. To hold the tool in place, some use padded rubber, either surrounding the entire blade opening or as small pads on either side of the opening. Also used is a sandpaper-type finish surrounding the blade opening, or two four-pronged metal studs that are spring-loaded and adjustable in depth.

What *is* important in a fence will be different for each woodworker. For many, the extra angle capacities are not necessary. What is important for all is being able to read the height and angle scales easily and to quickly adjust those settings. Also, the effort required to make the plunge cut affects the accuracy of the cut. The plunge motion should be smooth and take a certain amount of pressure. But too loose or too tight and things can get sloppy.

Finally, a word on size. When it comes to fences on biscuit joiners, bigger is better. A larger fence is easy to hold in place during cuts and makes your joints more accurate.

The Motor Puts Things in Motion

Unlike many power tools, the raw power provided by the motor isn't a particularly critical factor. All the joiners tested operate at 10,000 rpm and draw between four and seven amps under load. The cut itself is fairly minimal, so only a certain amount of power is necessary. Though noise is a concern with these motors (all operate in the "ouch" range; 85 dB is harmful), there isn't a dramatic difference between the many models, even including the gearing differences between body styles. Just wear hearing protection.

Hidden Carbide

While the motor's power may not be critical, the blade and its performance is. All the blades we tested are carbide tipped for extended wear. Most have six teeth with, once again, the Ryobi-made models being the exception with eight.

Because the blade is where all the action takes place, we did a little more testing here. A biscuit should fit into the slot reasonably snug, but shouldn't have to be forced in place.Because of this, the kerf left by the blade is critical. Too wide (due to vibration, loose bearings or poorly machined teeth) and the biscuit might wobble in the slot. Another situation for concern is the relationship between the fence and the blade. The slot must be parallel to the material (whether aligning the tool using the fence or the work surface). If the slot is out of parallel with the material, it can keep the biscuit from fitting, or throw the alignment off.

The variance found between the blade thickness and the thickness of the slot it makes can be an indicator of poor quality. But don't get too hung up on that. We're talking about thousandths of an inch variance, and biscuits are designed to swell with glue to .16". If the machine cuts a slot .16" or slightly smaller (and I mean slightly), you're in good shape.

One last bit of testing needs some discussion. We've listed our opinion of the difficulty required to change the blade in each tool. For most woodworkers this is a task that may be undertaken once a year (if you use the tool a lot). Three exceptions exist. Both the Porter-Cable 557 and the two Lamello machines offer a second, smaller blade designed for cutting biscuits for use in face-frame construction. To be able to benefit from this extra capability, it's particularly important that blade change be simple in these tools. **PW**

Craftsman 17501

Though this machine ties for lowest price with the Freud JS100, it doesn't compare in quality or performance. The 17501 is essentially the same machine as the Ryobi JM80K, but with a poorer quality plastic fence (though the large handle at the front of the fence is reasonably hand-friendly). Two knobs simultaneously adjust both the height and angle of the fence. This makes adjustment awkward and difficult, as well as making it possible to lock the fence out of parallel with the blade. The indicator markings on the depth stop are difficult to interpret. There is no switch lock to hold the machine in the "on" position. This machine does offer the best dust collection facility, with a port that is virtually impossible to clog.

Craftsman 27730

A near-clone of the DeWalt DW682, this tool is worlds better than the less expensive Craftsman 17501. The fence is an exact copy of the one on the DeWalt, and that's a good thing. The scales are easy to read, and the dual rack-and-pinion height adjustment is accurate and easy to use. The one-piece flip-down fence allows it to be used at an angle or squared to ¾" material without leaving a loose part lying around. The paddle switch has a nice feel, but the lock-on switch is in an awkward location. The location of the exhaust port forces air into your face during a cut, which isn't a critical flaw, but is annoying. Different from the DeWalt, the Craftsman employs a single top knob and a shortened stubby body. Both of these changes make the tool more awkward to use.

DeWalt DW682K

This tool offers a nice one-piece flip-down fence for easy changeover between angled and square cuts. The fence has dual rack-and-pinion height adjustment for accurate and simple operation. With an extended body compared to the Craftsman 27730, the paddle switch location is away from the dust bag, causing no ergonomic problems, and the grip size is comfortable in your hand. All the indicator scales are easy to read and operate. The blade runout during our testing was negligible. As with the Craftsman clone, this model suffers from a poorly located switch lock-on, and the exhaust air tends to blow directly into your face during a cut. One stand-out from all the tools tested is the sturdy steel storage box included with this tool.

Biscuit Joiners

		FENCE				MOTOR				BLADE				
MODEL	STREET PRICE	SCALE/ DETENTS	MAT.	ANGLE CAPACITY	SIZE	AMPS/ NO-LOAD	AMPS/ LOAD	AMP VAR.	dB/ NO-LOAD	#OF TEETH	ANTI-KICK BACK	BLADE KERF	HOLE KERF	VARIANCE
Craftsman 17501	$100	135, 105, 90 75, 60, 45°	Pl.	0-135°	3-3/4" x 5-1/4"	3.5	6.7	3.2	102	8	Yes	0.159	0.165	0.006
Craftsman 27730	180	0, 90°	Al.	0-90°	2-1/2" x 4-3/4"	2.8	6.75	3.95	104	6	No	0.155	0.166	0.011
DeWalt DW682K	150	0, 90°	Al.	0-90°	2-1/2" x 4-5/8"	2.7	5.89	3.19	103	6	No	0.150	0.154	0.004
Freud JS100	100	0, 45, 90°	Al.	45, 90°	2" x 4-3/4"	2.8	3.89	1.09	103	6	Yes	0.155	0.164	0.009
Freud JS102	125	0, 45, 90°	Al.	0-90°*	2" x 4-3/4"	2.7	4.49	1.79	104	6	Yes	0.154	0.157	0.003
Lamello Classic C2	329	0, 22.5, 45,° 67.5,90	Al.	0-90°*	2-1/2" x 5"	2.64	4.07	1.43	105	6	Yes	0.154	0.159	0.005
Lamello Top 20	629	0, 22.5, 45, 67.5,90°	Al.	0-90°*	2-1/2" x 5"	4.0	5.89	1.89	101	6	Yes	0.133	0.159	0.026**
Makita 3901	160	0, 45, 90°	Al.	0-90°*	2-3/8" x 5"	2.47	4.93	2.46	102	6	Yes	0.153	0.156	0.003
Porter-Cable 557	200	0, 90, 135°	Al.	0-135°	3-3/4"x 5-1/4"	3.08	5.29	2.21	98	6	No	0.159	0.159	0.000
Ryobi JM80K	115	0, 45, 90, 135°	Steel	0-135°	3-3/4" x 5-1/4"	3.55	6.08	2.53	101	8	Yes	0.188	0.191	0.003

KEY: * Angles past 90° (including 135°) can easily be achieved by attaching the 90° fence and adjusting the angle of the adjustable fence. ** Blade geometry for the Top 20 is different than all the

Freud JS100

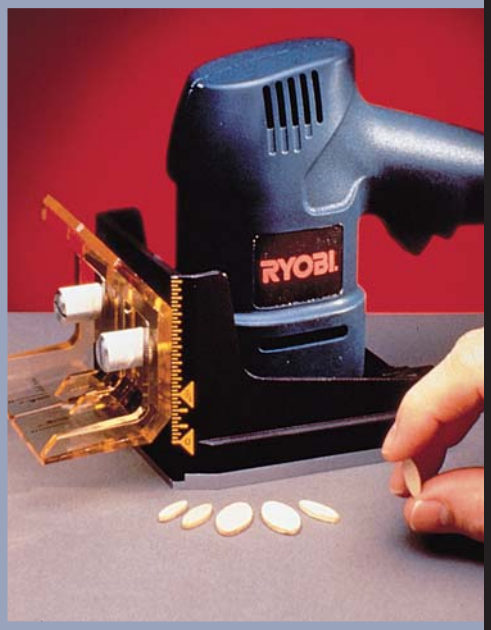
This inexpensive tool hasn't changed significantly in a number of years and is light on features, but it performs its job reasonably well. It makes smooth cuts, thanks in part to its blade (Freud manufactures excellent blades). The auxiliary fence slides on dovetailed ways, which allows you to adjust the height of the fence. The scale for that adjustment is located on the fence and is almost unusable, and the fence is limited to 0°, 45° and 90° cuts. The front fence is undersized, making it difficult to place your hand on the fence to steady the cut. The power switch is located on the barrel, and while not amazingly handy, it is efficient and locks on easily. This tool functions very adequately and is a value for the price. However, for an extra $25 we recommend you move up to the Freud JS102.

Are Mini-Biscuits For You?

There are two biscuit joiners that are absent from our review because they are specialty tools, but they deserve mention. The mini-biscuit joiners from Ryobi and Craftsman are designed to cut slots for three sizes of biscuits that are smaller than the traditional #0, #10 and #20 biscuits. With three biscuit sizes (R1: 5/8" wide, R2: 3/4" wide and R3: 1" wide) smaller than specialized face-frame biscuits, these machines offer an alternative joinery method for small projects, including jewelry boxes, frames and many hobby projects. We keep this tool around the shop because there are times it's the only tool that can tackle a thorny joinery problem.

The mini-biscuit joiners are different than their larger cousins in a few ways. They operate at 19,000 rpm rather than 10,000, and they sport a six-tooth, 1 1/2" steel blade (no carbide tips here, so the blade will obviously dull faster). The plastic fence only adjusts for 45° or 90° joinery, but also adjusts in height for material thickness.

Should you buy one? If your woodworking is typically on the smaller side, these tools are made for you. But if you are building cabinets, tables and the like, your money will be better spent with one of the standard biscuit joiners, even with an upcharge of $25 to $50. The Ryobi model is the DBJ50 and sells for around $70. The Craftsman model 17550 (which is made by Ryobi) sells for around $80.



There are times when only a mini-biscuit will do. These tools tackle unusual joinery problems and are great for small-scale work.

	OTHER STATS						PW RATINGS		
	CORD LENGTH	WEIGHT	BODY STYLE	SIZE BISCUITS	NON-SKID MATERIAL	DUST COLLECTION	BLADE CHANGE	ERGO-NOMICS	OVERALL PERFORMANCE
Craftsman 17501	10', Pl.	6.5 lbs	In-line	0, 10, 20	Rubber face	Dust box	●●○○○	●●○○○	●●○○○
Craftsman 27730	8', R	6.7 lbs	Right angle	0, 10, 20, max	4-prong pins	Cloth bag, vacuum port	●●●○○	●●●○○	●●●●○
DeWalt DW682K	8', R	6.9 lbs	Right angle	0, 10, 20, max	4-prong pins	Cloth bag, vacuum port	●●●○○	●●●●○	●●●●○
Freud JS100	7' 8", Pl.	6.14 lbs	Right angle	0, 10, 20, A, B, Max	Rubber pads	Cloth bag, vacuum port	●●●○○	●●●○○	●●●○○
Freud JS102	7' 8", Pl.	7 lbs	Right angle	0, 10, 20, A, B, Max	Rubber pads	Cloth bag, vacuum port	●●●●○	●●●◐○	●●●●○
Lamello Classic C2	10', Pl.	7.3 lbs	Right angle	0, 10, 20, S, D, Max	Rubber pads	Vacuum port	●●●●○	●●●●○	●●●●●
Lamello Top 20	10', R	7.11 lbs	Right angle	0, 10, 20, S, D, Max	Rubber pads	Vacuum port	●●●●○	●●●●○	●●●●●
Makita 3901	9', R	6.15 lbs	Right angle	0, 10, 20, S, D, Max	Rubber face	Cloth bag, vacuum port	●●●●●	●●●●○	●●●●○
Porter-Cable 557	7', R	7.7 lbs	Right angle	0, 10, 20, S, D, Max, FF	Grit face	Cloth bag, vacuum port	●●●●○	●●●●○	●●●●●
Ryobi JM80K	10', Pl.	6.8 lbs	In-line	0, 10, 20	Rubber face	Cloth bag, vacuum port	●●○○○	●●○○○	●●○○○

other blades. The teeth are offset. As a result, the variance is not a measure of runout. Pl. = plastic, Al. = aluminum, R=rubber, FF=face frame

Freud JS102

This machine is similar to the JS100, with the addition of an improved fence that allows for angled biscuit cuts and an easily read scale for height, angle and biscuit size. The fence size has not been improved, however, still making it awkward to steady the cut. Also improved over the JS100 is the blade-changing process, made almost as simple as that on the Lamello or Makita machines. This is an affordable machine with good performance, and only a few deficits, as noted earlier. We consider it a best value.

Lamello Classic C2

Selling for $129 more than its nearest-priced competition (the Porter-Cable 557), expectations were high for this machine. The fence is a two-piece version with a dovetailed auxiliary fence for height adjustment. Though the fence functions much better than those on the Freud tools, there is no scale to tell you which angle you're cutting at. The performance of this machine is good, the ergonomics comfortable, and it is generally a user-friendly tool (though depending on your grip you can bang your knuckles during cuts). With the purchase of an auxiliary blade, you can cut slots for face-frame biscuits. This tool is very well-engineered and has a very smooth plunging action and cut. However, unless you're making your living with this tool, we feel the cost is prohibitive.

Lamello Top 20

Priced significantly higher than any other tool in this test, the Top 20 was expected to perform head and shoulders above the competition. Performance was indeed excellent, and the knob-adjustable blade height makes this a unique and highly accurate machine. This tool offers an unusual blade technology to improve the efficiency and accuracy of the cut by providing two teeth sized to cut the desired kerf thickness, while the other teeth serve more as undersized rakers to clear the material. The tool comes with a wood carrying case and an auxiliary face-frame blade. The Top 20 is operated using a paddle switch. The fence angles are conveniently marked, and the fence operates smoothly and is very accurate. This is an excellent tool with superior performance and deserves special mention. But $600 is too much for a biscuit joiner unless it is imperative to your livelihood.

Aren't All Biscuits the Same?

Once you purchase the perfect biscuit joiner, you need to buy a good box of biscuits. If you have any experience with these little guys, you know that some boxes of biscuits contain a bunch of freaky beech. Most will fit fine, but some are too thick and will only fit with a hammer. Others are stamped wrong, broken or splintered.

To see who made the best-fitting biscuits, we tested 100 biscuits from five major manufacturers. Two testers put each of the 500 biscuits into a standard-size biscuit slot. Each biscuit was then placed into one of three categories.

Fit perfect: Both sides of these biscuits went in and out of the slot easily.

Press fit: One or both sides of these biscuits required moderate hand pressure to insert into the slot. We considered all of these biscuits to be ultimately usable.

Didn't fit: These biscuits wouldn't fit into the slot for a variety of reasons. Either they were misstamped, too thick or splintered in such a way as to be unusable. Biscuits that were both broken and unusable were also included in this category.

As we gathered information for this article we noticed that the Porter-Cable biscuits were made from birch instead of beech, which is the species used by all the other manufacturers in this test. We also learned from the manufacturer that the Porter-Cable biscuits weren't compressed when stamped, unlike all the other biscuits in our test. So we decided to see how much each biscuit would swell when it came in contact with moisture. We measured the thickness of each biscuit with a dial caliper. Then we submerged the biscuit in water for one minute, let it sit for another minute and then we measured its thickness. Finally, we let the biscuit sit for five minutes and measured it a third time.

We were surprised by the results. The American-made Porter-Cable biscuits fit better than any of the others in our test. Every one of the biscuits in the tube of 100 was usable. When exposed to moisture, the Porter-Cable biscuits swelled up more than the Lamello or the Ryobi biscuits. Here's the best part: Porter-Cable biscuits are a bargain. A box of 1,000 Porter-Cable

Makita 3901

Though an older design, this tool still offers many nice features. The fence is a two-piece design with an auxiliary fence that adjusts using an efficient and accurate single rack-and-pinion mechanism. The height scale is easily read, though the angle scale is less so. The knobs to tighten and loosen the angle and height adjustments are a toggled cam-style, unique in the tested models and easy to maneuver. The cut of this machine was very smooth, and the ergonomics were nice. All-in-all the 3901 is a very pleasant and accurate machine to use. The price is a little higher than some low-priced machines, but it's worth the extra cash.

Porter-Cable 557 Type 2

The 557 offers a unique two-position flip-down fence that adjusts between 0° and 90°, or will adjust beyond to 135°. The fence is well-designed, easy to operate and all the scales are easy to read. The fence height is adjusted by a threaded screw. It moves smoothly, and the fence stays parallel and accurate. Another unique feature is that the top handle is attached to the fence assembly rather than the motor body, making it easier to support the front of the machine during a cut. The paddle switch is convenient, with an easy lock-on. We found the model we tested to have no blade runout. Slight concerns with this machine include the fence redesign, which causes an awkward offset (see our website at www.popwood.com for how to fix this), and the air exhaust design that directs air into your face during a cut. Otherwise it's our favorite tool.

Ryobi JM80K

This tool is similar to the Craftsman 17501. A couple of features are better than the Craftsman, but the flaws remain the same. The fence is steel rather than plastic, so the fence is less likely to twist when you lock it down. The two dual-function adjustment knobs are still tricky to adjust for height without affecting the angle setting. The scales are difficult to read and there is no lock-on for the switch. While better than its Craftsman variant and sold with a plastic case, the JM80K is $15 more than the Craftsman, and still not a tool we can comfortably recommend.

biscuits costs between $18 and $20. Call 800-487-8665 for a distributor near you.

Tied for second place were the Lamellos and the Kaisers. Out of the 100 biscuits tested, 99 were usable. Both brands swelled adequately (the Kaisers swelled the most of any tested). Lamellos cost about $32 for a box of 1,000. Call 800-252-6355. Kaisers cost about $30 for a box of 1,000. Call 800-847-8839.

After I soaked all the biscuits in water, I decided to test a couple strategies for shrinking biscuits that had swelled due to humidity and were too big for their slots. One suggestion was to squeeze them in a vise. I tried that with several of the swollen biscuits and it seemed to work, but only some of the time. It took a lot of effort for meager results. Save this trick for when you're down to your last biscuit.

Another suggestion I hear all the time is to microwave the faulty biscuits to shrink the misfitting miscreants. I put four biscuits in our commercial-grade microwave here at work and pressed the button for reheating two large sandwiches. After about a minute of cooking, some of the biscuits began to stink and scorch, and my co-workers evacuated the cafeteria. The good news, however, is that the biscuits did indeed shrink, somewhere in the neighborhood of .001" and .013", depending on the amount of initial swelling.

Next time I shrink biscuits in the microwave, I'm going to use the button for reheating a dinner roll. That just seems fitting somehow.

- Christopher Schwarz

The Beef on Biscuits

MANUFACTURER	FIT PERFECT	PRESS FIT	DIDN'T FIT	DRY SIZE	WET SIZE	FINAL SIZE
Freud	87	7	6	.156"	.165"	.168"
Kaiser	98	1	1	.150	.165	.173
Lamello	97	2	1	.154	.159	.162
Porter-Cable	99	1	0	.153	.158	.166
Ryobi*	91	5	3	.154	.157	.159
BBBTB**	95	1	4	NA	NA	NA

Notes: "Dry size" is the largest size measured on the biscuit straight from the box. "Wet size" is the size of the biscuit after soaking it in water for one minute and then letting it sit for one minute. "Final size" is the size of the biscuit five minutes after the soaking.

**There were only 99 Ryobi biscuits in our sample size.*

*** "Big Box of Badly Treated Biscuits." To see what effect poor storage has on biscuits, we also tested our shop's box of biscuits, which is a mix of all the types tested here. The biscuits are not kept in a sealed environment, though our shop is pretty dry in the winter, which is when this test was performed. Oddly, these biscuits fared pretty well.*

biscuit join

b a

Few tools generate as much passionate debate as a biscuit joiner, arguably the most important woodworking tool invention in the last 50 years. Learn how to make your biscuit joints stronger, faster and more accurate.

My first woodworking class years ago was all about hand-cut joints. We cut mortises, tenons, dovetails, half-laps, bridle joints, you name it. All with hand tools. It's a lucky thing a coping saw doesn't make much noise because while cleaning out my 114th dovetail pin I overheard a classmate talking about biscuits.

Biscuits, he told us in hushed tones, are a faster and easier way to join wood. But some people, and he looked up at that moment to see if our instructor was looking, think that biscuits are cheating. Well that was enough for me. I had to find out what all the fuss was about.

As it turns out, biscuit joinery is, in actuality, cheating — the same kind of way that nuclear weapons are cheating. Like 'em or not, they get the job done faster than anything else out there. Biscuits aren't right for every situation (chairs come quickly to mind) but for many projects, biscuit joints are just the thing.

First, they're strong. Lamello, the inventor of biscuit joinery, has done extensive stress tests on the joints. In one of these tests the scientists joined two pieces of beech end-grain-to-end-grain using a #20 biscuit. This is just about the weakest joint I could imagine. Then they had a machine grab each end and pull the thing apart. It took an average of 972 pounds of force to destroy the joint. Not bad for a little wafer of beech or birch.

Second, they're fast joints to make. We checked the amount of time it took to make several common joints for face frames. The winner was the pocket screw, but that's because there's no clamping time. Take the clamping time out and biscuits and pocket screws are a tie for the fastest method.

Finally, they're safe and easy to use. It's difficult to hurt yourself with the machine, and injuries are rare. In fact, I know of only two ways an injury can occur. First, the tool slips or kicks out of a cut and your left hand gets chewed up before the blade retracts. Or second, you plunge the biscuit joiner before you turn it on. The tool walks into your hand that's holding the piece and up your arm. I'll show you how to build a simple jig that will quickly clamp narrow pieces and make it almost impossible to hurt yourself.

If you've never used a biscuit joiner, it probably will take you about five minutes to learn the basics. That said, there are some tricks to ensuring that all of your joints are perfectly lined up. Because the tool is so fast, it's easy to get lazy and a little sloppy.

The three most common sizes of biscuits: a #0 (the smallest), a #10 and a #20.

Photo by Al Parrish

by Christopher Schwarz

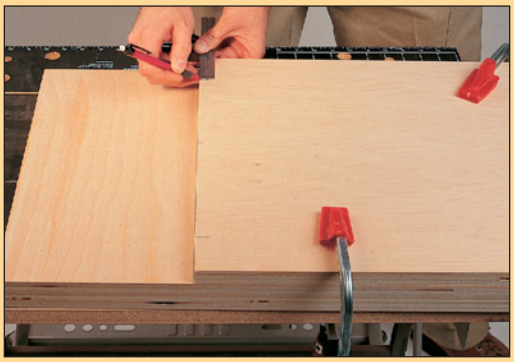
Comments or questions? Contact Chris at 513-531-2690 ext. 407 or ChrisS@FWPubs.com.

ery
sics

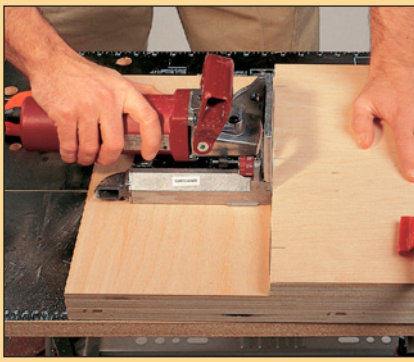
Biscuit joiners cut a semicircular slot that's the perfect size for a biscuit — essentially a manufactured loose tenon. To illustrate how the machine works, we cut a slot in some Lexan,a tough polycarbonate plastic.Though this isn't a common application for the tool, it handled the job with surprising ease.

Biscuiting a partition in the middle of a panel

The best way to biscuit a partition into the middle of a panel is to use the partition itself as a fence for your biscuit joiner. Here's how: Mark on the panel where you want the partition to be placed.



Lay the partition flat on the panel and against the line you marked. Clamp the partition and panel to your bench. Mark on the partition where you want your biscuit slots to go. There is no need to mark the panel beneath it.



Now remove the fence from your biscuit joiner. Place it flat on the panel and cut the slots in the partition.

The Basic Basics

Biscuits can add strength to a joint, such as when you join a table apron to a leg. Or they can be used as an alignment aid, such as when you glue up a slab using several boards or you need to glue together veneered panels. The biscuits won't add strength here, but they will keep your parts in line as you clamp. In a solid-wood panel, the biscuits reduce the amount of time you spend leveling your joints. In veneered panels, biscuits keep your parts in line so you don't end up sanding through the veneer.

When making a biscuit joint, first put the two parts together and decide how many biscuits you need for that joint. A basic rule of thumb is to place your first biscuit 2" from the edge and then every 5" to 7" or so, though the spacing is really up to you. Draw a line across the joint at each spot where you want a biscuit. Set the fence on your biscuit joiner so the biscuit will be buried approximately in the middle of your material (for example, if you're working with ¾"-thick wood, set your biscuit joiner for a ⅜"-deep cut. Don't worry about being dead-on in the middle. If you cut all your joints on one side, say, the face side, everything will line up). Select the size biscuit you want to use and dial that into your tool. Use the biggest size you can.

Clamp one of your parts to your bench. Line up the line on the tool's fence or faceplate with the line on your work. Turn on the tool and allow it to get up to full speed. Plunge the tool into the wood and then out. Repeat this process for the other side of the joint.

Now glue up your joint. There are at least two ways of doing this. You can put glue in the slots and then insert the biscuit, or you can put glue on the biscuit and insert it in the slot.

For small projects, paint half the biscuit with glue and insert it into one of the slots. Then paint the other half of the biscuit and clamp your pieces together. This method produces clean joints with minimal squeeze-out, but it's a bit slow.

When assembling big projects, I like to put the glue in the slots first using a bottle designed for this task. Squirt a dab of glue in all your slots and use a spare biscuit, piece of scrap or brush to paint the edges. Put the biscuits in the slots and clamp up. The downside to this method is it's easy to use too much glue, and you're liable to get more squeeze-out.

No matter which method you use, be sure to go easy on the clamping pressure. It's easy to distort a frame made with biscuits. If you're using a regular yellow glue, clamp the project for at least 30 to 45 minutes before taking it out of the clamps.

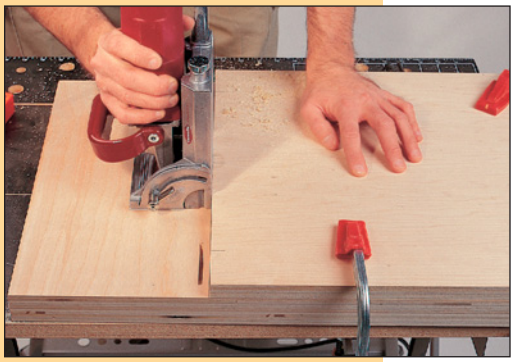
Attaching a tabletop to an apron

One of my favorite tricks with a biscuit joiner is using it to cut the slots for tabletop fasteners. Set the fence for ½" (you want the slot to start 7/16" down from the top of the apron) and make your cuts on the inside of the apron (you can do this after the table is assembled). The "Z"-shaped fasteners now slip into the slots and can be screwed to your tabletop.

Where to Use Biscuits

Making the biscuit slot is easy. The tricky part is knowing when to use biscuits and how many to use. Here are some situations when you should be careful:

Long-grain joints: Many people use biscuits to join several narrow pieces into a panel, such as a tabletop. Biscuits help align the boards so they don't slip as much when you clamp them. However, don't let anyone tell you that the biscuits make the joint stronger. In long-grain to long-grain joints, the glue is stronger than the wood itself. So biscuits here are only an alignment tool. Also, be careful to place the biscuits where they won't show after you trim your part to finished size. Once I raised



Now turn the biscuit joiner on its head and cut the slots in the panel. Use the layout lines on the partition and the centerline on the bottom of the tool to properly line up the biscuit joiner.

the panel on a door and exposed half a biscuit. That panel had to go in the trash.

Face frames: Biscuits are just right for face frames as long as your stock isn't too narrow. A #0 biscuit will only work with stock as narrow as 2⅜". Any narrower and the biscuit will poke out the sides. To join narrow stock you need a biscuit joiner that can use a smaller cutter (such as the Porter-Cable 557 or Lamello Top 20) or a tool that cuts slots for mini biscuits from Ryobi or Craftsman.

Continuous-stress joints: Biscuits are strong, but I wouldn't build a kitchen chair with them. The joints in chairs, especially where the seat meets the back, are subject to enormous amounts of stress. Call me old-fashioned, but I'd use a mortise-and-tenon joint.

With polyurethane adhesives: We like poly glue quite a bit, but you must remember that biscuits swell and lock your joint in place by wicking up the water in your white or yellow glue. Poly glues have no moisture in them. In fact, these glues need moisture to cure. If you want to use poly glue with biscuits, dip your biscuits in water before inserting them into the slot. The water swells the biscuit and activates the poly glue.

Building tables: If you're going to build a table using your biscuit joiner, use two stacked biscuits to attach the aprons and stretchers to the legs. This might mean making your aprons ⅞" thick. See the photos below for an easy way to get the apron in the right place and two biscuits into your joint. In fact, whenever you're joining thick stock it's a good idea to add an extra biscuit.

With ½" plywood: When using a biscuit joiner to join pieces of ½"-thick plywood, you might have trouble with the biscuits "telegraphing" their shape into the surface of your material. Use #0 or #10 biscuits with ½"-thick material and go a little easy on the glue.

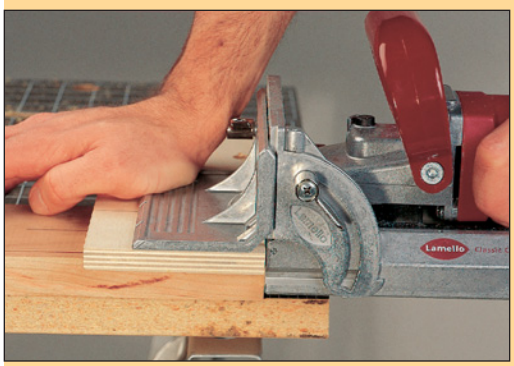
Fence or no fence? Some woodworkers always rest the tool's fence on the work to control how deep the cut is; others prefer to take the fence off and let the tool's base ride on their bench or a table. There are advantages to each approach. When you take the fence off and use your bench as the reference surface, you have a large flat area for your tool to rest against and sniped boards won't throw off your joiner. However, you have to watch for sawdust on your bench and work with all your parts face-down on your bench. Advocates of the fence approach say it's easier and more accurate to work with your parts face-up on your bench. But you have to ensure your biscuit joiner is square to your work. If you lift up or press down on the tool during the cut, it could throw off your joint. Try each method and see what works best for you.

Quick Jig Speeds Your Work

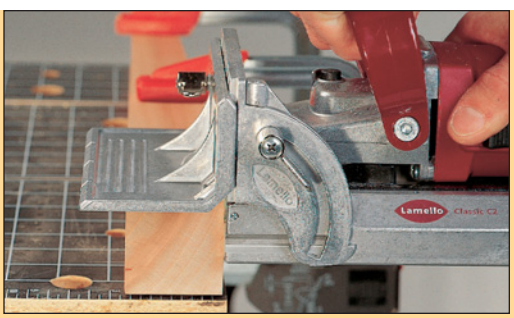
There aren't a lot of jigs and fixtures for your biscuit joiner. However, building this jig will make the tool easier and safer to use. When I first started using biscuit joiners, I held the wood with my left hand and the tool with my right. After my grip failed me a couple times, I became an advocate of clamping your work in place.

But clamping takes time. This jig makes clamping quick and easy. The quick-re-

Biscuiting an Apron to a Leg



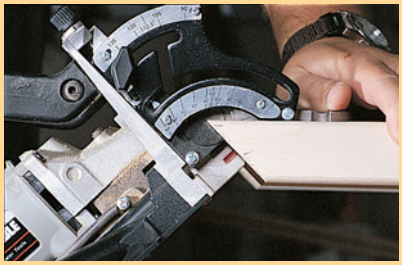
If you're going to use biscuits to attach a leg to a table apron, then you really should use two biscuits stacked on top of one another. This joint, according to experts and scientists, is nearly as strong as a mortise-and-tenon joint. The other challenge with this joint is you are going to want to offset the apron so it joins the middle of the leg. Here's the best way to do this. First determine what your offset is. I wanted my aprons to sit ½" back from the legs. Now get a scrap piece of wood that is the same thickness as the offset. Put this block of wood on top of your apron and set the fence on your biscuit joiner to make the first cut. Make the cut on the apron.



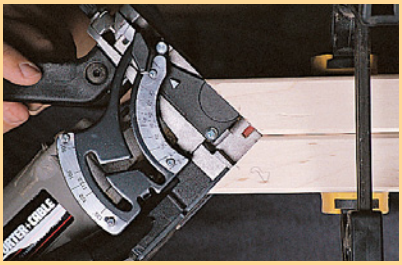
Now cut the biscuit slot on the leg without the spacer. When that's done, go back to your apron and adjust the fence to make the second biscuit slot.

Finally, cut the second row of slots on the leg without the spacer. When you're done, you've got a double helping of biscuits that's ready for some glue.

Biscuiting Miters

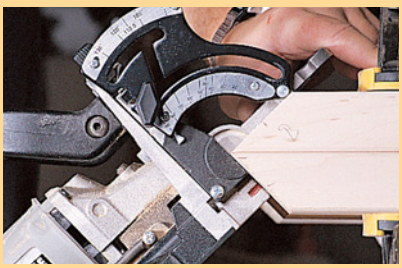


The fence on the Porter-Cable 557 allows you to biscuit your miters with the fence on the outside of the joint — a nice feature.



You can biscuit miters without using your fence by clamping the two joints together.

If your fence is adjustable only between 0° and 90°, you can cut the joint on the inside of the miter. Just be careful when positioning your tool.

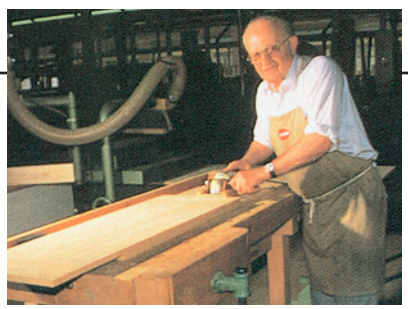


Or, if you have a fixed 90° fence on your tool, you can clamp them together this way to cut your slots.

lease clamps allow you to fix your work in place in a second or two (with almost 300 pounds of clamping pressure) and it gives your biscuit joiner a bed to ride on.

Why is that important? You see, if you retract or remove the fence on your tool, the tool is designed to cut a slot in the middle of a ¾"-thick board when resting on a flat surface. So with this jig you don't need to set your fence. You simply clamp your wood in place, mark where you want the slot, put your tool on the bed and plunge.

This jig also makes your cuts more accurate because it ignores snipe on the ends of your stock. If you use the fence on your biscuit joiner when building face frames you can get in trouble when the end of the board is sniped. Because of the snipe, your tool won't cut the slot in the right place



Hermann Steiner, inventor of the Lamello joining system.

Where do Biscuits Come From?

As important as the tool itself is the lowly biscuit. These football-shaped pieces of wood are a bit of an engineering marvel. Out of the box, biscuits are about .15" thick, and they fit into a slot that's about .16". When the biscuit comes in contact with the water in your glue, it swells up, locking the joint in place. To ensure the joint is strong, the grain direction on biscuits runs diagonally. This prevents your joint from splitting and gives you, in the worst case, a cross-grain joint.

But just where do these little suckers come from? Kathleen Oberleiter, the dealer sales manager for Lamello, says her company has one plant in Switzerland that produces biscuits for Europe and the United States. In addition to producing biscuits under its own name, she says Lamello also makes the same quality biscuits for Makita and Black & Decker (and Black & Decker's sister company, DeWalt).

Lamello (800-252-6355) employs two people whose job is to find the perfect European beech trees for making biscuits. They look for trees that are at a particular stage of growth and choose those for harvesting. The trees are debarked, cut into thin panels and kiln-dried. When the panels are dry the biscuits are stamped and compressed from those panels. Lamello brags that all its biscuits are within one-tenth of a millimeter in thickness and with a moisture content between 8 and 10 percent.

Here in the United States, Porter-Cable (800-487-8665) started making its own biscuits in Jackson, Tenn., in the mid-1980s, according to company officials. Then the company concluded it would be better to have another company make the biscuits using Porter-Cable's tooling and equipment. Now Hill Wood Products of Cook, Minnesota, makes all of Porter-Cable's biscuits. The company also makes Ryobi's face frame biscuits. In fact, Hill Wood's plant is the only major producer of biscuits in this country and makes between 60 percent and 70 percent of the biscuits sold in the United States, says Hill Wood President Steve Hill.

Since his company started making biscuits for Porter-Cable, Hill says his company has upgraded the original equipment three or four times and can now easily make 1 million biscuits a day.

Instead of beech, Hill Wood makes biscuits using Northern white birch from Minnesota, most of which comes from within a 150-mile radius of the plant. The trees are sawn using special equipment and then dried to a moisture content between 6 percent and 8 percent. Then the strips of birch are transformed into biscuits by the company's machinery.

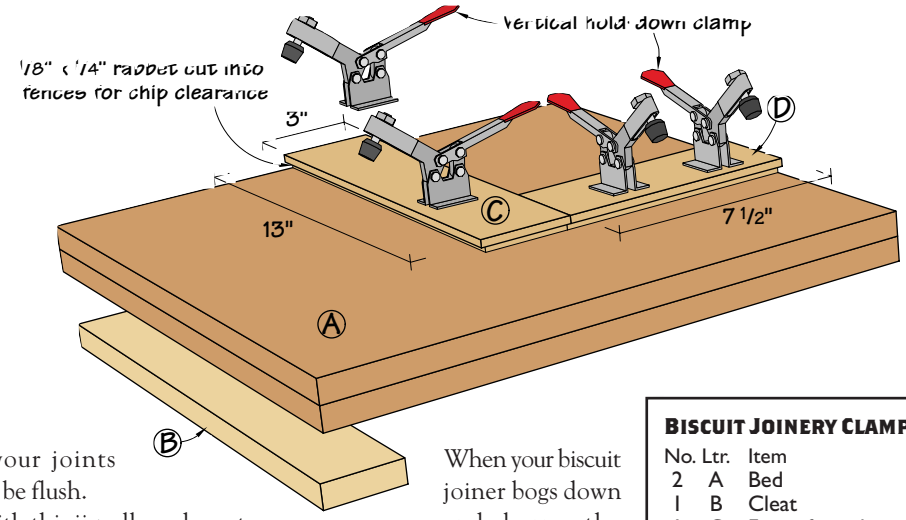
Interestingly, Hill says Hill Wood does not compress the wood for its biscuits and relies on the moisture in the glue to swell the biscuit and lock the joint tight. The company's equipment is capable of compressing the biscuits, but Hill says he's found that wood can compress unevenly, resulting in biscuits of different thicknesses. Hill Wood cuts its biscuits within 5-thousandths of the optimum thickness.

So how does birch compare to the European beech? Hill says beech is actually a little harder and the grain is a bit tighter than in birch, but that it's real close. "The glue or the wood is more likely to fail than the biscuit," he says.

Freud (800-334-4107), a major player in the biscuit market, has its biscuits made by a Spanish firm that makes biscuits for many other firms, according to Jim Brewer, vice president of operations. Freud's biscuits are made of beech and are compressed, he says.

Biscuits sold by Ryobi (800-323-4615) are manufactured in Minnesota from beech and are compressed, company officials say.

Kaiser biscuits, which are made in Austria from beech, have been distributed in the United States for the last five or six years by Practical Products Co. (800-847-8839) of Cincinnati, Ohio, according to Donald Baltzer, company president. Kaisers are well thought of in Europe and are compressed during manufacturing.



and your joints won't be flush.

With this jig, all you have to do is remember to put all your pieces face-side down on the jig and keep it free of sawdust. Because the tool rides on the jig and not the work, your slot is going to be exactly where you need it.

I also made an attachment for this jig that guides the biscuit joiner when cutting slots in miters. This attachment keeps your tool on target and prevents it from kicking left as you plunge.

Building the jig takes less than 30 minutes. The most important part is the bed itself. You want it to be as flat as possible. Glue two pieces of ¾"-thick plywood together and check the "sandwich" for flatness with a straightedge. Then nail another piece of plywood on the bottom of the jig's front edge so the jig hooks over your bench.

Nail and glue two strips of ½"-thick plywood in the locations shown in the diagram. Then screw the clamps in place. Let the glue dry before you go to work; engaging the clamps at this point can tear your jig apart.

Troubleshooting

Not much goes wrong with biscuit joinery, but here are some of the troubles we've run into and how to remedy them.

Sometimes when you get in a hurry your biscuit slots aren't aligned. The joint will either be whopper-jawed or impossible to clamp shut. Using a ruler, figure out which of the slots is off (it might be both). Glue a biscuit into the botched slot and let the glue dry. Then trim the biscuit flush to your material and cut your joint again.

When your biscuit joiner bogs down and burns the wood, it's trying to tell you something. Usually your blade is gummed up with resin or it's dull. Remove the blade and spray it with an oven cleaner. If that doesn't help, replace the blade.

Probably the weakest feature on most biscuit joiners is the dust collection. Typically, the tool tries to shoot the chips out a small port and into a cloth bag. This usually works for about half a dozen biscuits, then the port gets clogged and dust sprays everywhere when you make a slot. Sometimes this is a sign that your bag is getting old and frayed. The frayed ends cling together and the chips back up into the port and then get clogged. If your bag is old, first try turning it inside-out. If that doesn't help, just get an adapter to connect your tool to a shop vacuum. That will solve your problem. **PW**

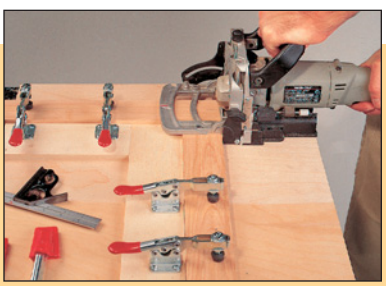
Biscuit Joinery Clamping Jig

No.	Ltr.	Item	Dimensions T W L	Material
2	A	Bed	¾" x 18½" x 18½"	Ply
1	B	Cleat	¾" x 2½" x 18½"	Ply
1	C	Fence for stiles	½" x 3" x 13"	Ply
1	D	Fence for rails	½" x 3" x 7½"	Ply
1		Mitering guide	¾" x 8" x 15"	Ply

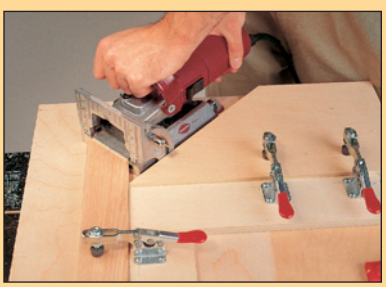
4 De-Sta-Co clamps. Reid Tool Supply 800-253-0421, item # TC-215-U. $8.15 each.

Biscuit Jig

This jig is useful for two reasons. First, it will make your tool more accurate. You use the plywood base to guide your tool. That way if there's any snipe on the end of the board, your biscuit will still end up in exactly the right spot. Second, it will make your work a whole lot faster. The quick-release clamps on this jig (which supply hundreds of pounds of clamping force) will keep you from clamping each piece to your bench, which slows you down. If you're one of those people who holds your face frame parts down with your hand as you cut them, you'll find this jig is just as fast as that method, and your work is a lot less prone to slipping.



The beauty of this jig is that it holds both a rail and stile in place for cutting. You can cut one right after the other if you please, or cut them one at a time.



If you cut biscuits to join a mitered frame, this jig is quite useful when you add the 45-degree spacer shown in the photo above. The spacer helps guide the tool and prevents it from kicking to the left, something the biscuit joiners are prone to do in narrow stock


the writer's market
WRITER'S MARKET
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WRITER'S MARKET
ITER'S MARKET—1945

Show off your pottery, books and good taste by building an authentic reproduction of a turn-of-the-century classic.

Limbert Bookcase

In 1996 I stopped purchasing Arts & Crafts furniture, and this bookcase is the reason why. After collecting Arts and Crafts furniture since 1990, I had amassed a small but nice collection on my salary as a newspaper reporter. However the piece I wanted but never could find is a glass front bookcase. So I patiently saved my money and went to an auction in Chicago, ready to buy this very bookcase, which had been featured prominently in the auction's catalog.

I was outbid. Well, completely blown out of the water is more like it. I went home that day with two smaller pieces that, while nice, were not exactly what I wanted. So like any scorned woodworker, I plotted and planned. I sought out dimensions from auction catalogs and reprints of historical materials. And when I was ready, I built the bookcase I'd always wanted. Limbert pieces were almost always made from quartersawn oak or ash, but I decided that cherry with a deep mahogany finish was what I wanted.

Everything about this piece is as authentic as I could get, from the knob to the shiplapped beadboard back. My only compromises were some nonmortise hinges (I'm convinced Limbert would have used these if Amerock had been making them in 1904), and a thin bead of silicone to help hold the glass in place. Construction is simple — well within the reach of most beginning and intermediate woodworkers. The top, bottom and gallery back rest in dadoes in the sides. The beadboard back is screwed into rabbets on the case members. And the doors are simple mortise-and-tenon construction. In fact, the only tricky part is the mullions on the doors. But if you take some care when building them, you should have no problem at all.

You need about 50 board feet of 4/4 cherry (that's 1" thick) to build Limbert's #340 bookcase, and not a scrap of plywood. Begin by surfacing all your material and gluing up the panels you'll need for the sides, top, bottom or shelves.

Start with the Sides

Begin working on the case by cutting the $\frac{3}{8}$" x $\frac{5}{8}$"-deep rabbets on the back edges of the top, bottom and side pieces for the back. The rabbeting bit I own for my router table wasn't large enough to make this cut easily, so I made the rabbet in two passes on the table saw. While you're at the saw, cut the $\frac{5}{8}$" x $\frac{3}{8}$"-long tongues on the ends of the gallery back. These tongues allow the gallery back to lock into the rabbet on the side pieces.

by Christopher Schwarz

This plywood jig cuts the dadoes in the sides that hold the top and bottom pieces. Here I'm cutting the dado for the bottom. Note how the edge of the jig is flush to the bottom of the case.

Now it's time to mill the 3/8"-deep dadoes in the sides that will hold the top and bottom in place. Make a simple plywood jig (it takes about five minutes) to cut these dadoes. Here's how to do it: first study the photo above to see generally what the jig looks like. Basically it's two pieces of plywood with two pieces of scrap nailed to them. You'll notice that the two pieces of plywood that the router rides on are different widths. This is no accident. One of them is 4" wide and the other is 2" wide. The dado that holds the top needs to go 4" from the top edge. The dado that holds the bottom needs to go 2" from the bottom edge. With this little jig, all you need to do to make a perfectly placed dado is put the 4" wide part flush against the top edge of the side. Clamp the jig in place, and make the dado cut using a pattern bit (with a top-mounted bearing) that's chucked into your plunge router. Turn the jig around and put the 2"-wide edge against the bottom edge and cut the dado for the bottom.

Here's the easy way to make the jig. Rip the two pieces of plywood to size and place them on top of one of the side pieces. Now put pieces of 3/4"-thick scrap under the plywood that's the same thickness as the sides. Now take another piece of scrap that's exactly as thick as your top and bottom pieces and place it between the two pieces of plywood. Press the pieces of plywood together against the piece of scrap between them and nail the plywood to the wood below. Your jig is done.

Place the jig on top of the sides, clamp it down and rout the 3/4"-wide x 3/8"-deep dadoes for the top and sides. You'll need to make these dadoes in at least two passes to be safe.

Before you can assemble the case, you need to cut the 1/2" radius on the front corner of the side pieces and the front corners of the top piece, which extends beyond the front of the case by 1/4". Make the pattern using a piece of plywood. Cut the radius on the plywood using a band saw and then sand it smooth. Use this pattern with a pattern-cutting bit in your router to shape the corners.

Now sand all the case parts up to 150 grit and get ready to assemble them.

Assembly

To assemble the case, I recommend you use polyurethane glue. First, it is superior

Schedule of Materials: Limbert Bookcase #340

Cabinet

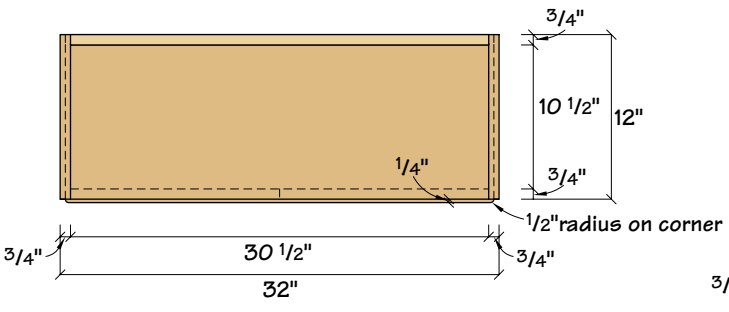
No.	Item	Dimensions T W L	Comments
2	Sides	3/4" x 12" x 46"	
1	Top	3/4" x 12 1/4" x 31 1/4"	in 3/8" dado
1	Bottom	3/4" x 12" x 31 1/4"	in 3/8" dado
1	Gallery back	3/4" x 4" x 31 1/4"	in 3/8" x 5/8" rabbet
1	Kick	3/4" x 2" x 30 1/2"	
2	Adj. shelves	3/4" x 10 1/2" x 30 3/8"	
	Back	5/8" x 31 1/4" x 38 3/4"	in 3/8" x 5/8" rabbet

Doors

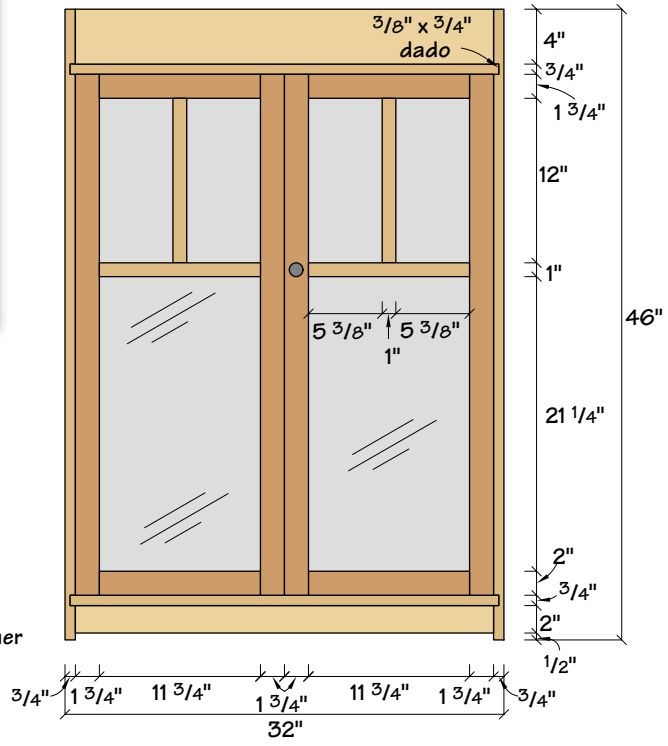
4	Stiles	3/4" x 1 3/4" x 38"	
2	Top rails	3/4" x 1 3/4" x 13 3/4"	1" TBE
2	Mid rails	3/4" x 1" x 13 3/4"	1" TBE
2	Bot rails	3/4" x 2" x 13 3/4"	1" TBE
2	Mid stiles	3/4" x 1" x 13"	1/2" TBE
	Retaining strips	1/4" x 1/4"	

TBE= tenon on both ends

Plan



Elevation



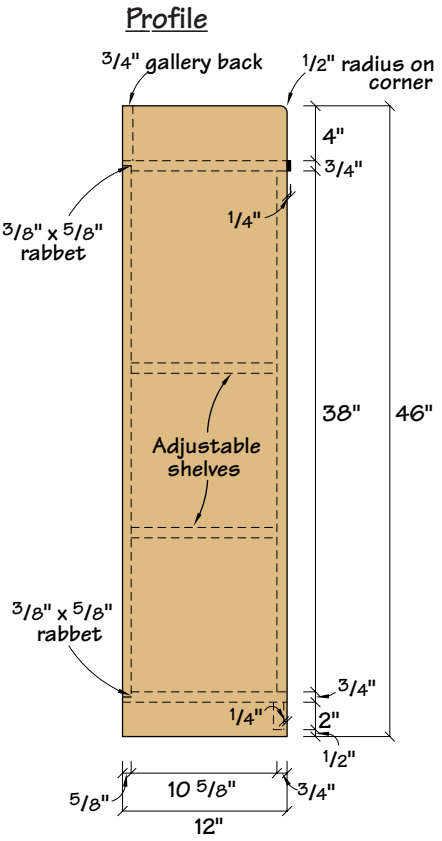
to yellow glue where joining long grain to end grain. Second, it has a long open time so you have about 20 to 40 minutes to make sure your cabinet is square.

If you've never used polyurethane glue, let me tell you that you should use as little as possible because the foamy squeeze-out is no fun to clean up. I like to coat one part that's being glued with a very thin (but consistent) film of the glue.

Then I wipe a little water on the part it's being joined to. Moisture activates the glue and speeds curing. Glue the top, bottom and gallery back between the sides. Clamp up your case and let it sit overnight.

When the glue has cured, take the case out of the clamps and drill the holes for your adjustable shelf pins. I made a plywood jig using my drill press and a 5 mm bit. I drilled holes every 3" and placed each row 2" from the front and back of the cabinet. Finally, glue the kick to the bottom of the case. I cut biscuit slots in the bottom and in the kick to keep the piece aligned as I clamped it to the bottom.

Get a pocketful of quarters when putting the back in place. You want the back to expand and contract with the seasons, and the thickness of a quarter is just about right.



The Back

If you've never built a solid wood shiplapped back, I think you're going to find the reward is well worth the effort. Build the back before you build the doors because the back, when screwed in place, holds your case square. A square case is critical when hanging your doors.

Make your back pieces out of any scrap pieces of cherry you have lying around. Narrow pieces are OK. You just want to make sure that the width of the pieces will add up to 31¼" when in place in the rabbet in the case sides.

Begin by cutting 5/16"-deep x ¼"-wide rabbets on the edges. I like to use a rabbeting bit in a router table. Cut the rabbet on both long edges of the boards (one on the front face of the board and the other on the back) for the back boards — except the boards that will go on the outside. Those need the rabbet on only one edge. Now cut the bead on one edge of the tongue pieces using a beading bit in your router table. Beading bits look confusing at first. Just remember to run the boards on edge through your router table.

Now fit your back pieces in place in the rabbet in the case. Put quarters between your back boards to space out the boards. This allows the back to expand and contract with the seasons. When everything fits, screw the back boards in place. Use only two screws to attach each back board: one centered at the top and one at the bottom. (This will prevent your back from self-destructing later.) On the boards on the ends you can also screw the back boards into the side rabbets.

Doors

I like to build my doors to the exact size of the opening and then fit them to size on the jointer. These doors are built using mortise-and-tenon joinery. I cut my tenons

Dealing with Warped Doors

Once you hang your doors, you might find that the stiles don't line up just right. No matter how flat you plane your stock, there's still a chance that your stiles won't be perfect and one will bend out in front of the other. Sometimes this is caused by clamping too tightly. Sometimes it's squirrely wood.

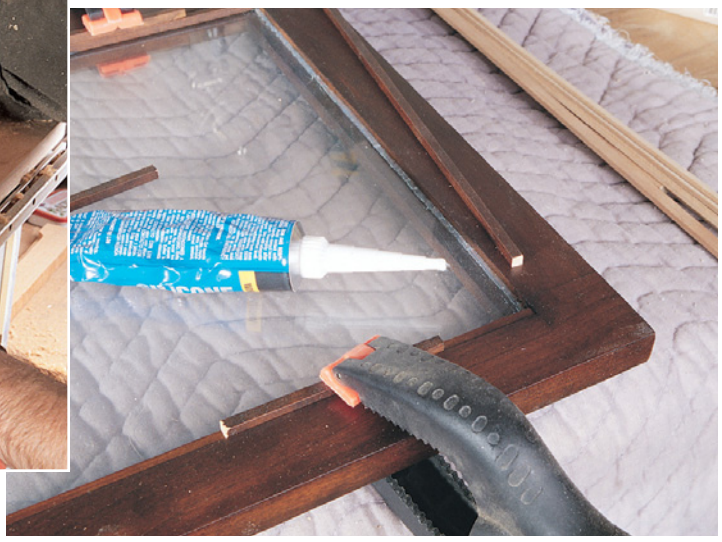
There are two ways of dealing with this. First, you can make your door parts out of two thin pieces of cherry laminated together. I made these stiles from two pieces of ½" cherry that I glued together at the face and then planed the lamination down to ¾".

This process produces a primitive form of two-ply plywood that will resist warping.

Second, after you hang your doors, you can cheat by removing the warp with a handplane. With the doors hung in the case, mark the one that sticks out. Use a pencil to draw a line on the edge of this proud door all along the place where it juts forth.

Take the door off its hinges and plane the stile down to that line using a handplane. Rehang the door and check your work.

Cut the rabbet for the glass using a rabbeting bit in your router table. After the rabbet is cut, you'll need to square the edges with a chisel. Because this work is delicate, make sure your chisel is super sharp.



Put down a thin bead of silicone in the rabbet, then put the glass on that. Then lay down another bead of silicone and press the wooden retaining strip into place to cover the goop. Now your doors look good when both open and shut.

on a table saw using a dado stack and then used them to lay out my mortises.

All the tenons for the doors are 3/8" thick. The tenons on the rails are all 1" long. The tenons on the middle stiles are 1/2" long. I cut 3/16" shoulders on all the tenons.

When cutting your mortises, make them 1/16" deeper than the tenon is long. This prevents your tenon from "bottoming out" in your mortise.

Check the fit of everything and then glue up the doors. When the glue is dry, you need to cut 3/8" x 3/8" rabbets on the back side of the door to hold the glass. The best way to do this is to use a bearing-guided rabbeting bit in your router table as shown in the photo above.

Take it slow in the corners so you don't blow out the wood around the middle stile and middle rail. Sand your doors and get ready to hang them.

Get a Perfect Gap

The goal when hanging an inset door like this is to get a 1/16" gap all around. If your case is square and your doors are square, it's going to be a simple task.

Start by putting one of the doors in place and holding the stile against the side. This is where you're going to find out if everything is square. If things are square, you can just start shaving off a little bit from the stiles and rails until you have the gap you want.

If things aren't square, you need to make some tapered cuts on your doors. You can do this on your jointer, but I prefer to use a handplane to shave off the excess. This allows you to stop your cut exactly where you want it. Keep working at it until the gap looks reasonably uniform.

Now hang the doors. I used Amerock non-mortise hinges. These hinges are adjustable so you can get your inset doors lined up just right. And installing them is a snap.

First screw the hinges to the case. Then attach the doors to the hinges using spring clamps. Drill pilot holes for your screws and screw the doors to the hinges. Remove the spring clamps. While you're at it, add the knob and the catches you've chosen to hold the doors shut.

Remove all the hardware and then cut some 1/4" x 1/4" retaining strips to hold the glass in place. Sand everything to 150 grit and prepare for finishing.

Finishing

This finish consists of a reddish dye, followed by a coat of lacquer, a coat of warm brown glaze and then three more coats of lacquer. Begin the finishing with a water-based dye. I use Moser's Light Sheraton Mahogany dye (from Woodworker's Supply, 800-645-9292, item #844414, $11.90). Then I covered the entire project with one coat of Lily's warm brown glaze. You can usually find glaze at professional painter's stores for about $26 a gallon. Wipe the glaze on with a cheesecloth. Allow it to flash after a couple minutes, and then wipe off the excess until you achieve an even tone. Allow the glaze to dry overnight. Finally, apply three top coats of a clear finish, such as lacquer.

Glass

Normally I would pin the strips to the doors to hold the glass in place. But because the mullions are so small this was out of the question. Silicone to the rescue. Put a small bead of 100 percent clear silicone (available at any home center) in the rabbet, and place the 1/8"-thick glass in place. Then run another small bead of silicone in the gap between the wood and the glass and press the wooden retaining strips in place. Use spring clamps to hold them in place while the silicone sets up.

Now that the bookcase is done, I plan to set it up in my study, right where I always envisioned it. And the first thing I'm going to put in there is all those auction catalogs I don't have any more use for. **PW**

SUPPLIES

Woodworker's Supply
800-645-9292
4 • Amerock non-mortise hinges, item # 890626, $2.95 each.

Lee Valley Tools
800-871-8158
2 • 1 15/16" double catch, item #00W12.02, $1.40 each
1 • Brass knob, item #01A21.24, $2.40 each
2 • Bronze shelving sleeves (20), item # 63Z05.03, $2.95 each
1 • Bronze shelving supports (20), item # 63Z05.04, $2.95 each

Router TABLE-MAT

Everything you'd want in a router table for just $50 and a long weekend in your shop.

Commercially made router tables are everywhere these days. Some of them come with more gizmos and gadgets than a '59 Edsel. By the time you tally up all the add-ons, the price approaches a medium-duty shaper. Here's my short list of "must-have" features for a good router table:

- A table the size of a carrier deck.
- Compact design so it can store easily.
- A stout fence that's long and easy to adjust.
- Easy bit-height adjustment with no stooping.
- Great dust collection.
- A $50 price tag.

With all these features in mind, I hit on the idea of using my folded-up Workmate stored under the stairs. Can't I just make a top for it? Then I remembered the great idea from Contributing Editor Nick Engler in our January 2000 issue. Nick made the top of his router table tilt up for easy adjustments. Bingo. Now my Workmate/router table goes right back under the stairs and takes up only another 1½" of space, the thickness of the router tabletop. You can also use this router table without a Workmate. A simple pair of sawhorses will suffice.

Customizing Your Table

While the fence is generic to any router table setup, the table needs to be customized for your needs. You may have a different brand router than mine, so you will have to relieve the underside of the table to accommodate the shape of your tool. You'll have to locate the mounting holes for the base to suit your router. You may prefer a different table height. If you are below average height, you'll want the make the angle at which the table props up less steeply.

The top is made from two pieces of ¾" birch plywood that are glued together and band-

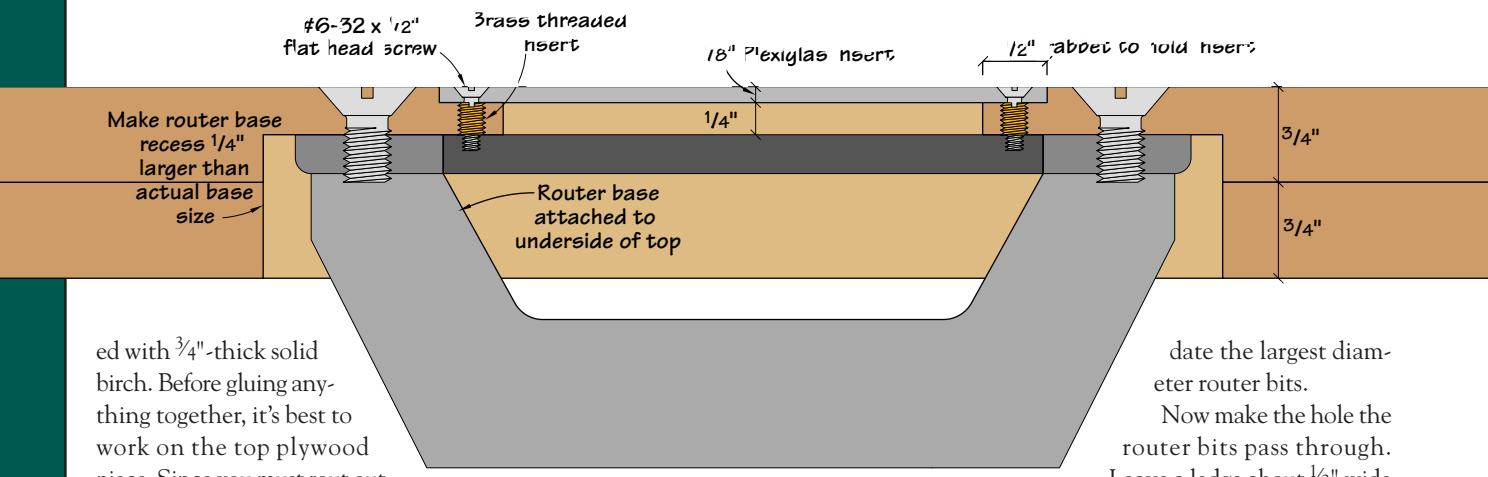
by Steve Shanesy

Comments or questions? Contact Steve at 513-531-2690 ext. 238 or SteveS@FWPubs.com.

Photo by Al Parrish


E

Cutaway view of the router base in the table



ed with ¾"-thick solid birch. Before gluing anything together, it's best to work on the top plywood piece. Since you must rout out the underside of this top piece where the router base will be mounted, do it before gluing the two sheets together. The hole in the bottom sheet can be simply cut with a jigsaw.

First, lay out where you want your router base to be mounted and find the exact center of the base. I put the centerpoint on my table 8" in from the back edge and centered right to left. So once the point is established, drill a 1/16" hole straight through to the other side. You'll need this location for work later on.

Now set up a router with a circle-cutting jig and a ½" straight bit. Set the bit so it will cut to a depth that will leave a ⅜" thickness in the plywood top. Cut a circle (assuming your router has a round base) on the underside of the top that is approximately ¼" larger in diameter than the router base. Place the circle jig's indexing pin in the center hole you just drilled. Rout the circle and the remaining waste inside the circle.

Next, turn the plywood piece over. Use your center hole and circle jig to cut a ⅛"-deep circular rabbet or ledge for your plastic inserts to fit into. The insert diameter is 4¾". But before you use this insert size, check the size of your router's base. You may need to make a smaller-diameter insert based on the size of your router base. The router I mounted in the table is a massive Porter-Cable 7518. I made the insert hole size large enough to accommodate the largest diameter router bits.

Now make the hole the router bits pass through. Leave a ledge about ½" wide all around for the removable inserts to rest on.

Now take the second sheet of plywood and jigsaw the cut to accommodate the router base. Also, make any cuts necessary to allow for your router base's handles. When done, glue the two sheets together. Keep the edges flush.

When the glue is dry, trim the top to finished size on the table saw. Now prepare some stock for the solid-edge banding. Miter the corners and glue it on. Make sure it is flush to the top. When dry, sand everything flush, then rout a roundover profile on the top edge.

Tabletop Inserts

Make the round tabletop inserts from ⅛" acrylic. I made three inserts to cover most of the router bit sizes I'd encounter. First set the circle jig to cut a circle that is the same size as the insert hole. Set your router to make an outside cut instead of

A larger base for the router was the ticket for bridging the open areas left by routing out the plywood for the router's base. It was later used as a small circle cutting jig for the tabletop and plastic inserts. Use the same cutter and it's easy to keep track of dimensions for cutting inside or outside circles.

ROUTER TABLE AND FENCE

No.	Ltr.	Item	Dimensions T W L	Material
2	A	Table top	¾" x 23" x 35"	birch ply
1	B	Top edge banding	¾" x 1½" x 11'	solid birch
1	C	Workmate board	¾" x 4" x 27⅜"	any hardwood
1	D	Prop stick	¾" x 18¾"	dowel stock
1	E	Prop bracket	½" x 1½" x 4"	Baltic birch
1	F	Fence bottom	½" x 8" x 41"	Baltic birch
2	G	Fence sub fronts	½" x 3" x 12½"	Baltic birch
2	H	Dust chute sides	½" x 4⅛" x 8"	Baltic birch
1	I	Dust chute top	½" x 4" x 5"	Baltic birch
1	J	Chute angled top	½" x 5" x 4¾"	Baltic birch
1	K	Chute back	½" x 5" x 5"	Baltic birch
2	L	End ribs	½" x 2⅝" x 3"	Baltic birch
2	M	Mid ribs	½" x 2⅝" x 2⅝"	Baltic birch
2	N	Fence adjust. front	¾" x 4" x 16"	any hardwood

Hardware: 3, 6/32 threaded inserts and ½" 6/32 screws; 4 each ⅜" x 1½" round head machine screws, star washers, flat washers and wing nuts, 1 pr. medium-duty loose-pin hinges. Acrylic ⅛" sheet 12" square, 1 switched plug strip.

Inside view of the dust chute from the rear including the plastic 4" to 3" dust collection hose adapter. Rout the 3" hole for the adapter with the circle-cutting jig or use a "fly cutter" in your drill press.

As you assemble the fence, make sure it is square along its length. Be sure and check it again after it is clamped up.

an inside cut. To rout the acrylic, just drill a hole to accommodate the circle-cutting jig's pin or nail.

The three hole sizes I made in the inserts were 1", 1¾" and 2¾". The smaller holes were drilled using hole saws but the larger size required the circle-cutting jig.

Complete the Top

To fasten the inserts to the table, install three threaded inserts in the rabbet. I used inserts for a 6/32 flush machine screw. Once installed, transfer their locations to the acrylic inserts, then drill and countersink the plastic.

Next make a new piece to replace the rear board on the Workmate's table. The homemade board is narrower and allows the router to swing up unencumbered. Cut the board to the dimensions given in the materials list and locate holes that match those in your existing Workmate. The new board is slightly shorter than the original. Install the Workmate connecting hardware and place the board in the furthermost connecting hole of the Workmate.

On the underside of the router tabletop you'll need to install a piece of ½" material where the stick that supports the top in the open position locks in place. I used a ¾" dowel for a prop stick and drilled an oversized hole on a 25° angle in the block to nest it.

As mentioned earlier, the length of the prop stick will depend on how tall you are. On the end of the stick opposite the 25° angle, drill two holes that intersect each other to allow the stick to pivot in two directions, side to side so that it can be lowered when not in use and angled to allow you to tip it forward when propping the tabletop. Use a stout wood screw, a #10 or #12, to connect the prop stick to the edge of the new shop-made top board.

Next use a pair of hinges to connect the top to the Workmate's front board. Locate them about 4" in from each end.

Now Make the Fence

Keep in mind the most important factor in making the fence is that it is straight and square to the table. It could be shimmed later, but you'll be fussing with it forever.

Start by laying out the full size shape of the bottom piece on the material you will actually use. Be sure you have a true, straight edge for what will be the front.

Go ahead and lay out where the dadoes will be cut, including where the half-round throat opening for the router will be. It's best to do the layout by first establishing the center of the length of the fence and working out from there. When done, cut the back shape. It need not be pretty.

Next cut out the two subfronts for the fence. Install your dado blade on the table saw to cut the thickness of the Baltic birch.

Now set the dado blades to make a ⅛"-deep cut. While holding the front edge of the fence bottom against the slot miter gauge, cut the six dadoes, following the layout lines already marked. When done, cut the center dado on the subfronts making sure it locates precisely where the dado in the bottom falls. Next raise the dado set to cut ⅜" deep and run the rabbets on the ends and bottom of the fence subfronts.

Remove the dado and cut the fence ribs and pieces that make up the dust collection chute. Use the diagram for the shape. Before assembling the fence, cut the half circle in the fence bottom for the throat opening, then use a rasp to slope the back edge for more efficient dust evacuation.

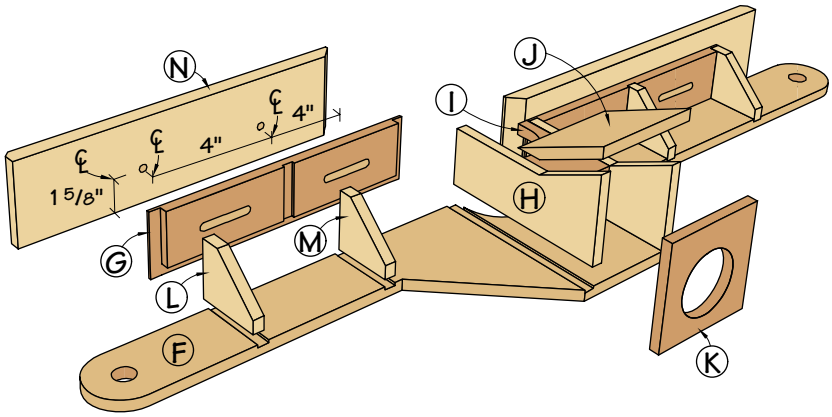
Once the tabletop is hinged to the Workmate's front board, it's easy to locate the the positions for the prop stick and stick bracket. Note the shop-made replacement board for the Workmate top.

Assemble the Fence

Be careful when you assemble the fence to make sure it goes together square. First dry-fit all the parts to be sure you have a good fit. Then glue the ribs and dust chute sides to the

Break in your router table by milling the slots in the fence subfront that will allow the fence faces to adjust into or away from the router bit. Lay out the stop/start lines and plunge cut the slots.

Attach the fence faces using 3/8" roundhead machine screws, a star washer, flat washer and wing nut. I tried using hex-head bolts but switched to screws because a screwdriver can be used and makes a more secure attachment with less trouble.



bottom, making sure all the edges are flush to the front edge. If you have a brad nailer, set these in place with a couple short brads. Glue the fence subfronts to the bottom and ribs. Clamp front to back until the glue dries.

Now cut the three remaining dust chute parts: the top, angled top and back. Cut a half circle in the top similar to the one in the fence bottom. After the glue in the fence assembly has dried, glue the dust chute top in place. Afterwards, install the angled top and the back piece. The angled top requires a steep angle cut on the lower edge to seat down to the flat top. I cut this angle on my band saw. The back of the chute requires a hole for dust collection. The chute is set up to take a 3" hose or a fitting that reduces a 4" hose to a 3" hose. I used a "fly cutter" in my drill press to make the 3" hole. To complete the assembly of the dust chute, screw the angled top, then the back in place.

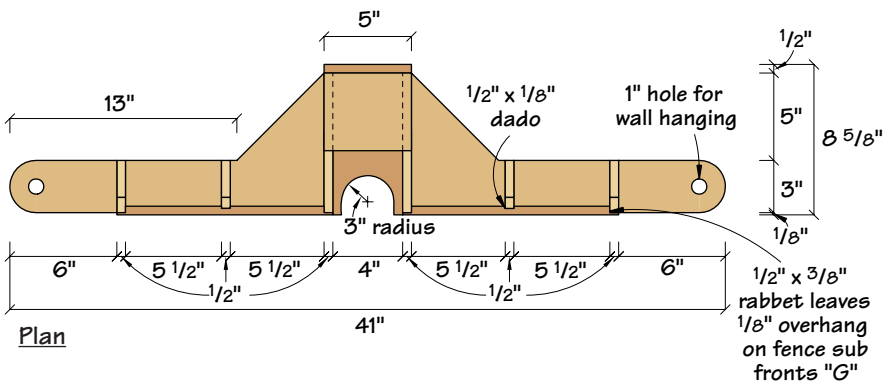
Use Your New Router Table

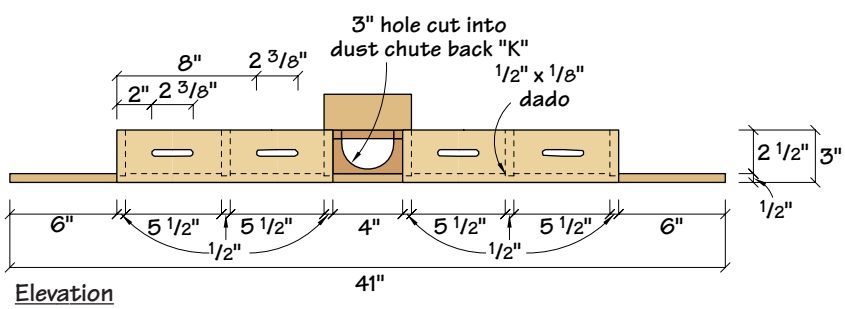
Now use your router table to mill the slots in the fence's subfronts that allow the fence fronts to slide left to right.

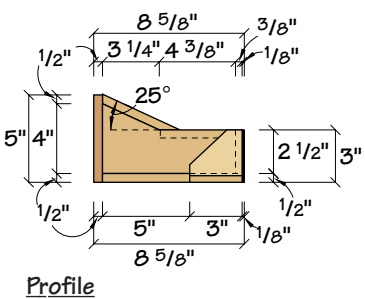
Set your router in the table with a 3/8" straight bit. Make a temporary fence from a straight piece of scrap and clamp it to the tabletop. Use the fence diagram for setting the distance. Cut the 2"-long slots in the center of the openings between the ribs.

Make the adjustable fronts from a tight-grained hardwood such as maple. Be sure the material is flat and straight. Cut the two pieces to the lengths given. Make bevel cuts on the ends as shown in the diagram. Carefully locate the hole locations where the 3/8" machine screws attach the fronts through the slots in the subfronts. Drill and countersink the holes. For attachment, I used the screws along with star washers, flat washers and wing nuts.

The last detail is to cut a small piece of acrylic as a "window" on the top of the dust chute into the router opening area below. **PW**







Learn to set up and use a matched set of router bits to create doors that are strong, easy to make and beautifully detailed.

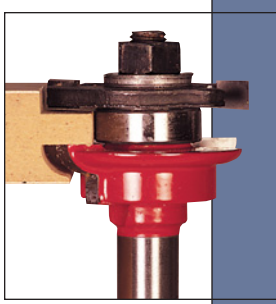
Cope and Stick Joinery

Photo by Al Parrish

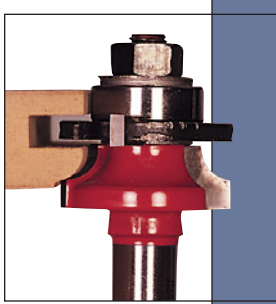
Cope-and-stick joinery today is all about tungsten carbide. But the origins of this important door-joinery method are rooted in the world of moulding planes, chisels and backsaws. A little history is in order as to the origin of the terms "cope" and "stick." According to Graham Blackburn, a noted author on woodworking and its history, frame-and-panel construction came into its own back in the 14th and 15th centuries. Different methods evolved for joining a rail and a stile together and capturing a panel. The object is, of course, to circumvent wood movement and make stable panels and doors for furniture.

When the frame required a profile on the inside, it was made with moulding planes. This is referred to as a "stuck" moulding. As in, it's not an applied moulding, it's "stuck" on or made on the existing edge. Hence the term "stick." The rail and stile were joined using a mortise-and-tenon joint with a miter on the moulded edge, where the rail and stile met. This is commonly referred to as a "mason's miter." "Coping" comes from its actual definition: "to deal with a problem." In the case of rail-and-stile joinery, the problem was dealing with the stuck edge. The solution was to make an opposite of the stuck profile that fit over the edge, filling the profile.

With the advent of mechanization in the 19th century, different, faster methods had to be devised to join those pesky rails and stiles. Enter high-speed cutting tools. They could be set up to make thousands of feet of stuck moulding and then the opposite of the cutter could be made to cut the cope on the rail ends.



Cutting the stick



Cutting the cope

Which Bit is Right for Me?

You can still make cope-and-stick doors using moulding planes, but most people use a router in a router table. Router bit catalogs are filled with cope-and-stick bits that are priced anywhere from about $50 to $150. Essentially there are three types of bits to choose from. The least expensive is what is called a reversible cope-

by Jim Stuard

Set Your Fence
Setting up and using a cope-and-stick set of bits is relatively easy after the shimming is done. First, make sure the bearing on the bit is flush with the fence on the router table. Flushing the bearings makes sure that the profiles will match up. Use a straightedge that spans the two fences and tap the fence flush to the bearing. If possible, close the fence faces so there's about 1/8" clearance on both sides of the cutter.

Cut the Stick Profile
Using fingerboards to keep your stock in place, press the stock into the fence and down onto the router table. Which profile you cut first isn't critical. Use test cuts to get your bits in the ballpark. I cut the stick first. For door construction, you can cut your stock to finish length, but I prefer to leave the stiles a little long for trimming later.

and-stick cutter. This single bit has two cutters, a bearing and shims to adjust it. You cut the stick part of the moulding, then you disassemble the bit and stack the pieces in a different order to cut the cope. These are decent entry-level bits, but keep in mind that disassembling the bit can be a hassle, and you have to remember exactly how many shims go between each part or your joints won't fit. Also, wear on the cutter is doubled, necessitating resharpening more often.

The other "single-shank" solution is the non-adjustable combination bit. This one-piece bit is basically a chunk of metal on a ½" shank. It has a bearing on top and bottom. You cut the stick part of the moulding with the top section of the bit, then you raise the bit to cut the cope. The only drawback to these bits is they are a little long and will exaggerate any runout problems you might have with your router.

Last but not least expensive is the matched set. In a matched set, each bit has a fixed cutter close to the shank, a bearing and another matched cutter. These bit sets have advantages over the other sets. When they're sharpened, it's just a matter of proper shimming to get them back to an airtight fit. There's two separate sets of cutters, giving them longer life between sharpenings. They're relatively shorter than combination bits so they'll be more stable in a router. And once you get them set up, you won't have to take them apart until they're resharpened. The only real drawback is that they are usually the most expensive solution.

Which bit is right for you? If you make an occasional door, use a single-shank solution. It's cheaper and you won't be sharpening the bit any time soon. If there are a lot of doors in your future or you just want a setup that will last a long time, a real time-saver is having two bits in two tables and running all your stock at once. The price differences between one-bit and two-bit sets is around $20 to $50 dollars, depending on the manufacturer and quality. **PW**

Freud 99-260
$111.50

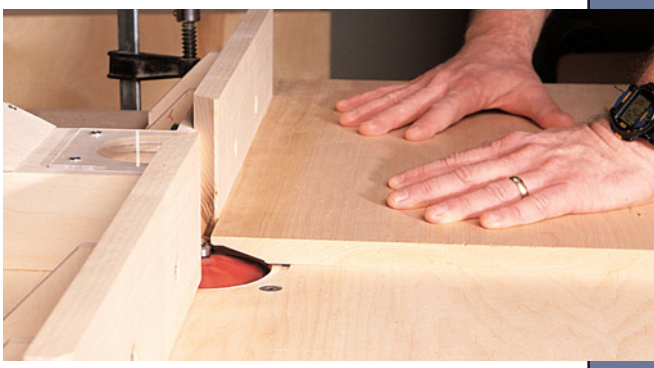
CMT 891.521
$127.50

MLCS 8852
$65

The three types of cope-and-stick bits. On the left is a matched set of cutters. One bit for the stick; another for the cope. In the center is a non-adjustable combination bit. You change from cope to stick by changing the height of the router. On the right is a reversible bit. After cutting the stick profile, you disassemble the bit and rearrange the pieces to cut the cope.

Cut the Cope

Next, cut the cope profile on the ends of the rails. Make sure to use a backing piece (sometimes called a "cope block") of scrap. Because of the usual narrow width of a rail and the force of a router, the rail can easily be pulled into the bit. Hold the rail tightly to the cope block to avoid this. It's not necessary to push the entire setup through the cutter, just the rail ends. Once the front of the push block is touching the outfeed fence, gently pivot it away from the fence from the outfeed side.

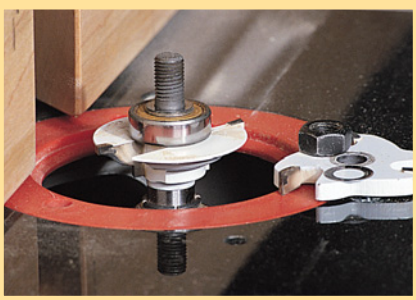


Cut the Panel

Once you've got rails and stiles that are sized properly, fit the parts using light clamp pressure and take the measurements for the panel. Leave a 1/8" gap all around to allow for seasonal expansion. Run the panel on the router by pressing it flat to the table. Cut the end grain sides first, then the long-grain sides. Make the cut in several passes, adjusting the height of the panel cutter after each pass. If you're using a big panel cutter such as the one shown here, you'll probably want to slow the bit's speed (if you have an adjustable-speed router).

The Easiest Way to Set Up a Two-Bit Set

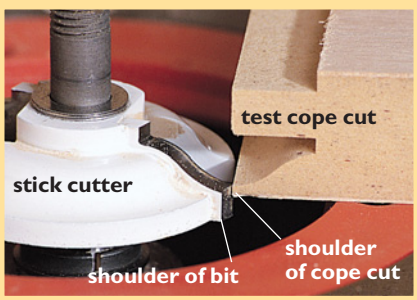
If you're one of those people who plunked down your hard-earned dollars on a two-piece bit set, you may test it out and find that the joint isn't tight or aligned. Some sets require some fine tuning upon arrival. Here's how it's done:



Get Familiar With the Parts

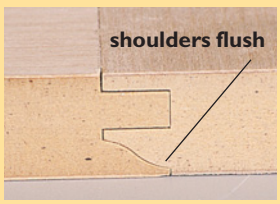
Many two-bit sets work great right out of the box; others make joints that are too loose or too tight. You can fix the problem, but you're going to have to disassemble the bits to adjust the cutters. Plan on this taking an hour or two of your time. It's a pain, but remember you won't have to do this again until you get your bits resharpened.

The easiest way to take these bits apart is to chuck them into a router. Use a wrench on top of the bit to loosen the cutters as you hold the bit in place with one of the router wrenches on the collet. Two-bit sets have a fixed bottom cutter, a bearing and a grooving cutter that are separated by thin shims. To get your two-bit set (or your reversible set) working you're going to have to figure out which shims go where for a perfect fit.



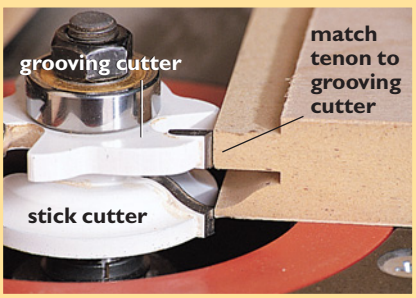
Step One: Align the Shoulders

Start by chucking the cope cutter in a router and making a test cut on a piece of scrap. I use MDF for setup because it is made up of small particles that have no grain direction. This gives accurate, highly visible test cuts. Cut the cope leaving about 1/16" on what will be the top shoulder of the cut. Next, chuck the stick cutter into the router and remove the grooving cutter, bearing and shims. Start the alignment process by placing the shoulder cut of the sample cope cut up against the fixed cutter in the stick bit and matching shoulder heights by raising or lowering the router (see the photo above).



Result: Flush Shoulders

At this point the joint made by these cutters would be pretty sloppy, as shown in the photo at left. You can see, however, that the cut is flush on the shoulder (bottom) of the joint, which is the point of this important first step.

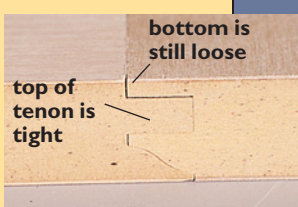


Step Two: Tighten the Top of the Tenon

The next step is to tighten up the joint between the tenon and the cope. Using your test cope piece as a guide, mount the grooving cutter and shim it as best as you can to match the tenon on the test cope piece.

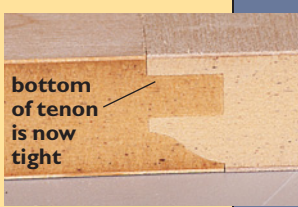
Result: Top of Tenon is Perfect

After properly shimming the grooving cutter, you'll get a tight fit on the cope and the top of the tenon. Keep a test cut from the stick cutter. This is the finished, shimmed setup for the stick cutter.



Step Three: Shim the Cope Cutter

Remove the stick cutter from the router and chuck up the cope cutter. It also has a grooving cutter on top that needs to be shimmed to get the bottom of the tenon to fit snugly. Disassemble the bit and shim the grooving cutter so it is flush with the bottom of the tenon on the stick test piece. Now your joints should be tight.



TRADITIONAL Entertainment Center

Don't be intimidated by the size of this case piece; the joinery is simple yet rock solid.

I chuckle to myself every time I build one of these cabinets for a customer. A Shaker entertainment center. Now that's an oxymoron. But everybody loves Shaker and everyone needs an entertainment center these days. So who am I to argue?

As cabinet construction goes, this is about as basic as it gets, and it still offers old-world joinery, styling and strength. The entire piece is solid lumber, using a face-frame front and a shiplapped back. The raised-panel doors are held together with mortise-and-tenon joinery, and the crown moulding is all simple cuts on the table saw and jointer.

I start construction on face-frame cabinets by making the face frame first. All the other pieces will be sized to fit the frame, so it just makes sense to begin there. Also, the width of the face frame's stiles are 1/16" wider than shown in the drawing. This will allow you to trim them flush to the case after assembly.

There are a number of ways to fasten a face frame together, but when I'm making a piece of furniture that has the potential to be moved every so often I prefer the strongest joint I can think of — mortise and tenon. That's because if it's moving it's racking. While a strong back will help keep the cabinet from racking, the face frame does most of the work. In addition, if the piece is a reproduction, like the one here, it's appropriate to use a mortise-and-tenon frame.

I prefer to cut the tenons on the ends of the rails first, then use the tenons to lay out the mortises on the stiles. Set up your table saw to cut the 3/8" x 1"-long tenons, centered on both ends of the top and bottom rails. Then set up your mortiser to cut the mating mortises, setting your depth to 1 1/16" to avoid having the tenon bottom out in the mortise.

Once the mortises and tenons are cut, assemble the frame by putting glue in the mortises. Don't overdo it; glue can keep the tenon from seating properly in the mor-

by Troy Sexton

Troy Sexton designs and builds custom furniture in Sunbury, Ohio, for his company, Sexton Classic American Furniture. Troy is a contributing editor for Popular Woodworking.

Photo by Al Parrish

When you trim the doors to size, make sure you support the door adequately and start with the top and bottom edges. That way any tear-out on the end grain will be removed when you run the long-grain edges over the jointer.

SHAKER ENTERTAINMENT CENTER

No.	Item	Dimensions T W L	Material
2	Face frame stiles	¾" x 2 9/16" x 71½"	Maple
1	Face frame top rail*	¾" x 4½" x 37"	Maple
1	Face frame bottom rail*	¾" x 5" x 37"	Maple
3	Door stiles	¾" x 2½" x 62"	Maple
1	Door stile	¾" x 3" x 62"	Maple
6	Door rails*	¾" x 3½" x 14½"	Maple
2	Door bottom rails	¾" x 3½" x 14½"	Maple
2	Door panels	⅝" x 13" x 13"	Maple
4	Door panels	⅝" x 13" x 19¾"	Maple
2	Cabinet sides	¾" x 23¼" x 71½"	Maple
3	Fixed shelves	¾" x 22¾" x 39"	Maple
3	Adjustable shelves	¾" x 22¼" x 38¼"	Maple
1	Back	½" x 39½" x 71½"	Maple
1	Door stop	¾" x ⅞" x 37"	Maple
1	Crown moulding	¾" x 3¾" x 96"	Maple
1	Crown cap	½" x 3⅛" x 96"	Maple
6	Hinges, Lee Valley #00H52.03, $2.30 each, 800-871-8158 or www.leevalley.com		

*Measurement includes 1"-long tenon on both ends

After the face frame is glued to the cabinet, it's a simple step to walk around the case with a flush-cutting bit in your router to trim the frame flush to the cabinet. A little sanding and you're ready to move on.

tise. After the glue is dry, I pin the joints using ⅜"-square stock.

Three-Panel Doors

Since I'm already set up for making mortise-and-tenon joints, I go ahead and make the doors next. The doors are basic frame-and-panel construction using raised panels with an 8° bevel on the front face. Determine the size of the doors by making them exactly the size of the opening in the face frame. We'll trim them to fit later.

Before cutting the joints for the doors I make the groove in the rails and stiles for the raised panels. These grooves are ⅜" x ⅜" and are centered on the inside edge of each piece, with both edges of the center rails receiving a groove. After the grooves are run, start making the tenons on each end of the rails. Make the tenons and mortises the same size as you used for the face frame. Because the panel groove was run through the ends of each stile, the tenons on the top and bottom rails need to be haunched (the tenon shoulder is left wider to fill the notch left by the groove).

Next mark the locations for the mortises at the locations shown in the diagrams, and cut the mortises in the stiles.

The panels themselves are cut to size allowing ½" extra in both height and width to fit into the grooves in the door frame. With the panels sized, set your table saw blade to an 8° angle. Then set the rip fence to bevel the faces of the panels. The distance between the fence and blade should be set so that the bevel is about ⅜" thick, ¼" in from each edge.

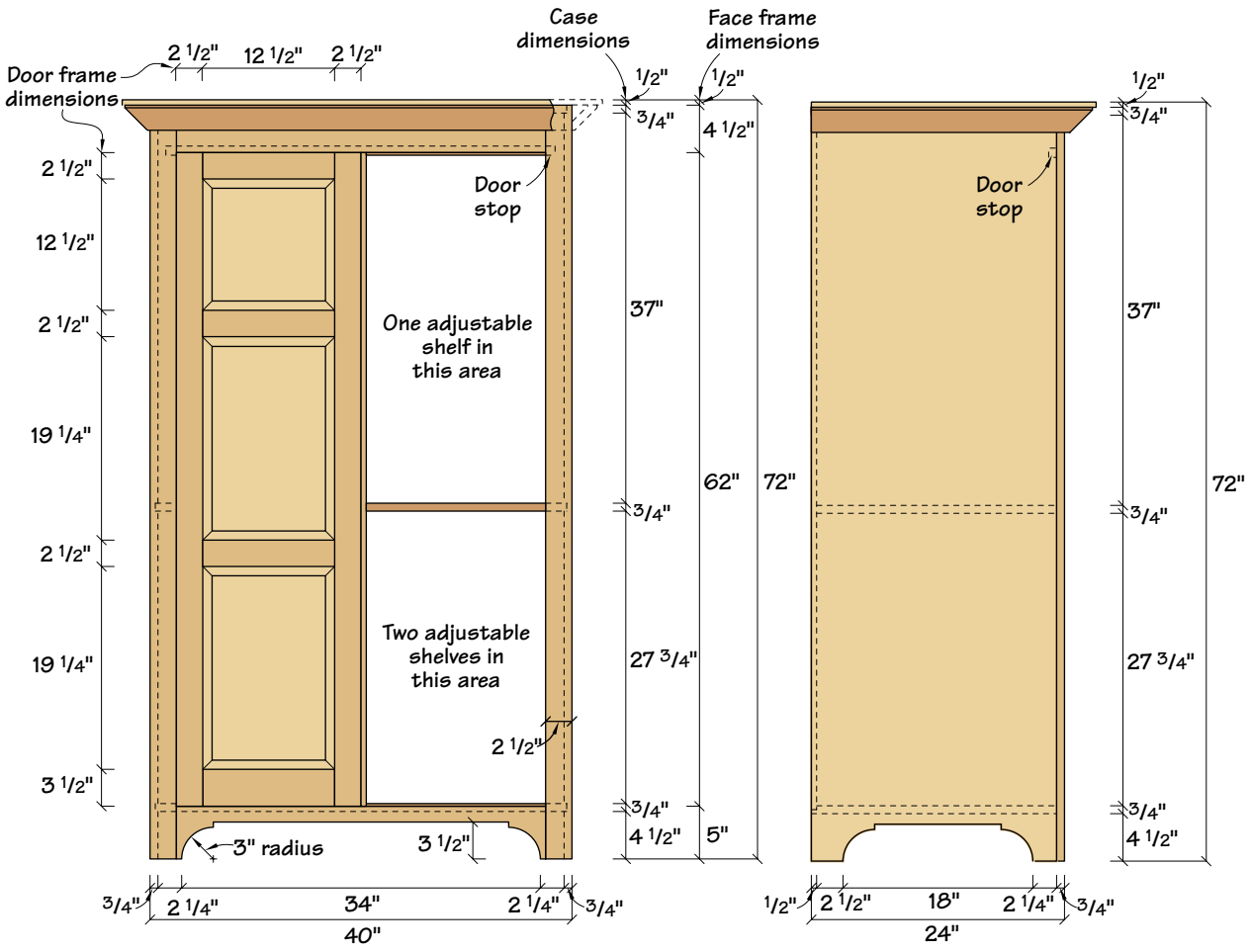
When the door pieces are ready, assemble the doors, again being careful not to use too much glue on the joints. Clamp up the doors and determine if the doors are square by measuring corner to corner. The distance should be the same in both directions. If not, adjust the door by tightening a clamp diagonally across the longer length. When everything is square, tighten the clamps and set the doors aside for the glue to cure.

When the doors are ready, take them to your saw and cut a ⅜" x ½" rabbet on the two interior edges to form a shiplap joint to keep the dust out. Then head to the jointer and trim them to size, allowing a 1/16" gap all the way around the doors. When fitting the doors, run the top and bottom of the doors over the jointer first, as the end grain on the ends of the stiles may tear out. By running the long grain edges last, you should be able to clean up any tear-out on the stiles.

With the doors fit, go ahead and mount the doors in the face frame. I used 2½" non-mortise butt hinges (see schedule). They look good, are easy to attach and are adjustable. When the doors are attached, take them off again to make it easier to glue up the cabinet.

Cabinet: Dadoes and Nails

You're now ready to make the cabinet

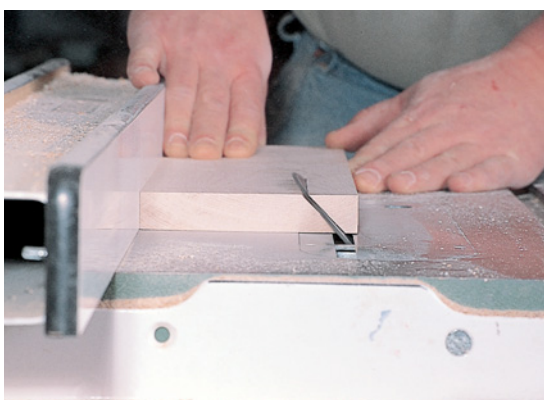


itself. All the cabinet pieces are made of solid lumber on this piece to keep it reproduction quality. The center shelf, top and bottom are fit into ¼"-deep by ¾"-wide dadoes in the sides. Use the diagrams to locate the dadoes. The sides of the cabinet have ⅜" x ½" rabbets run on the inside edges for the back. Cut the dadoes, then glue and nail the top, bottom and center shelf between the sides.

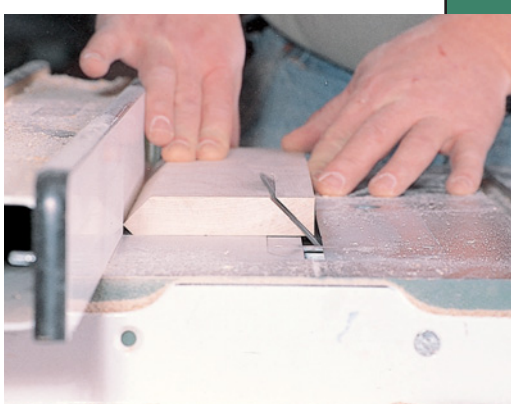
After assembling the case, lay it on its back and glue and clamp the face frame to the cabinet. Check for square, and make sure the overhang on the sides is even. When the glue is dry, I simply remove the clamps and use a flush-cutting router bit to trim the face frame flush to the sides.

I used a ½" hardwood beaded shiplap back for this piece. The number of back slats is up to you. They can be random widths, or they can all be the same. I cut a ¼" x ½" rabbet on the slat sides, then add a ¼" bead on one edge using a beading bit in my router table. Don't attach the back yet, as it'll only make finishing more difficult. Set the pieces aside for now.

Shaker furniture is known for its lack of ornamentation, but the Shakers still



To bevel the crown pieces, first bevel cut one edge (shown) with the table saw blade set at 45°. Then move to your joiner (also set at 45°) and put a ¼" flat at a right angle to your first bevel.



Head back to the saw to cut the second bevel. As you'll see in the photo, by cutting the return bevel on the first edge you've provided a bearing surface for the rip fence, rather than let the bevel slip under the fence, messing up the cut.

With one last pass on the joiner you're ready to start hanging the crown.

To make sure the crown moulding is flush to the top of the cabinet, I temporarily screw two scrap strips to the top of the cabinet while I align the front piece. When the front piece is attached, it's fairly easy to carry the height orientation around to the sides. Then simply remove the strips.

had a sense of style. Style for this cabinet requires a crown moulding. Cut the moulding pieces to the sizes given in the materials list. Set your table saw blade to a 45° angle and bevel one long edge of the moulding piece. Then move to your jointer, adjust the fence to 45° and run the sharp bevel edge of the moulding over the jointer to leave ¼" flat on the moulding's edge. Repeat the entire process on the opposite edge.

Fit and cut the crown pieces to length, then glue and nail them to the case. On the side pieces I only glue the first 8" of the moulding and attach the back end with a screw through a slotted hole in the case. This allows the sides of the case to move during humidity changes without tearing the crown moulding off. I use small triangular glue blocks behind the crown moulding to support the crown. Next cut the ½" cap pieces to length, mitering them to overhang the crown by ¼", then attach them to the case as well.

A Simple Base

You're almost done. To give the case a base (and to make it sit on an uneven floor without rocking) I used a jigsaw to cut out a pattern on the bottom of the face frame and the sides of the piece, essentially leaving legs. Drill the holes for the shelf pins. Then cut slots for ventilation in the back pieces, and holes through the shelves to pass wires.

The next to last step was finishing. I used a coat of dark oak stain over the entire piece and then applied three coats of semi-gloss spray lacquer.

All that's left is the hardware. You can use whatever you find attractive. I used a couple of turned pulls and added a stop rail behind the doors (at the top of the cabinet). A couple of bullet catches and I was ready to deliver it to the customer. Of course it'll take them another two days to get all the equipment hooked up and arranged the way they want it. **PW**

The last step on the crown is to attach the cap to the crown and cabinet. Notice the glue blocks behind the crown moulding to support the crown and add stability.


Cincinnati Bell
White Pages

Photo by Al Parrish

EUROPEAN telephone console

Being worldly woodworkers, the *Popular Woodworking* staff spends time checking out woodworking ideas from Britain, Australia and even Germany. It was in a German woodworking magazine called *Selbst* that we saw a similar entry hall stand. Its clean lines and utilitarian efficiency caught our eye, so we decided to give it a little American schooling and share it with our readers.

Keep your phone, phone books, keys and small umbrellas in order — all without taking up a single square inch of floor space in your front hall.

by David Thiel

Comments or questions? Contact David at 513-531-2690 ext. 255 or DavidT@FWPubs.com

Two Triangles

I was able to get all the necessary parts (except the back) out of a 4' x 4' piece of cherry plywood. Start construction by ripping two 12½"-wide pieces from the sheet of plywood, then crosscut the pieces to 38" long. Next, strike a pencil line from one corner, 12" from what will be the back edge, and connect it to a point on the opposite corner, 1½" from the same back edge. Mark both pieces, making sure you have left- and right-facing pieces.

Head to the band saw with the two pieces and cut along the pencil line, leaving about an ⅛" wide of the line. Then take the two pieces to the jointer and trim the angled edge straight and fairly close (1/16") to the line. To make the two pieces identical, clamp them together, flushing up the back and top edges. Using a sharp bench plane I made a few passes on the angled edge to even up the pieces.

Parts for the Middle

Grab what's left of your plywood sheet and rip an 11"-wide strip from it. From this 11" x 48"-long piece you'll be able to get the door, the kick, the two cleats and the shelf. Crosscut all the pieces except the shelf to size. The piece that is left is enough to make the shelf, but I turned the shelf so the grain would run longways to better match the veneer tape. Go ahead and cut the shelf to size now.

Now it's time to disguise the plywood as solid wood. The front and top edges of both sides receive iron-on veneer tape, as well as the front edge of the shelf, the top edge of the kick and the top edge of the lower cleat. Don't tape the door edges until the case is assembled. If it's your first time using veneer tape, see the instructions on the next page.

Put it All Together

There are a couple of joinery methods you could use to join the pieces together, but I chose biscuits. Start by marking the location of the shelf

Once the two side wedges are cut to rough size, trim them a little closer to accurate on the jointer. Once you're within about 1/16" of the finished line, clamp the boards together and get out a bench plane. With a little hand work the pieces will match up perfectly.

on the two sides and cut those biscuit slots. Then mark the location of the upper cleat to biscuit it to the underside of the shelf and into the two sides. The lower cleat is biscuited flush to the back edge and bottom of the sides, while the front kick is flush to the bottom edge, but held in 1/8" from the front edge to add shadow lines and to keep you from having to align the door perfectly with the edge of the cabinet. With all the biscuit slots cut, sand the inside faces, add some glue and clamp the piece together. Though there's little chance of the piece racking, check it for square.

After the glue is dry, remove the clamps and roll the piece onto its face. Chuck a rabbeting bit into a router and cut a 3/8" x 3/8" rabbet in the back edge of the sides and in the top and bottom cleat. Cut a 1/4" back to fit the space and round the corners to let it drop into place. Don't put the back in yet as it's easier to finish and mount the door hardware with the back off. Go ahead and fit the door, then veneer all four edges.

Finishing Touches: A Clear Top and the Right Hardware

The door is held in place using a continuous hinge mounted to the kick. You should be able to catch six holes in the hinge. Start by mounting the hinge to the kick, then use the two center holes to attach the door. Check to see if the hinge location allows proper clearance. If not, back out your first two screws and use two other holes to scooch the door one way or the other. When you've got it right, plug the misaligned hinge holes with a toothpick and some glue, then redrill the pilot hole and put the screws back in. The door is held in place using a brass lid support and a magnetic catch.

The clear acrylic top is the last construction step, and it's fairly easy to install. Simply drill four shelf pin holes in the sides to allow a 3/8"-thick piece of acrylic to rest 1/16" below the top edge. The acrylic piece is available as a 12" x 12" piece from a number of catalogs as a router-table insert. Cut the piece close to finished size on the table saw, then sand the piece to a press fit a little at a time. To make the two visible edges presentable, file the edges flat, then sand through 360 grit to a near-perfect edge.

Two coats of clear finish will protect the wood, and the piece is ready to hang. The upper cleat works great as a mounting point using a couple of molleys in the wall. Add a few simple cup hooks to the backside of the door, and you've got a convenient place to hang fold-up umbrellas, keys or any other "near-the-door" items. **PW**

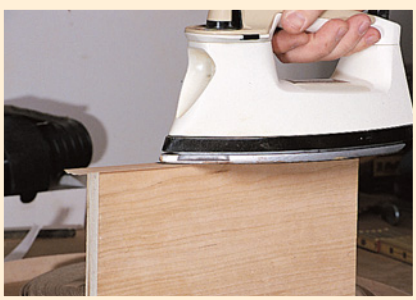
With all the cross members cut, the biscuit joiner makes it possible to pull the project together. This photo also shows the two cleats in place at the top and bottom of the case.

Iron-on Wood

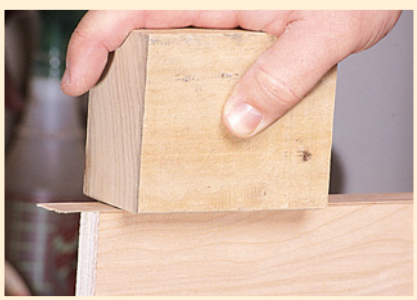
There are lots of reasons to use plywood in a project. Cost, weight, wood movement and even environmental considerations. But just because you aren't using solid wood, you don't need to give up the look of solid wood. Iron-on veneer tape has been around for a long while, but it has sort of a "cheap" reputation. I'm here to tell you it's worth a look.

Available in a wide variety of wood species, veneer tape is actual wood veneer with a heat-sensitive adhesive applied to the back. With the heat of a simple household iron and a few simple tools you can turn a piece of plywood into a finished and attractive piece of wood.

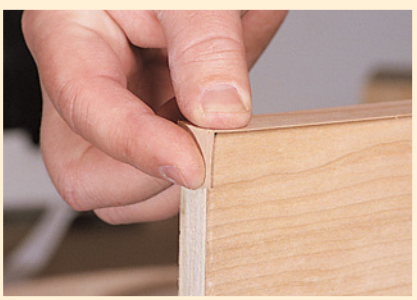
I've been asked about the durability of veneer tape. I can't



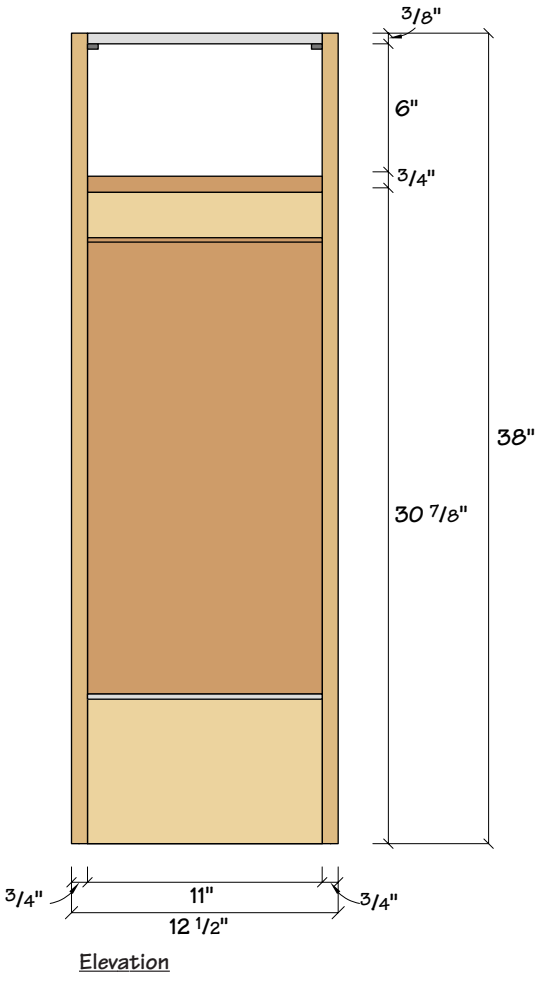
Start with a piece of tape that's about 2" longer than the edge you are covering. Your iron should be on a cotton setting, with the steam turned off. Make sure the tape overhangs the edge evenly, then start ironing. Make long passes over the edge, not stopping in any one place for any length of time, applying heat evenly. The tape will start to curl up a little as the glue melts.



Since trying to use the iron to hold the tape in place as the glue dries just re-heats the glue, switch to a simple block of wood. The chunk of poplar shown here works great. The bottom surface is sanded smooth and the edges are broken to avoid snagging or scratching. Simply apply pressure and make long passes over the edge for about 30 seconds. If you have a few pieces to veneer, set the first piece aside for now to let the glue cool.



To trim the edge, start by carefully bending over the ends until the veneer breaks. Make sure you apply pressure to the end of the attached veneer so it doesn't splinter back onto the visible edge. Then pull the "dangling chad" of veneer downward to tear it free. By the way, if you're doing four edges of a board, do two opposite edges first, trim the edges, then apply the other two edges.

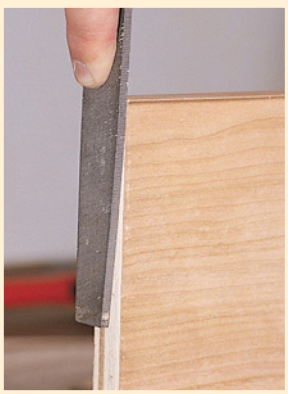


EUROPEAN TELEPHONE CONSOLE

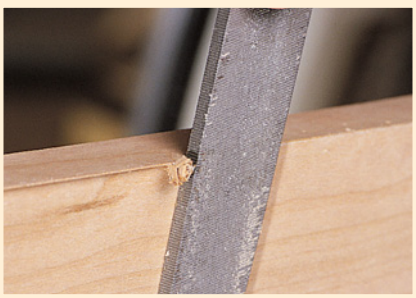
No.	Item	Dimensions T W L	Material
2	Sides	¾" x 12" x 38"	Cherry ply
1	Shelf	¾" x 10" x 11"	Cherry ply
2	Cleats	¾" x 3" x 11"	Cherry ply
1	Kick	¾" x 11" x 7"	Cherry ply
1	Door	¾" x 11" x 22"	Cherry ply
1	Back	¼" x 11¾" x 25⅝"	Cherry ply
1	Top	⅜" x 11" x 12"	Acrylic

honestly think of any application for solid wood where tape wouldn't hold up as well.

Follow the steps below for some tips to getting the best results from your veneer tape.



To trim the long edges of the veneer tape, the tool of choice is a mill bastard file. Start by flushing the ends you just broke over, keeping the file flat to the side, and using only a pushing stroke. It should only take a couple strokes to flush up the end.

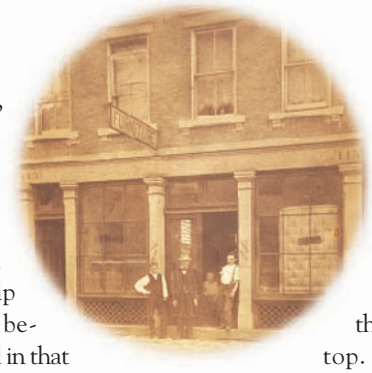


To trim the tape edges, use the file again, working right to left against the edge. The best method is to start the file at the end of the tape and push lightly against the overhanging edge to start a curl of veneer breaking away from the edge. Continue rolling the curl along the piece, keeping the file angled forward and at a slight bevel to the veneer tape. Once the curl is knocked off, lightly file the bevel again to remove any excess.

The file is too aggressive for a finished edge, so trade it in for some 220-grit sandpaper and finish cleaning up the edge. You'll find some of the adhesive is stuck to the face of the board. This can be lightly sanded off, but proceed carefully to avoid sanding through the face veneer. That's all there is to it, but don't go using the clothes iron, buy your own for the shop!

This table may look complex, but it requires mostly simple joinery.

by John Tate



Carl Wulff's furniture shop located at 145 Wade St. in downtown Cincinnati.

In our living room, we keep a mahogany table that I vaguely knew one of my ancestors had built. After I began my internship at this magazine, I became more interested in that table. I asked my paternal grandmother about the table, and she told me that my great-great-grandfather, Carl Edward Wulff, built it at his furniture shop in downtown Cincinnati about 1870. She even had a photograph of his shop dated 1878. In the picture you can see the simple sign that says "Furniture." With this proof, I knew that woodworking was definitely in my blood. Having the family tradition in mind, I set about building a slightly simplified facsimile. In fact, the joinery in this project is so simple that almost any beginner can do it.

Start with the Basics

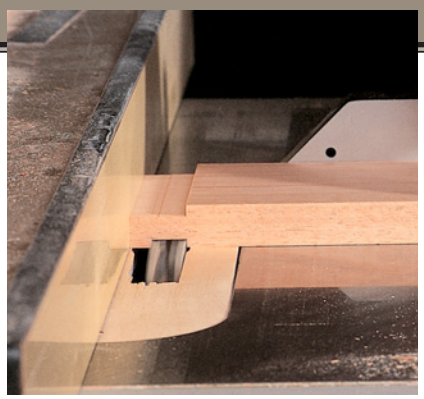
After cutting all your rough stock to length, surface your wood down to ¾" thick (except for the legs). The original 19th-century table's top was only one board. You can still find mahogany in these widths, but I couldn't. To obtain the appropriate width, I had to glue up two boards for both the leaves and the tabletop. I used three biscuits at each joint to keep the boards aligned during glue-up. Also, if you can't get 2¼"-thick stock for the legs, ask for turning blanks at the lumber store instead; you might just get lucky.

Mortises, Tenons and Tapers

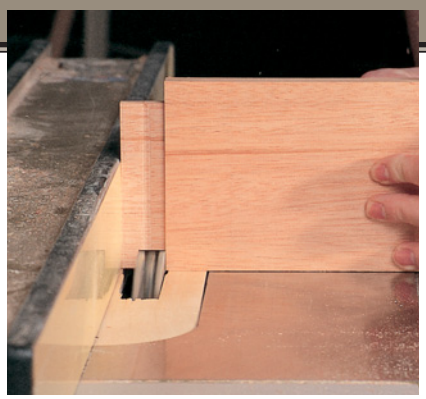
The first step is to make mortise-and-tenon joints where the aprons join the legs. I made the tenons using a dado stack on the table saw. Cut the shoulders as shown in the photo on the next page. Make the tenons ⅜" thick, 1" long and 3¼" wide. After cutting your tenons, cut a groove in the aprons for the tabletop fasteners, which will attach the top to the table's base. Make this slot by cutting a kerf in the aprons that's 7/16" down from the top edge. For a nice detail, I routed a bead on the bottom edge of the aprons.

TRADITIONAL drop-lea TABL

Photo by Al Parrish



To cut the tenons, use a dado stack on the table saw. Reduce the tenon in thickness by 3/16" on each side.



Cut 1/2" shoulders on each side of the aprons.

You will need to fasten the tabletop using tabletop fasteners, which requires making a kerf in the aprons. I made this kerf on the table saw 7/16" from the edge and 1/4" deep.

I made the mortises using a mortiser. In order to form the holes more safely, you should think of the path of least resistance. Instead of just going in a straight line from left to right or right to left, make two holes with a slight gap between. Then clear out the gap. If you simply work in a straight line, the mortiser's chisel could bend or break.

The mortises on all the legs are made 1 7/16" from the inside for the short aprons and 7/16" from the inside for the long aprons as shown in the diagram below. Cut your mortises on the legs; I used a mortiser, but you can use a chisel or Forstner bit.

The original table had turned legs, but in order to simplify things, I tapered the legs. Tapering jigs for the table saw can be tricky, so I used a band saw to cut the tapers about 1/16" shy of my line and then cleaned up the cut on the jointer. The taper should start 1" below where the aprons end and result in a leg that tapers to one-half the original thickness. Remember: taper only the sides that have mortises.

Install the Hinges

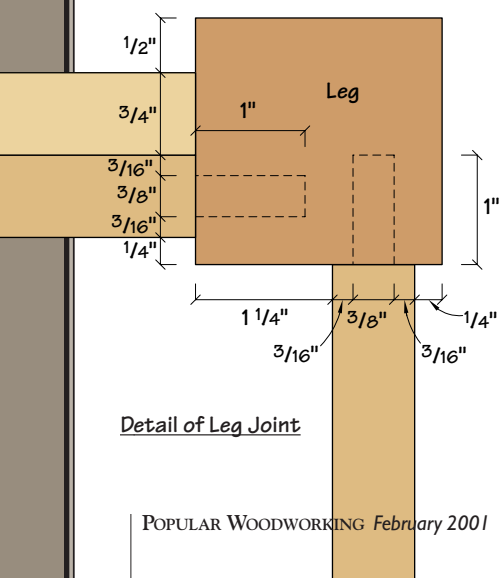
After tapering, sand the legs and aprons. Start with 100-grit sandpaper, move up to 150-grit, then finish with 220-grit. Next, glue up the legs and aprons and clamp. After gluing up the base, turn your attention to the top.

Install the hinges that connect the tabletop to the leaves. Use two on each side, and place them 7 1/4" inches from the end to allow room for the leaf supports. Lay out the location of the hinges by first placing a 1/16" spacer (I used pieces of plastic laminate) between the leaf and tabletop. Clamp the pieces together, put the hinges down and trace them with a pencil. Use a router with a straight bit to hog out most of the area. Then use a chisel to define the corners. Install the hinges and make sure they work properly.

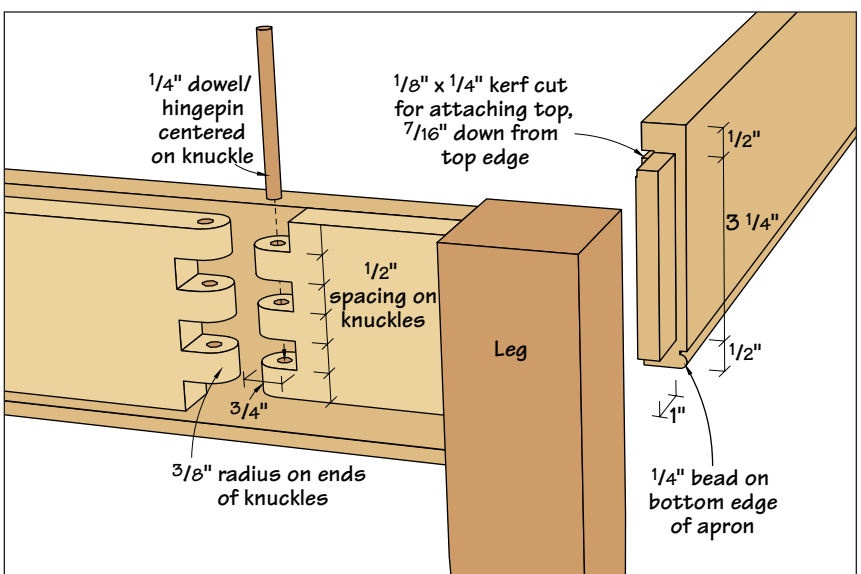
A 4" radius on the outside corners of the leaves on the original table was a nice touch. In order to recreate this, I traced the curve from the original and made a template using a piece of plywood. Cut the shape to size on a band saw and then use the template with a router and straight bit to finish the radius.

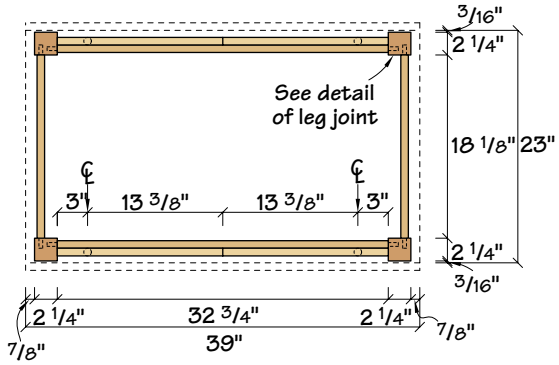
Make the Leaf Supports

To keep the leaves upright, assemble two supports for each side. These are basically two pieces of wood finger-jointed together to form a "knuckle" joint hinge. The 1/2" knuckle joints are made on a table saw using a finger-jointing jig. Round the edges of the "fingers" with a rasp or sandpaper so the joint pivots. Then drill a 1/4" hole through the fingers and tap a 1/4" dowel in place. Instant wooden hinges. One note: you'll have to cut a notch in the two supports so they'll clear the hinge barrels on the top. Mark the location of the notch when you dry-assemble the table. The angle cuts on the supports form a triangular hole against the apron. Cut a triangular piece of mahogany to fill this space, being careful not to let the filler rub against the supports. For simplicity, you may use brass hinges instead of knuckle joints.

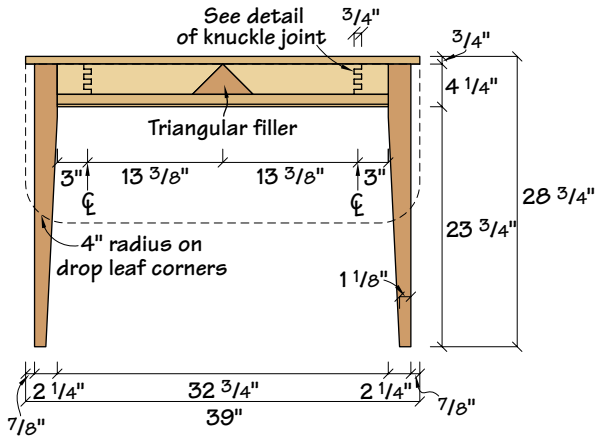


Detail of Leg Joint

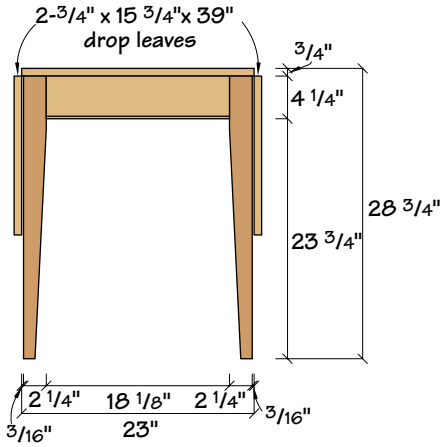




Plan



Elevation



Profile

SCHEDULE OF MATERIALS: DROP-LEAF TABLE

No.	Item	Dimensions T W L	Material	Notes
1	Table top	3/4" x 23" x 39"	Mahogany	
2	Leaves	3/4" x 15 3/4" x 39"	Mahogany	
4	Legs	2 1/4" x 2 1/4" x 28"	Mahogany	
2	Short aprons	3/4" x 4 1/4" x 20 1/8"	Mahogany	1" TBE; 1/4" offset
2	Long aprons	3/4" x 4 1/4" x 34 3/4"	Mahogany	1" TBE; 1 1/4" offset
4	Leaf supports	3/4" x 3 1/4" x 18"*	Mahogany	
2	Triangles	3/4" x 3 1/4" x 6 1/2"	Mahogany	

TBE= Tenon, both ends; * cut to fit

Supplies

4 Hinges for drop-leaves; Rockler part number 29249; $4.29 for 2 hinges

6 Tabletop fasteners; Rockler part number 34215; $1.99 for 8 fasteners

Rockler can be reached at www.rockler.com or 800-279-4441

Sanding and Finishing

Remove the hinges from the tabletop and sand the table. Because the top will be the most visible surface, I chose to go up to 220 grit. The bottom requires only 150 grit. In order to simplify finishing, I waited to attach the supports until after finishing. This requires masking off the area where the support will be glued.

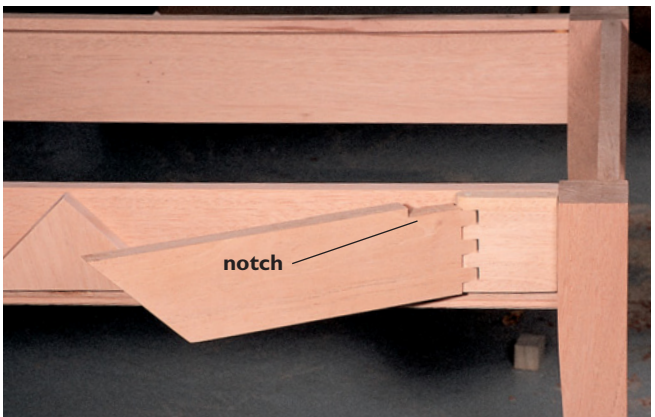
For the finish, I applied a dark mahogany stain made by United Gilsonite Laboratories (P.O. Box 70, Scranton, Penn. 18501; 800-272-3235; www.ugl.com). The color is called "118 Dark Mahogany," order number 11811, LR1294. Both the phone number and the website can refer you to a retailer in your area. After letting the stain cure, I applied four coats of clear lacquer.

Final Construction Details

After the lacquer has dried, attach the supports and the triangle with glue and nails through the inside of the aprons. Place the top on the base and make sure the supports keep the leaves level. Now attach the top. Because of the expansion and contraction of wood, you will need to attach the aprons to the tabletop using tabletop fasteners. These fasteners are available from Rockler and are listed in the Schedule of Materials. The tabletop fasteners are installed by simply screwing the fasteners into place. Because the wood will move more in width than in length over time, be sure to leave more space on the long apron sides for the fasteners.

Overall, I was extremely pleased with the results of my project. I think my great-great-grandfather would be proud to know that I've continued the family tradition. **PW**

I tapered the legs on a band saw, then ran the legs over the jointer in order to make them smooth.



I made the leaf supports using a knuckle joint. You can see the notch I cut out in order to allow the leaf support to swing out past the hinge. Though optional, I thought the triangle rest in the center was a nice touch.

Prevent, Remove and Disguise Glue Splotches

Nothing is more agonizing than discovering a glue splotch during staining.

There's no finishing problem more frustrating than glue splotches. You spend countless hours cutting, shaping, smoothing and joining pieces of wood only to have your work discolored where glue from squeeze-out or dirty hands seals the wood so your stain and finish can't penetrate. The wood under the splotch doesn't change color while all around it the wood is darkened.

Avoiding this common problem is easy with one of the following four steps.

- Keep the glue from getting on the surface of the wood in the first place.
- Wipe the glue off the surface while it's still wet.
- Identify areas of dried glue and remove it before applying a stain or finish.
- Remove or disguise the glue splotch after it has occurred.

Photos by Al Parrish

Glue squeeze-out is a particularly thorny problem when a joint meets at a 90° angle, such as a table leg to an apron. And because the apron is set back, it's easy to miss the squeeze-out during sanding.

Preventing Glue Splotches

Glue squeeze-out is a good thing when gluing boards edge to edge, because it's evidence you've applied enough glue and enough pressure with your clamps. This type of squeeze-out is seldom a problem, however, because you'll remove all traces of it when you plane, scrape or sand the surface level.

It's the squeeze-out from cross-grain joints, such as stiles and rails and legs and aprons, that causes problems because it's hard to sand or scrape a 90° joint without leaving unsightly scratches.

The most obvious way to prevent cross-grain glue squeeze-out is to apply no more glue to the joint members (mortise and tenon, dowel and hole) than necessary to make a good glue bond. This is hard to do when working fast, however, because it's difficult to avoid getting too much glue in the joint when you're even more concerned about not getting enough to make a strong bond. The trick is to create spaces within the joint for excess glue to collect, giving you more leeway for how much glue you can apply.

To create these spaces, make your mortise or dowel hole a little deeper than necessary, chamfer the end of the tenon or dowel (most commercial dowels come this way), and chamfer the front edges of the mortise or dowel hole. When you then slide the joint together, excess glue will collect in the cavities before squeezing out.

To keep your hands clean of glue while gluing up, keep a damp cloth and a dry cloth nearby. If you do get some glue on your hands, wipe it off quickly with the damp cloth, then dry your hands with the dry cloth so you don't cause grain raising.

To find glue splotches before you stain, wet the surface with paint thinner or water.The glue will show up a lighter color.

One way to avoid squeeze-out is to design your joints so that excess glue has a place to collect. Chamfering the ends of your tenons or using dowels with chamfered ends will help.

Removing Wet Glue

The best time to remove excess glue is while it's still wet by wiping with a cloth dampened with the solvent or thinner for the glue. To totally prevent glue splotching, however, you'll have to soak the wood and wipe it dry several times so you thin the glue so much that not enough is left in the wood's pores to cause a problem.

Some people remove glue squeeze-out by letting the glue dry just enough so it holds together and can be peeled off. This is a quick and easy way to remove most of the glue, but some will still remain in the pores and will have to be sanded, scraped or scrubbed out.

Identifying and Removing Glue

Once the glue has dried, it's usually difficult to see on the surface of the wood. To highlight these areas, wet the entire surface with water or paint thinner, which will soak deeper into unsealed wood and leave the areas that are sealed with glue a lighter color.

Water raises the grain of wood, so if you use water, you'll have to let it dry and then sand the wood smooth again. This procedure is called sponging or dewhiskering, and it's a wise step to take anyway if you plan to use a stain or finish that contains water.

Alternatively, there are commercial products you can add to white and yellow glues before use that will make them show up under a black light.

When you've identified the problem areas, remove the glue by scraping, sanding or scrubbing with a solvent for the glue.

You can break down white, yellow and hide glues with vinegar or water. (Hot water works best.) You can soften white and yellow glues with acetone, toluene, xylene or lacquer thinner. You can dissolve contact cement with acetone or lacquer thinner, and you can thin epoxy and polyurethane glues with these solvents until they have cured. Then you'll either have to use a methylene-chloride-based paint stripper or resort to sanding or scraping.

Whichever liquid you use to break down the glue, it's a good idea to scrub the area with a soft, brass-wire bristle brush in the direction of the grain to help remove all the glue from the pores. Then wipe the surface dry.

After cleaning all the glue off the surface, sand it with the same grit sandpaper you used elsewhere. You need to remove all raised grain and make the sanding scratches uniform, or differences in color may show up when you apply the stain or finish.

If you scrape or sand the glue off the surface, finish up by sanding with the finest grit sandpaper you've used elsewhere to make the scratch pattern uniform.

Correcting Problems

For those cases where you don't discover the glue splotch until after you've applied the stain, sand or scrape off the glue through the stain and restain that area or leave the splotch and disguise it later, after you've applied a coat of finish.

If you sand or scrape off the glue, you may have problems blending that area with the surrounding wood. Be sure to sand the damaged area to the same grit as elsewhere before applying more stain. If the damaged area still shows, try sanding the entire part (leg, rail, tabletop) while the surface is wet with stain, then wipe off the excess.

If the part you've wet-sanded is a little lighter than other parts, wet-sand again with a coarser-grit sandpaper. Most stains lubricate sandpaper, which reduces the coarseness of the scratching.

If wet-sanding doesn't solve the problem, you'll have to strip the stain using paint stripper or the thinner for the stain. Then resand the wood and begin again with the staining step. You don't have to remove all the color from the wood if you're restaining with the same stain.

An alternative is to disguise the splotch after you've applied a coat of finish in the same way you would disguise a wood-putty repair, a burn-in repair or a rub-through. Begin by drawing in the grain using pigment suspended in a shellac or padding-lacquer binder and a very fine artist's brush. You can also use pigment in varnish (the same as thinned oil paint or glaze), but you'll have to allow a day's drying time between coats.

When you have the grain lines connected to the grain in the surrounding wood, rub lightly with #0000 steel wool to soften the lines and apply a thin barrier coat of finish so the lines won't get smeared during the next step. Then color the areas between the grain lines with either pigment or dye in a binder. When you have the splotch disguised, continue applying coats of finish.

This last step doesn't work well on oil finishes because there's no film build. **PW**

Bob Flexner is teaching a finishing seminar at Marc Adams School of Woodworking in August. www.marcadams.com

Under the Rope and Into the Doghouse

One man's obsession with measuring a fabled antique results in one furious wife, one naked boy and an accurate cutting list.

I remember the first time I saw a picture of the clock at the Grove Park Inn in Asheville, N.C. It was a reproduction in the Stickley catalog. I looked at the picture of the clock in the catalog and instantly assumed from the photo that it was a mantel clock. I would learn later that this was a severe underestimation.

The clock in the Great Hall of the Grove Park is an 8'-tall, 4'-wide behemoth of quartersawn oak, copper and testosterone. Elbert Hubbard (of Roycroft fame) had designed it for the resort's grand opening in 1913. I looked at the picture in the book. I looked at the empty corner in my living room. I looked back at the picture again. I'm not certain what happened next, but, as with all great epiphanies, I started down the long, spiraling path to certain disaster and picked up the phone.

A few weeks later we arrived at the hotel. There is only one word that can describe walking into the Grove Park Inn on a spring day: aromatic. There were flowers everywhere. The building was littered with flowers. Every square inch of floor space (save a small footpath to the front desk) was jammed with flowers. I put my young son, Daniel, on my shoulders to look over the foliage in search of the clock. We found it.

There, behind a flower-wrapped red rope sat the object of my obsession: the only reason (other than the funeral of a wealthy relative) that I would spend eight hours in a car with my family. I was enthralled. The boy and I parted company with my wife, Helga, and my daughter and made a beeline through the jungle toward the giant timepiece.

Frankly, I knew that I wasn't supposed to touch the clock (otherwise, why would they have a rope around it?) So, being a civilized man, I stood back, pulled out a piece of paper and started scribbling wildly. I took pictures. I measured the rocks on the wall behind it, trying to get a point of reference.

I measured Daniel and had him stand next to the rocks behind the clock and took yet more pictures. Still, there was a critical dimension that was being missed.

Now, those of you who are without sin can cast the first stone, but I had come there to measure that clock... and by God, that clock was going to be measured.

Between a father and son, there is one phrase that is more significant and magical than any other in the human experience. Four simple words that solidify the bond between man and boy like no others can.

"I need a diversion."

Most boys wait their entire lives to hear their father utter that one sentence. It is a guarantee that the old man is about to do something either idiotic, ignorant, illegal or insane, and anything that they do to cover for him (short of a felony) will be approved of — even applauded. My 2½-year-old son understood the significance of the moment and rose to the occasion.

Thirty seconds later the boy was stripped naked and running full-bore through the Great Hall. Dancing through the flower display like Adam in the Garden of Eden and yowling at the top of his lungs. It was a sight to behold. Being a good (perhaps passable) father, I checked to ensure that my wife was apprised of the situation before I continued. In the few seconds that I watched her, Helga's face turned from its usual pasty white to an even more pasty white and then bright crimson before she darted from the reservation counter toward the boy as other arriving patrons stood watching, aghast.

We were "go" for launch.

In an instant I was under the rope and on the clock like white on rice. I measured everything I could reach. I clung to the rock wall and measured things I couldn't reach. All while my son (of whom I am very, very proud) eluded his mother and danced naked through the Great Hall. It was a moment of perfect harmony, and one that couldn't last.

You know what's wrong with modern America? Hidden video cameras. Followed closely by big, well-dressed men with walkie-talkies, I won't bore you with the discussion that followed in the manager's office, but suffice it to say that we watched quite a bit of television before he returned our deposit and recommended that we find other accommodations.

Helga's face was contorted with rage as we pulled into the Asheville Travelodge. Daniel, on the other hand, was wearing a smile that you couldn't pry off with a crowbar. I may be wrong, but, I think that's what family vacations are all about. **PW**

Walt Akers now stays exclusively at the Travelodge when not at home in Seaford, Virginia.