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Router Control

Using site-built jigs, bearing-guided bits and a router table to make precise cuts in wood

by Jud Peake

I've been using routers for over 15 years, and I'm still amazed by their versatility. Armed with a jig, a router and a sharp bit, I can hog out mortises for stair treads in a rock-hard stringer made of Douglas fir. Using the same rig mounted under the wing of my table saw, I can quickly mill a stack of delicately curved trim pieces out of expensive molding stock.

I'm a fan of big routers. Unless you plan to confine your router work to trimming the edges of plastic laminates or cutting out shallow mortises for hinges, a small router just won't cut it. You want big rpm (over 20,000), and you want big horsepower (2 hp minimum—3 hp is even better).

Not even a champion arm wrestler can free-hand control a 3-hp router spinning at 22,000 rpm. You've got to restrain the tool to make sure it goes where you want it, and that's what this article is about. Someone with only a little experience with a router can get consistently perfect results using the guides and jigs that I'll describe here.

Base-guided router—There are three common techniques used to guide a router as it cuts a negative shape, such as a mortise. *Base-guiding* the router requires a corral (top drawing, facing page). On a scrap of plywood tack a perimeter fence, or corral, that will confine the router's base to a set area. The size of the corral is found by this formula: mortise width + base diameter - cutter diameter = corral width.

When I use this method I make test cuts to see if I've tacked the fences in the correct position. Once I've got them right, I screw the fences down to make sure they won't move. I think this kind of time-consuming fiddling is the drawback with the base-guided setup. You also have to make sure that the base of the router is centered on the collet, or your results will be inaccurate. Also remember that a ding in the corral will be faithfully followed in each succeeding routing.

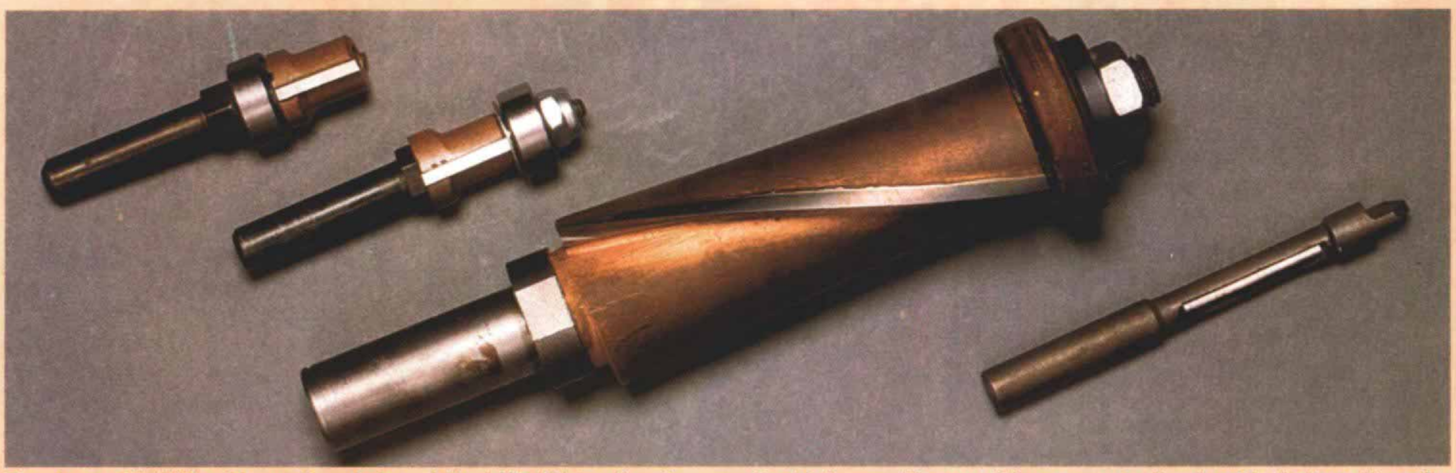
On the other hand, the fences are well away from spinning cutters as the base-guided router is inserted and withdrawn from the work. Consider this when making any production jigs expected to have a long life.

Collar-guided router—Some routers have a collar that will screw into the router's base (bottom drawing, facing page). The collar has a flange that bears against a template as the router is moved over the workpiece. The formula for calculating the dimension of the template corral is: mortise width + collar diameter - bit diameter = corral width.

I think the collar setup has the disadvantages of the base-guided one with none of the advantages. The calculating and fiddling take just as long, yet the template is so close to the bit that it's likely to be damaged.

Bearing-guided router bits—I think the low-tech (and thus low-budget) approach appropriate to construction-site router work is the bearing-guided flush-trimmer router bit (photos below). Because the guide bearing is the same diameter as the cutter, there is no need to account for the offsets typical in base-guided and collar-guided setups. This makes it easy to whip together perfect jigs.

Flush trimmers are available in several configurations. A bearing-over bit has the bearing mounted on the shank-end of the bit (photo below). Its cutter is retained by a nut at the end of the shank. A bearing-under bit has the bearing at the other end. I often use this kind of bit in my router table.



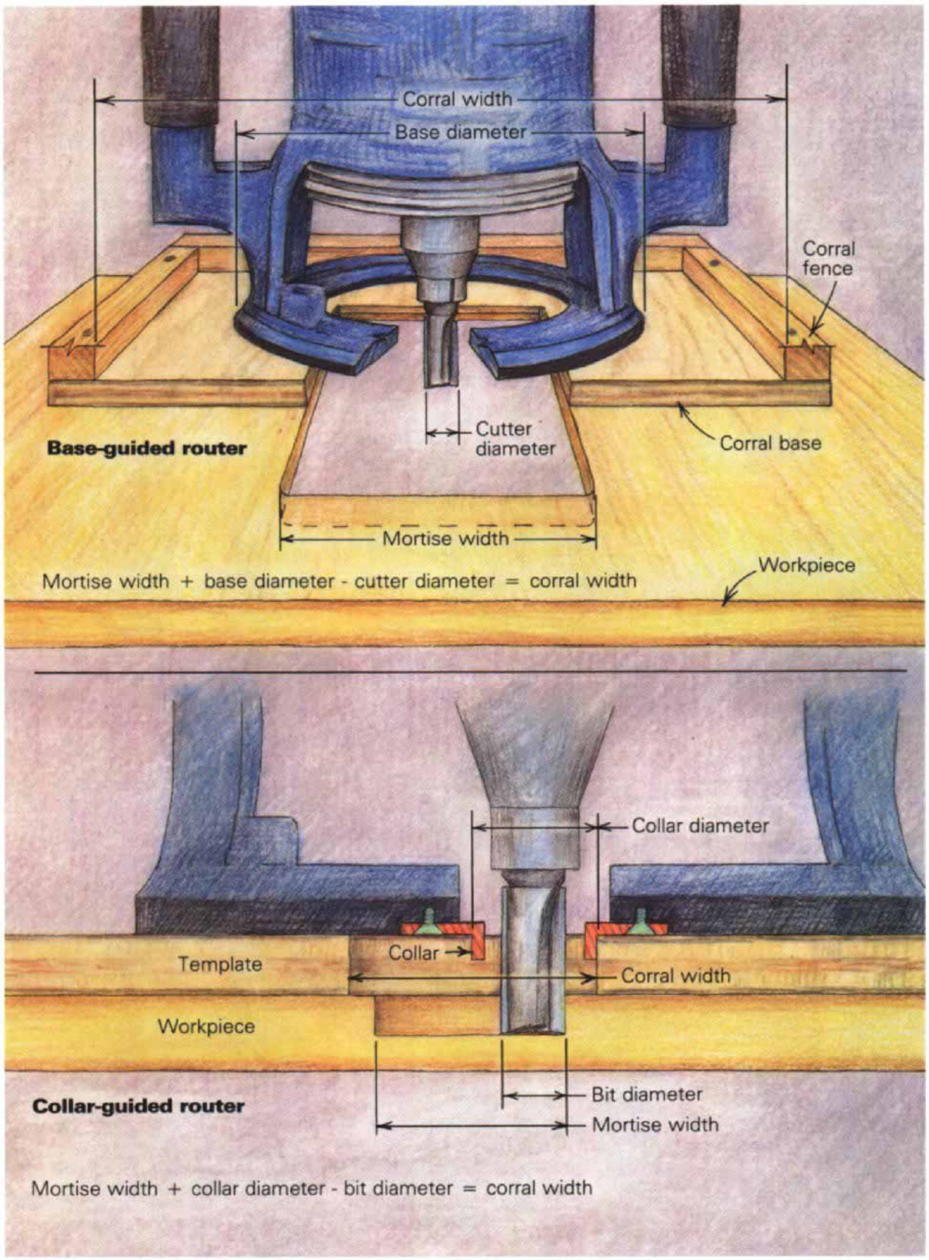
Bearing-guided bits. **Shown from left to right: A TA-170 is a *bearing-over* flush trimmer. Because it has a recessed nut on the bottom, it can be used to cut mortises. A *bearing-under* bit can be useful mounted upside down in a router table. A *face-frame* bit, called an FFT-2126, is a bearing-under bit with 2½-in. long spiral cutters. The pointed end of the *panel* bit allows it to be plunged through the workpiece.**

The flush-trimming bit I use for template mortising is called a dado bit and is made by by Paso Robles Carbide (731 C Paso Robles St., Paso Robles, Calif. 93446). It is called the TA-170, and it has a recessed nut on the bottom, allowing it to cut mortises. A type of flush-trimming bit that I use occasionally for cutting shapes in thin material (¼ in. or less) is called a panel bit (photo facing page). This inexpensive bit is made of high-speed steel, and it has no roller bearing. But its point allows the bit to be plunged through the workpiece. The bit also has a bearing surface that can be used like a bearing-under bit so long as the pattern against which it is riding is absolutely void-free and accepting of a little friction burning.

Large-diameter bits cut much better than small-diameter bits. If you plan on removing a lot of wood, as when mortising housed stringers, you'll be better off with a ¾-in. bit. For hinge and strike-plate mortises, a ½-in. bit is fine.

Most flush-trimming bits are available with spiral cutters. Of these there are two varieties: upshear and downshear. Upshear bits keep the material snug to the base of the router or to the router table. They also draw the sawdust out of mortises. Downshear bits aren't useful for the applications discussed here.

I see no point in buying a router bit made of any material inferior to tungsten carbide. The demands on the cutting edge of a bit are too great for anything less. Sharpening will still be necessary, though, and this presents a problem for flush trimmers. Sharpening reduces the diameter of the cutter, making it no longer flush with the bearing. With small-diameter trimmers the solution is to use detachable throw-away cutters (such as the TA-170) that allow the arbor and bearing to be saved. With large-diameter trimmers you can get fiber-covered bearings that can be resized to match the new diameter of a resharpened cutter.



Hinge butt templates—Store-bought hinge butt templates (see *FHB* #31, pp. 28-31) rely on a collar-guided router, and this is their main drawback. The bit, collar and template must all be compatible for the setup to work. Also, the collar has to match up with the router you plan to use. And once you've got all these things sorted out, if you hit the steel template with your bit, you've ruined both of them. As an alternative, I devised the hinge-mortising jig shown in the drawing (bottom left drawing, next page). I begin making one of these jigs with a piece of void-free material such as high-quality birch plywood or medium-density fiberboard (MDF). I pull the pin of the hinge I intend to use on the door and place the unfolded hinge, barrel up, on the template stock (top left photo, next page). Now I corral the hinge with fences that are thin enough to allow the bit's cutters a ½ in. or so of entry into the plywood as the bearing rides against the strips. The height and width of this corral is determined by the unfolded size of the hinge. You don't even have to measure the length of the strips because they can run wild at the corners.

Routers are noisy and they scatter a lot of wood chips. Before you make any cuts, protect your eyes with a pair of goggles that allow you a good view of the work, and use either foam plugs or the earphone-type headgear to protect your ears.

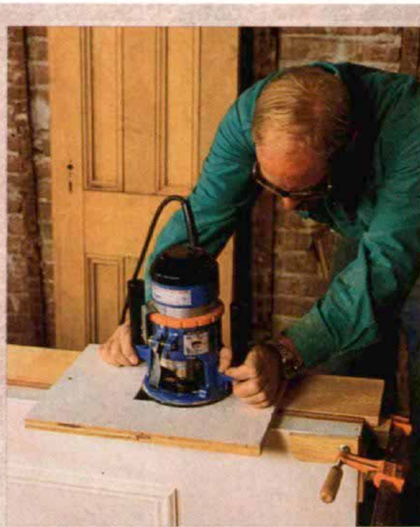
Using a dado bit, rout clockwise along the inside edges of the corral. If you go the opposite direction, the bit will try to pull its way into the wood as you advance the router, making it difficult to control.

Chances are, your bit didn't go all the way through the template stock because the cutters aren't long enough. Remove the wood strips and use the walls of the grooves you've already cut to guide the bit's bearing as you complete the cut with another pass. Consider this template the master copy, and use it to cut three working templates. That way, if you damage a working template you can use the master to make a new one in minutes, without even changing the bit. I make the working templates for hinge mortising out of ¾-in. stock, which is thick enough to allow the bearing to ride against the edge of the template while the bit cuts a shallow mortise (top right drawing, next page). This principle holds true for any template—it has to be thick enough to guide the bearing, yet thin enough to allow the cutters into the workpiece. Figure on a ½-in. deep cut as the maximum that you'll be making in one pass.

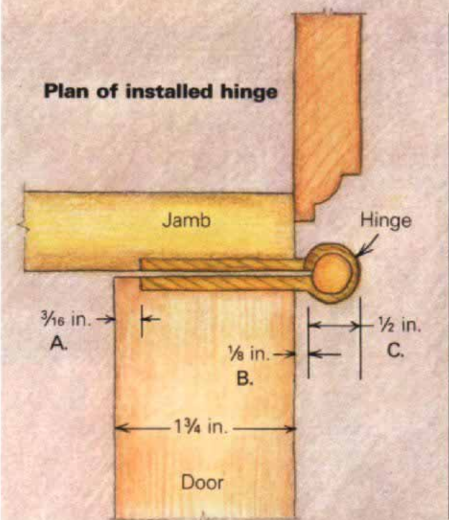
The rounded inside corners of templates cut with a ½-in. bit match the radius of hinges with rounded corners. If your hinges have square corners, use a chisel to square the in-

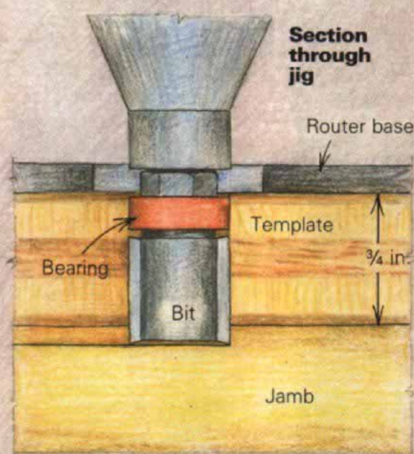
Drawings: Chris Clapp

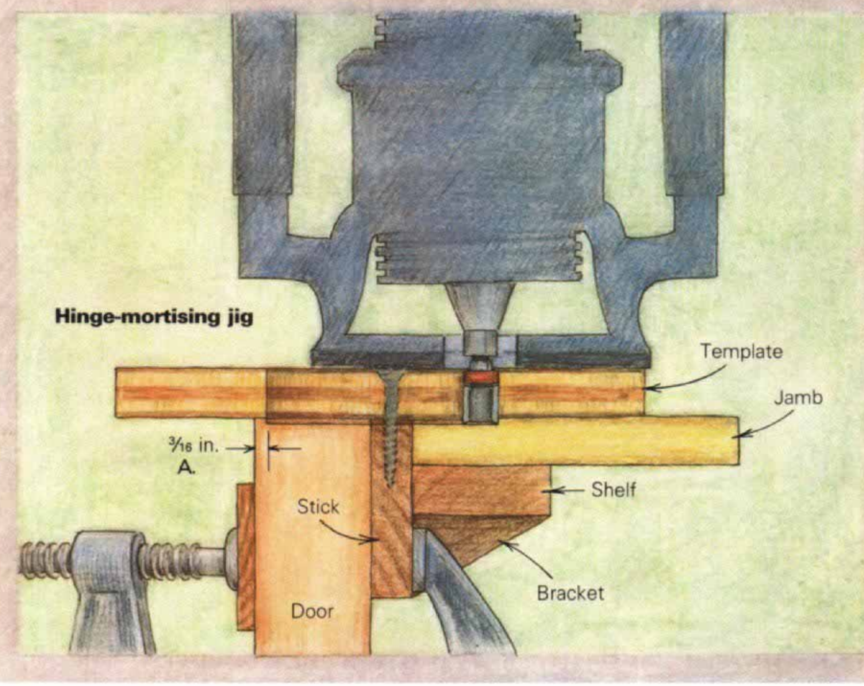
To make a hinge template, unfold the hinge (minus the pin) and corral it with wood strips to guide the router-bit bearing.



The author uses his hinge-mortising jig to simultaneously cut hinge gains in the door stile and the jamb.







side corners of the templates. The squared walls will act as a guide for the chisel as you square the corners of the hinge gains.

Making a jig from the templates—I screw the templates to a stick that fits between the door and the jamb (drawing below left). The stick's thickness is determined by the distance that the hinge will protrude beyond the plane of the door. For example, the hinge on the 1¾-in. thick door shown in the drawing is held back 3/16 in. from the edge of the door at A. The leaf of the hinge projects ⅛ in. past the door at B, and the barrel is ½ in. in diameter at C. The stick thickness is equal to the diameter of the hinge barrel plus two times B. That adds up to ¾ in. in this case. Three brackets mounted to the side of the stick support a shelf upon which the jamb rests. In use, a clamp at each end secures the jig to the door (top right photo).

The jig can be made reversible for left-hand or right-hand doors in two ways. First, you can make the jamb-shelf easily removable so that the position of the jamb and door can be switched. Another way is to make the projection of the stick past the top and bottom hinge template equal, so that the whole jig can be switched end for end. In either case make the stick ⅛ in. longer than the door to allow for clearance at the head jamb.

Stair-mortising jig—Currently on the market is a metal jig for cutting housed stair stringers with a router. Because it's made of metal, it can damage your bits, and it costs a fair amount of money. In the time it takes to go to a nearby store to buy one, you can make a better one of your own.

On a piece of voidless plywood approximately 24 in. by 30 in., drill a hole the same diameter as the thickness of your tread stock. This hole corresponds to the tread's bullnose, and it should be in roughly the position shown in the top drawing, facing page. Tangential to this hole draw a line parallel to the long edge of the plywood. This line represents the top of the tread. Draw a second line to represent the front of the riser; it should be 1 in. to 1½ in. back from the farthest reach of the hole. Carefully square this line to the first one. Tack wood strips along these lines, followed by some offcuts of your tread and riser material, and some samples of the wedges you intend to use (drawings, facing page). Corral this assembly with more strips of wood, remove the tread, riser and wedge samples and use a dado bit to rout a master template. Make a couple of working templates from the master.

At this point the housing template you've made is good for any rise and run of stair using your tread and riser stock. It has no pitch—only the rise and run. In this configuration you can use the template like a framing square, measuring the rise along the face of the riser mortise, and the run along the top of the tread mortise.

I use a pair of these templates to create a jig that can be used to rout the mortises in a pair of fully housed stringers (bottom drawing, right). I screw the two templates together with some 1x2 braces, making sure to keep them far enough from the mortises to allow the router clearance. Fences on the underside of the assembly align it with the stringers.

After you've routed the first pair of stair mortises, you can affix a pair of blocks to the underside of the jig. They are positioned to fit into the previously routed tread mortises, allowing you to advance the jig accurately without measuring.

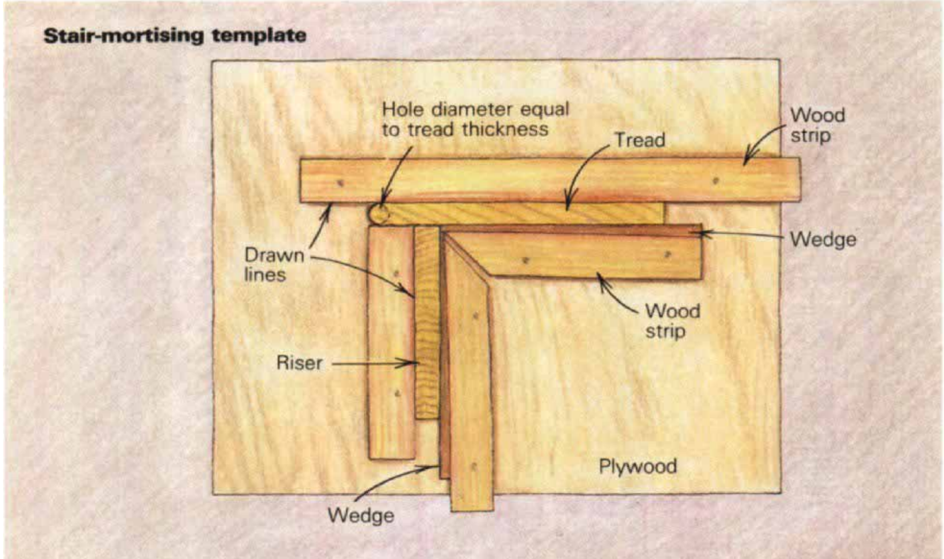
Table-saw router table—Negative shapes, such as mortises, are best cut with negative templates and a dado bit. I cut positive shapes, however, on a router table using a pattern and a flush-trim bearing-under bit. My router table is actually an extension wing that I affixed to the side of my table saw by way of bolts run through threaded holes in the saw's guide rails and cast-iron table. This arrangement saves space in my garage/shop.

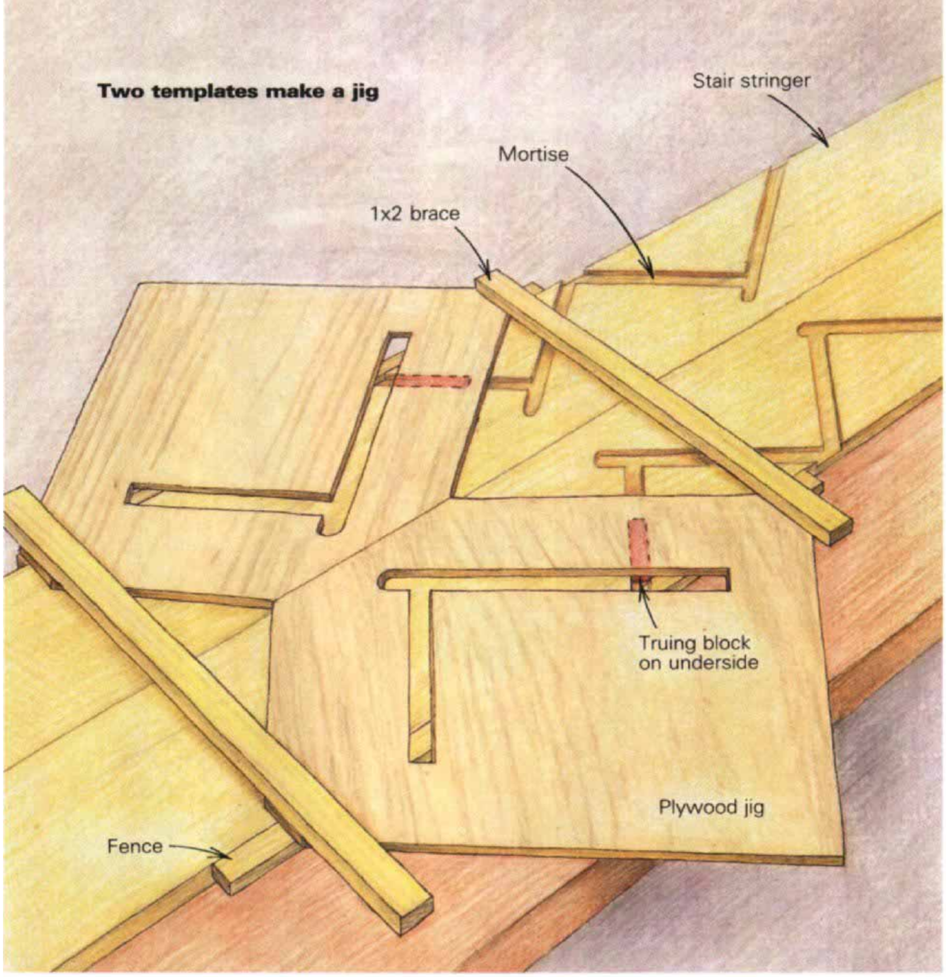
I made my extension wing out of Baltic birch plywood, and covered it with plastic laminate. It's easy to keep clean and materials slide across it with little effort, but to tell the truth, next time I'll omit the laminate. A sanded plywood surface is smooth enough, and I could easily attach fingerboards, fences and guards to the plywood with drywall screws without worrying about marring its finish.

Router-table safety—The safest way to use the router table with a fence is to make the cut so that direction of feed opposes the spin of the cutter (bottom left drawing, next page). A fingerboard guarantees that the material doesn't drift away from the cutter, resulting in a tooled edge with bulges and ripples. In my setup the workpiece passes to the left of the cutter. If I moved the fence over so that the workpiece could pass to the right of the cutter, I'd have a setup for sending wooden projectiles through my shop walls at high velocity.

A typical freehand router-table setup is shown in the drawing and photo top right, p. 41. The spin of the cutter is countered by the direction of feed, the guide bearing and the starting pin. A starting pin is simply a post or even a small block of wood that braces the workpiece as it enters the cutters (but before the stock has reached the guide bearing). It can keep the whirring bit from ripping the workpiece right out of your hands. My starting pin is an Allen-head screw driven into a teenut let into the underside of the table. To make it friction-free, I clad the exposed portion of the screw's threads with a short piece of chromed-brass plumbing-supply tube. Epoxy holds the assembly together.

The work has to go counter to the rotation of the bit. To make sure that I don't forget its direction, especially during repetitive production operations, I use a felt-tip marker to draw the cutter's rotation on my table.



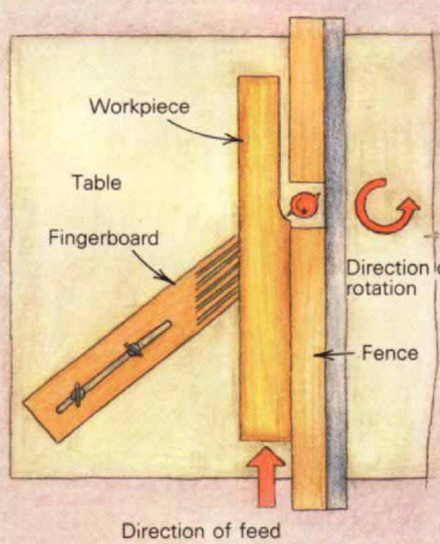


There is one setup for the router table that allows stock to be fed *with,* rather than against, the spin of the cutter. The drawing (bottom right drawing, next page) shows how this is done. This is called climb-cutting, and it's for dealing with heavy pieces of difficult woods. To make it safe, you must have a secure table and take a light cut (1⁄16 in. or so) off a fairly massive piece of wood. Milling the bullnose roundover on Douglas fir stair treads is a typical application of this technique. The stringy grain of the wood makes this backwards approach necessary, because the conventional method would tear the grain. In climb-cutting, a heavy workpiece that is easy to grip is essential for control.

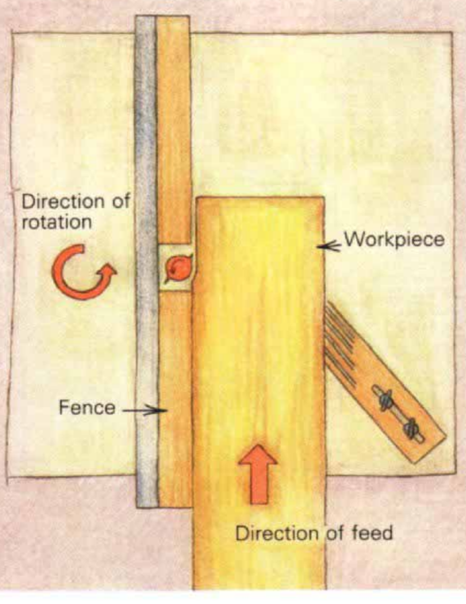
Mounting the router—My R 330 Ryobi router has two large holes for its removable handles. Two studs that I permanently af-

Peake affixes his router to a table-saw extension wing with a pair of bolts through the handle-brackets. Note the L-shaped flange screwed to the side of the router. The orange depth-adjustment ring bears against it in this inverted position, allowing the bit to be easily raised and lowered. A T-nut is embedded in the underside of the table near the router's base.

Fence-routing



Climb-cutting



fixed to the underside of the table pass through these holes, allowing the router to be held firmly in place with just two wing nuts (photo left).

A router that lacks these bolt holes can be secured by running screws through the table into holes tapped in the base of the router. If these screw holes are metric, it's usually easier to redrill and retap them with English threads rather than try to find the right metric screws.

I've yet to see a router with a depth adjustment that is easy to use when the router is upside down. This is important enough in table-routing that I added an L-shaped metal flange to the side of my router to give the depth-gauge threads something to bear against (photo left).

It's awkward to fumble around under a table, feeling for an unseen switch to turn off a screaming router. To avoid this scene, I mounted a switched outlet to my table saw's base. It's in an accessible position so I can easily flick the tool on or off.

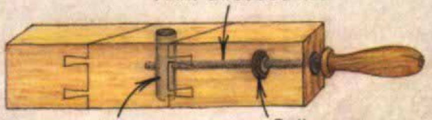
Pattern-routing—I worked on a Victorian hotel recently that has fancy redwood wainscoting bordered by custom trim. The vertical trim pieces framing each wainscot panel have two curves and a straight section, and I used the router table to mill them quickly and accurately. I started by making a pattern out of voidless ⅛-in. plywood that represented the profile of the trim piece. Then I used a bandsaw to stack-cut a bunch of redwood trim blanks that were about ¼ in. oversize.

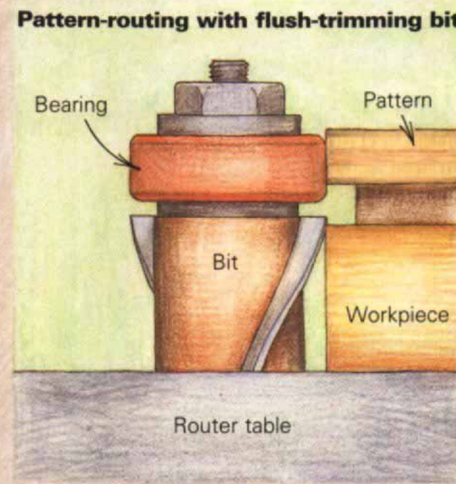
To mill each trim blank down to its finished size, I tacked the plywood pattern to the top of a blank and ran the pattern and blank against a flush-trimming bit (pattern-routing photo, facing page). To make sure the pattern made good contact with the bit's bearing, I used thin plywood spacers between the pattern and the blank.

Once I had all of the pieces trimmed to their finished size, I put an ogee bit with a pilot bearing in the router and ran a decorative edge on the trim using the same setup without the pattern. Because the radius of the router bit cannot make the crisp interior corners appropriate to some parts, I used a sharp gouge to clean up the inside corners on these trim pieces.

Jointing on a router table—With some additions to the fence that came with my table saw, I can use the router table to dress the edges of boards with jointer-like accuracy. I wrap the fence with ½-in. Baltic birch plywood. This gives me a surface to which I can affix wood blocks that create a space for the router bit. Rather than use blocks of the same thickness on both sides of the bit (which would work fine for most fence-based routing operations), I made the infeed side adjustable. By aligning the outfeed side of the fence flush with the cutter and offsetting the infeed side, I control the depth of cut. To

Adjustable infeed fence. **Oak blocks with dovetailed ways compose the infeed fence on Peake's router table (photos above and below). A barrel nut in the middle block is tapped to accept threaded rod (drawing below). Turning the handle clockwise moves the outer blocks away from the fence; counterclockwise retracts the blocks as a collar affixed to the threaded rod bears against a mortise shoulder in the block nearest the handle.**





Pattern-routing. **Precise, repetitive shapes can be quickly milled on a router table by tacking a pattern to the top of a blank and then passing the assembly against a flush-trimming bit with a bearing on the cutter end of the shank. To make sure that the pattern fully engages the bearing, a spacer can be placed between the workpiece and the pattern, as show in the drawing above. An arrow drawn on the table indicates the spin of the bit.**

Indexing. **Peake uses a sliding extension table on his table saw to cut dovetails on the end of drawer stock. Successive cuts are indexed by the aluminum registration pin.**

make the infeed fence adjustable, I cut dovetails in three 4/4 oak blocks. The center block is affixed to the fence, and it has a vertical pin in it with a threaded hole (adjustable infeed-fence drawing and photos above). The other two blocks nest on either side of the fixed block and are connected by a ¼-in. steel plate. A threaded rod passes through a lengthwise slot in the outboard block and into the pin. By turning the threaded rod, I expand or contract the thickness of the infeed fence.

The bit I use for this is called a "face-frame" bit (photo, p. 36), and it has 2½-in. long spiral cutters. Paso Robles Carbide is the only company I know of that makes it. Because the bit is so long, I can raise its bearing above the top of the typical workpiece during jointing operations (photo below right).

Whenever I'm using the fence to guide long, thin stock past a profiling cutter head, I use a fingerboard to apply pressure from the side. To make it adjustable, I put a couple of T-nuts in strategic places under the router table. A slot in the fingerboard and some wing nuts let me tighten it down where necessary.

Indexing—I made a sliding table for my table saw (for more on sliding tables see *FHB* #53, pp. 58-61). It has two hardwood runners that slide in the table-saw guide slots. These runners are attached to the underside of a piece of ½ in. birch plywood that is nearly as large as the table-saw top. Topside at the front and rear of this piece of plywood, perpendicular to both the runners and the saw blade, are wooden fences. I use the sliding table to crosscut material with the table saw, but I also use it for index cuts with the router. Indexing is a clever but simple way to produce repetitive, equally spaced cuts such as dovetails. Start by making a ⅛-in. thick aluminum registration pin that matches the profile of your dovetail router bit (indexing photo above). This pin must be set away from the path of the dovetail bit by an amount equal to the bit's profile (this will take some trial-and-error fussing). Once you've got it close, you can adjust the final spacing of the joint by slightly raising or lowering the bit.

Rout the sockets of the dovetail with the stock flat on the sliding table. You can affix blocks to the router table to act as depth stops. The tails are routed by standing the stock on end, flat against the back fence of the table. I use a 1x2 screwed to one end of the sliding table as a clamp to secure the stock while it passes over the bit. The 1x2 also serves to back up the cut, preventing tearout.

With some layout work you can calculate where to start the first pin and first tail so that the edges of the dovetailed boards align at the joint. To keep it simple, I work with extra-wide stock and rip the whole carcase down to size after the joint has been assembled. ☐

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