

# MORTISE-AND-TENON JOINTS

The mortise-and-tenon joint is one of the oldest methods of fastening wood. It was relied upon by builders of the sarcophagi of ancient Egypt and, centuries later, the sailing ships of Columbus. Today, the joint is used most often in furnituremaking—most typically for building frames in frame-and-panel construction and joining rails to legs on desks, tables, and chairs.

The joint consists of two key elements: the tenon, a projection from the end of one board that fits into a slot—the mortise—in the mating piece. The mortise-and-tenon features a relatively large gluing area, involving good contact between long-grain surfaces—the cheeks of the tenon and the sides of the mortise. Provided the tenon fits snugly in the mortise, the joint offers virtually unparalleled resistance to most of the stresses that wood joints endure. Only the dovetail joint is more difficult to pull apart.

There are dozens of variations of the standard joint, and many are shown in the inventory of joints on pages 88 and 89. For example, the tusk tenon is a common way of reinforcing a trestle table; a variation of the round tenon serves both an

esthetic and a structural role in Windsor chairs.

Whether a tenon is haunched, wedged, pegged, rounded, or angled, a few rules of thumb dictate the proportions when cutting this joint. The thickness of a tenon should be one-third the thickness of the workpiece; its width may be from two-thirds of the width to the full width of the workpiece.

A tenon's length depends on whether it passes completely through the mortise workpiece or remains hidden, or blind. The length of a blind tenon (page 94) is often  $\frac{1}{2}$  inch or longer, depending on the use of the mating workpiece; a through tenon (page 97) will be as long as the width or thickness of the mortise workpiece.

The pages that follow show several hand- and power-tool methods for cutting mortise-and-tenon joints. Tenons can be cut on the table saw (page 92), with a backsaw (page 95), or on the drill press (page 110). Mortises can be produced on the table saw or drill press, chiseled out by hand (page 94), or routed (page 97). Choose the method that suits your needs and the tools in your shop.

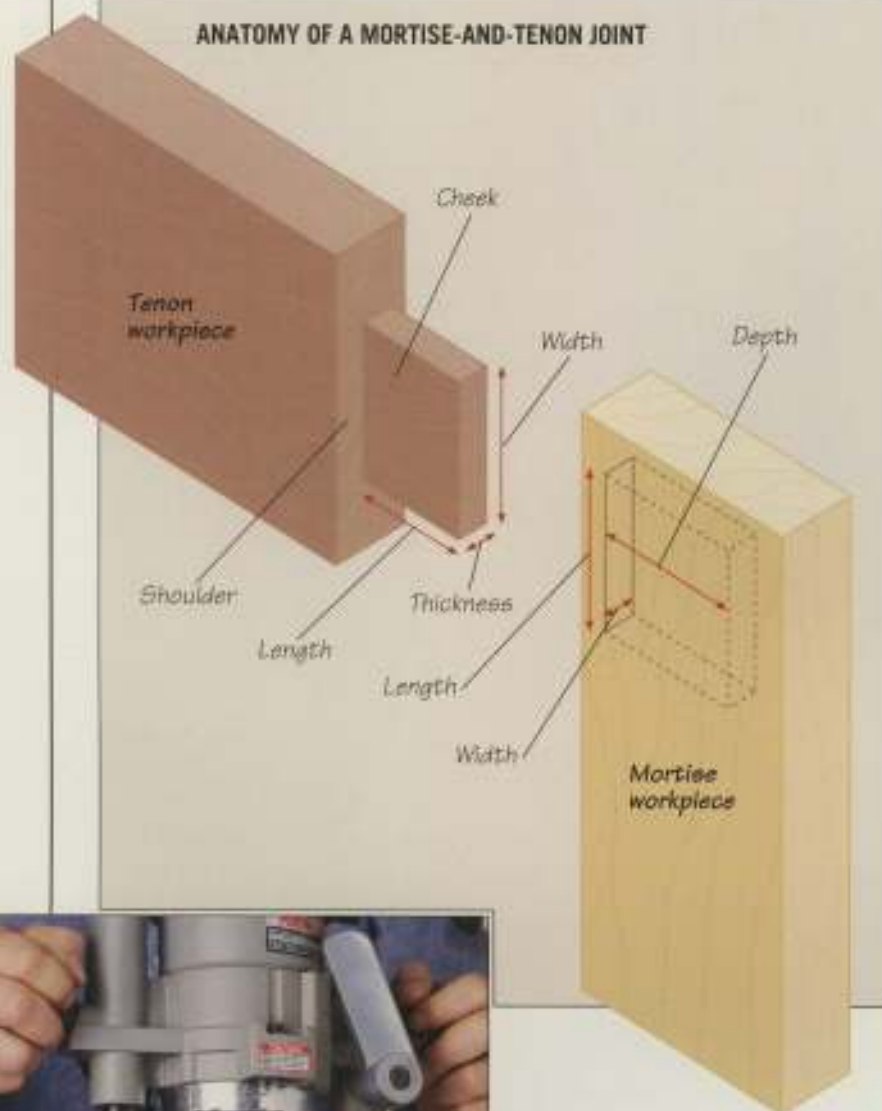


*The hollow chisel mortiser can drill mortises up to 3 inches deep quickly and accurately. The bench-mounted tool is fitted with the same chisel bits and mortising attachment used by the drill press.*

*A tenon at the end of a rail fits snugly in a mortise cut out of a table leg. This blind mortise-and-tenon joint is both sturdy and long-lasting.*

# MORTISE-AND-TENON JOINTS AND JIGS

## ANATOMY OF A MORTISE-AND-TENON JOINT



Clamped in a bench vise, a commercial mortise-and-tenon jig guides a router as it cuts a tenon. The jig template is turned end-for-end to rout the matching mortise.

## A COLLECTION OF MORTISE-AND-TENON JOINTS



**Haunched**  
(see page 101)



**Blind**  
(see page 94)



**Through**  
Mortise passes completely through workpiece, revealing end grain of tenon

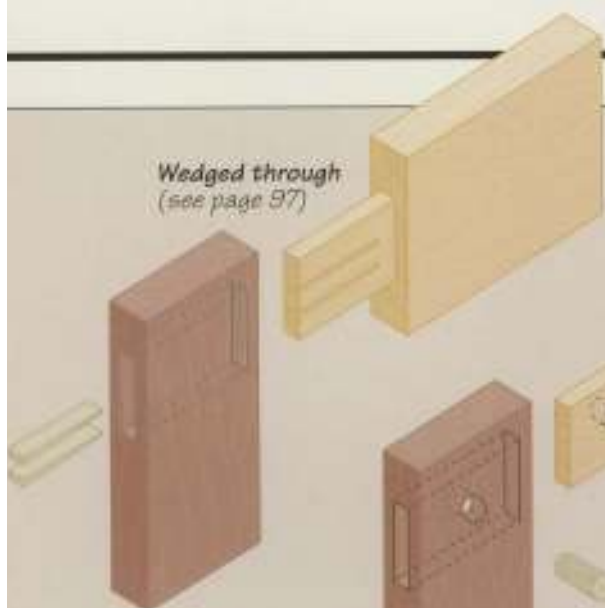
### Angled haunched

Also known as a sloping or secret haunch; identical to the haunched mortise-and-tenon, except that the haunch is angled, concealing it when the joint is assembled.



## MORTISE-AND-TENON JOINTS

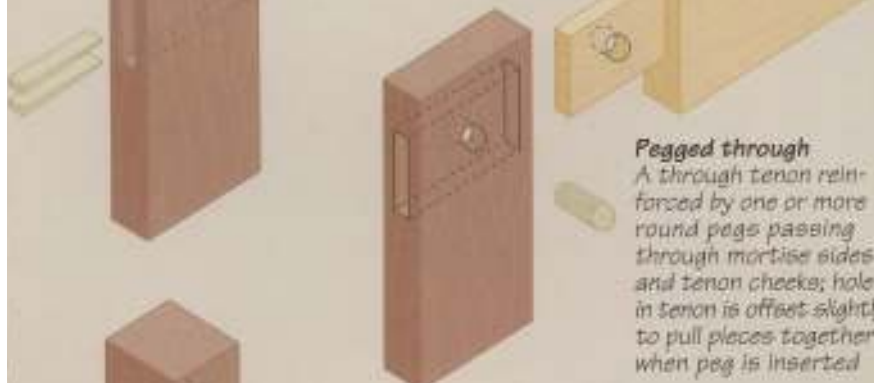
**Wedged through**  
(see page 97)



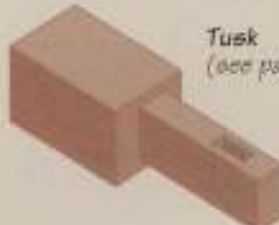
**Barefaced blind**  
A haunched blind mortise-and-tenon with no shoulders or cheeks; offers less gluing surface than a blind mortise-and-tenon, but easier to cut



**Pegged through**  
A through tenon reinforced by one or more round pegs passing through mortise sides and tenon cheeks; hole in tenon is offset slightly to pull pieces together when peg is inserted



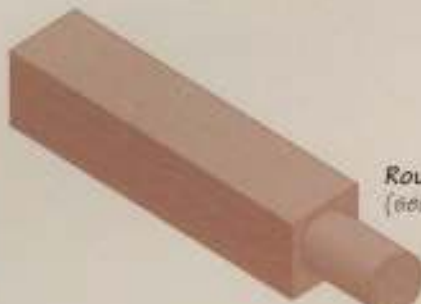
**Tusk**  
(see page 106)



**Angled**  
(see page 103)



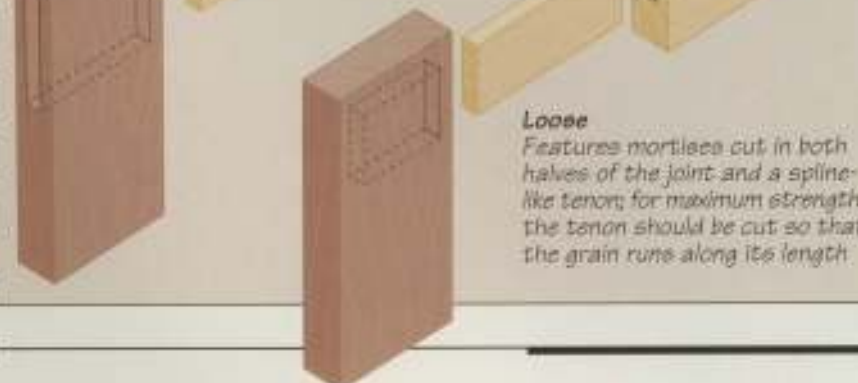
**Round**  
(see page 110)



**Open**  
(see page 91)



**Loose**  
Features mortises cut in both halves of the joint and a spline-like tenon; for maximum strength, the tenon should be cut so that the grain runs along its length



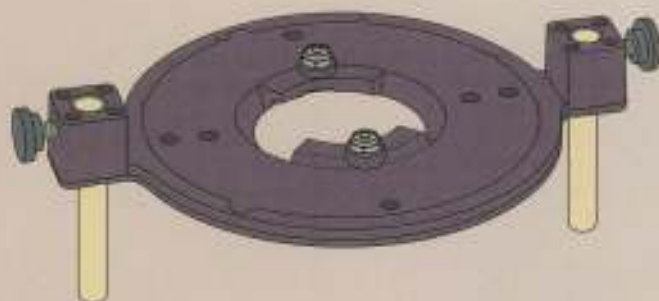
**Twin**  
(see page 108)





## MORTISE-AND-TENON JOINTS

### MORTISE-AND-TENON JIGS

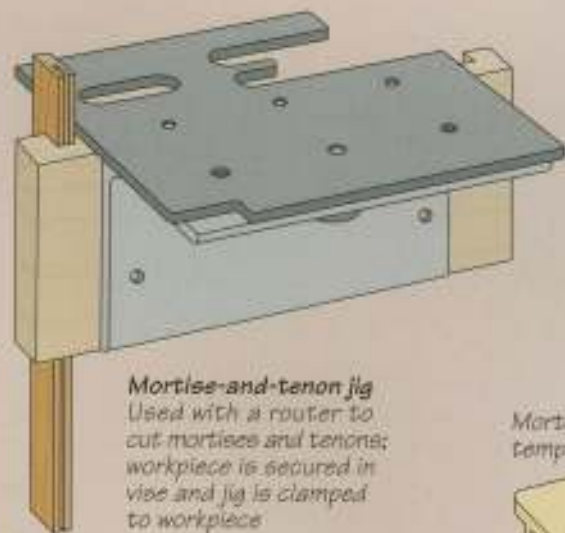
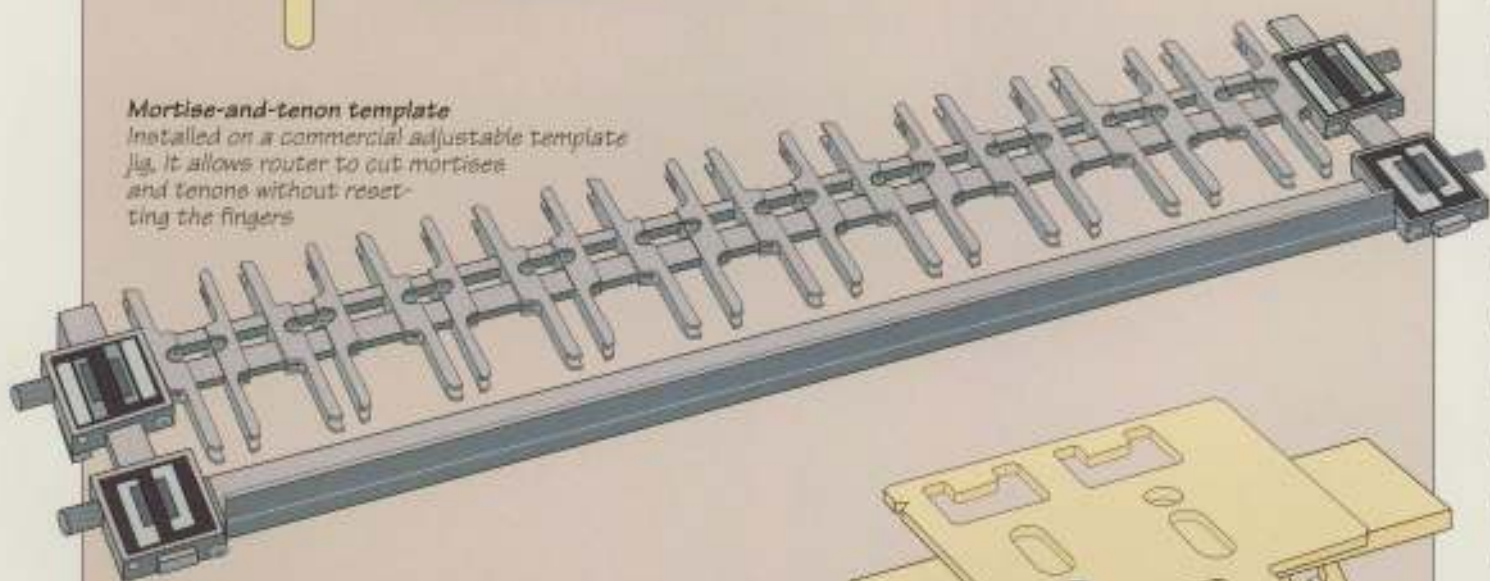


#### Mortising jig

Attaches to router base plate for routing mortises; guide pins are positioned against opposite board faces, centering mortise in edge

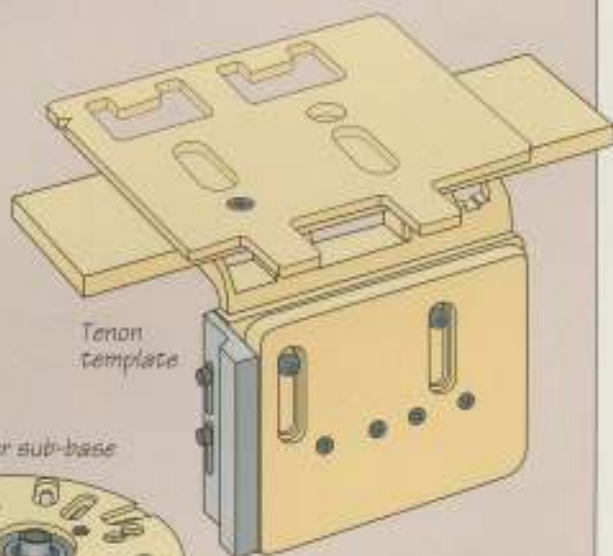
#### Mortise-and-tenon template

Installed on a commercial adjustable template jig, it allows router to cut mortises and tenons without resetting the fingers



#### Mortise-and-tenon jig

Used with a router to cut mortises and tenons; workpiece is secured in vise and jig is clamped to workpiece

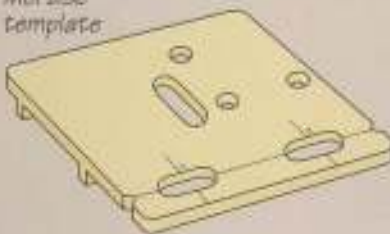


#### Tenon template

#### Router sub-base



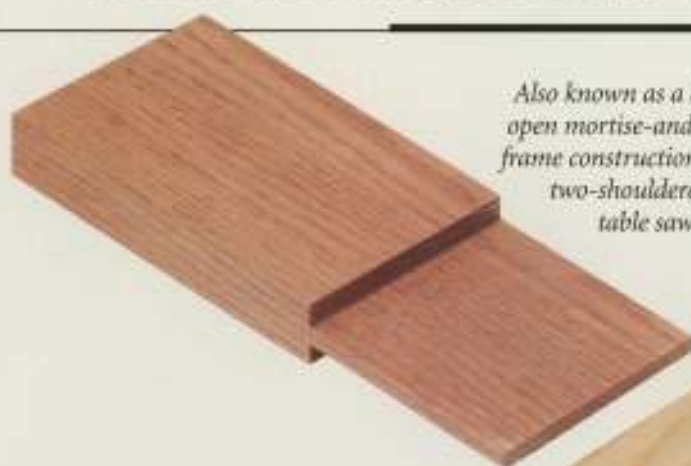
#### Mortise template



#### Multi-joint jig

Used with router to cut mortise-and-tenon joints. L-shaped bracket is fastened to backup board and secured in vise; appropriate template is attached to bracket. Comes with guide bushing, router sub-base, and bits

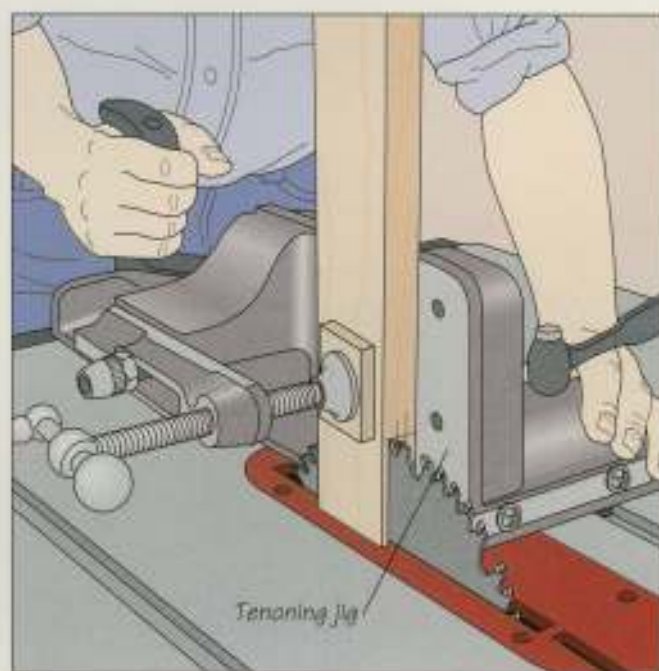
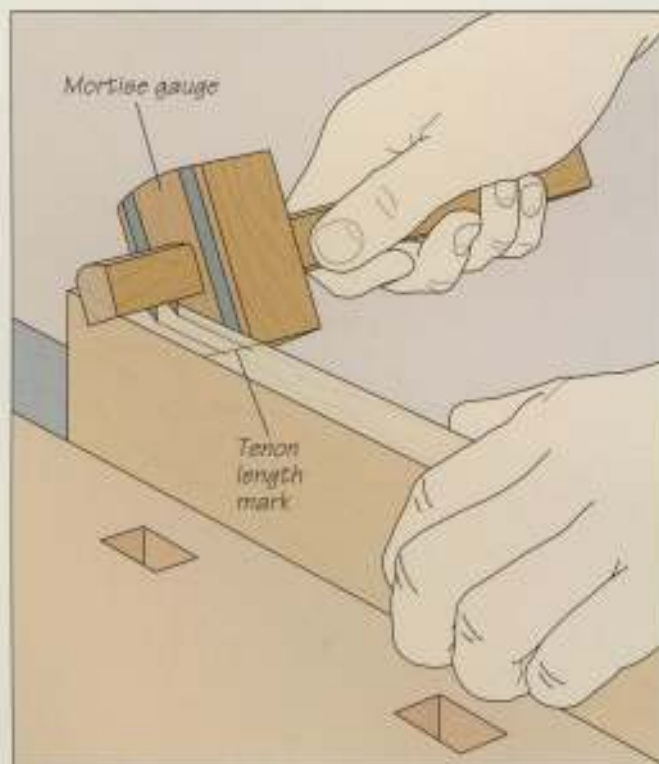
# OPEN MORTISE-AND-TENON JOINTS



*Also known as a bridle joint or slip joint, the open mortise-and-tenon is commonly used in frame construction. Both the open mortise and two-shouldered tenon can be cut on a table saw or radial arm saw.*



## AN OPEN MORTISE-AND-TENON ON THE TABLE SAW



### 1 Outlining the tenon

Secure the stock edge-up in a vise and mark a line across the edge for the tenon length. Then adjust a mortise gauge so that the gap between its pins equals the tenon thickness—typically one-third the thickness of the workpiece. Adjust the mortise gauge so that the tenon outline is centered between opposing faces of the workpiece. Hold the stock flush against the face of the workpiece as you guide the gauge along the surface, scribing the sides of the tenon outline in the wood (above).

### 2 Cutting the tenon cheeks

Make a tenon with the table saw by cutting the cheeks first, and then the shoulders. Install a tenoning jig on the table; the model shown slides in the miter slot. Protecting the stock with a wood pad, clamp the workpiece to the jig and raise the blade to the tenon length mark. Position the jig so that one of the cutting lines for the sides of the tenon is aligned with the blade. Feed the jig forward to make the cut (above). Turn off the saw, turn the workpiece around in the jig, and cut the other cheek.



## MORTISE-AND-TENON JOINTS



### 3 Sawing the tenon shoulders

Attach an extension to your miter gauge. Holding the edge of the workpiece against the extension, adjust the blade to the height of one of the cutting lines for the tenon cheeks. Align the tenon length mark with the blade, butt a stop block against the stock, and clamp it to the extension; cut a small notch from one corner of the block to prevent sawdust from accumulating between it and the board. Holding the workpiece flush against the extension and the stop block, use the miter gauge to feed the stock into the blade. Turn off the saw and remove the waste, then flip the workpiece over and repeat to cut the second shoulder (*left*). (**Caution:** Blade guard removed for clarity.)

### 4 Cutting the mortise

Reinstall the tenoning jig on the table. Outline the mortise the same way you marked the tenon (*step 1*) and clamp the workpiece to the jig. Raise the blade to the mortise depth mark and cut the sides of the mortise, using the same technique you used for the tenon cheeks (*right*). Once the sides have been cut, make as many passes as necessary to remove the waste between them.

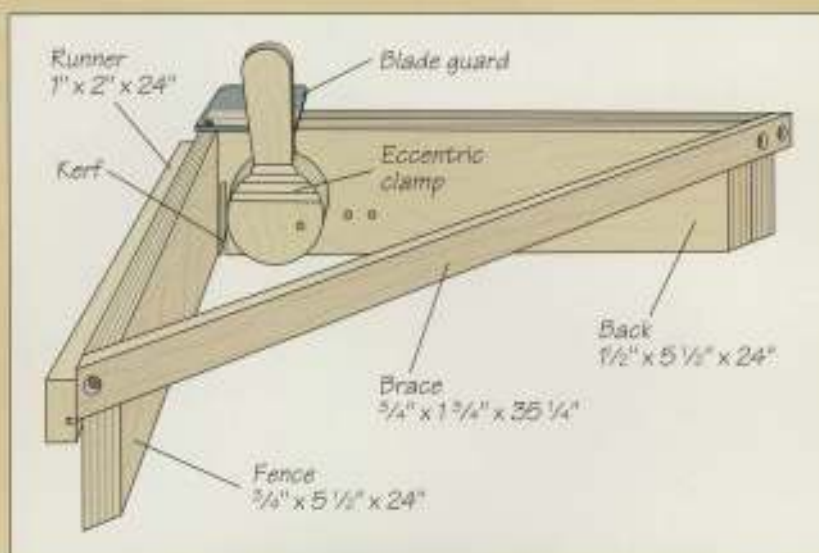


## BUILD IT YOURSELF

## A TABLE-SAW TENONING JIG

You can use the jig shown at right to cut both parts of an open mortise-and-tenon joint. Adapt the dimensions suggested in the illustration to customize the jig for your saw, if necessary.

Cut the jig fence and back from  $\frac{1}{4}$ -inch plywood and saw a 45° bevel at one end of each board; the pieces should be wider than the height of your saw's rip fence. Fasten two pieces together face-to-face to fashion the back, then use countersunk screws to attach the fence and back together in an L shape; make sure the fasteners will not be in the blade's path when you use the jig. Next, cut the brace from solid stock, bevel its ends, and attach it along the top edges of the fence and back, forming a triangle. Make the clamp by face gluing three pieces of  $\frac{3}{4}$ -inch plywood together and cutting the assembly into the shape shown. Use a hanger bolt, washer, and wing nut to attach



the clamp to the jig back, leaving a gap between the edge of the clamp and the fence equal to the thickness of the stock you will use. Offset the bolt so the clamp can pivot eccentrically. (You can drill additional holes in the jig back to enable you to shift

the clamp to accommodate different stock thicknesses.) Next, cut the runner from solid wood and attach it to the jig fence so that the jig runs smoothly across the table without wobbling. For some models, you will have to mill a groove down the length of the runner, as shown, to fit the rip fence. Finally, cut a piece of clear plastic as a blade guard and screw it to the jig back flush with its front face.

To use the jig, set it on the saw table in front of the blade with the runner and fence straddling the rip fence. Clamp the workpiece in the jig and position the rip fence to align the cutting mark on the workpiece with the blade. Feed the jig into the cutting edge. (Your first use of the jig will produce a kerf in the back.) Flip the workpiece around and repeat to cut the other cheek (*left*). (Refer to page 85 for instructions on making and using another style of jig that can cut open mortise-and-tenon joints.)





# BLIND MORTISE-AND-TENON JOINTS

*Completely hidden once assembled, the blind mortise-and-tenon is frequently used to join table legs to rails.*



## HAND-CUTTING A BLIND MORTISE-AND-TENON

### 1 Chopping the mortise

Clamp the workpiece to a work surface. Using a mortise chisel that is the same width as the mortise, make your first cut about  $\frac{1}{8}$  inch inside the mortise end mark. Hold the chisel vertically, with the bevel facing the waste, and strike it sharply with a wooden mallet so it penetrates about  $\frac{1}{8}$  inch. Make the second cut about  $\frac{1}{8}$  inch back from the first (*inset*), then tilt the chisel handle down and back to pry out the waste (*right*). Continue making cuts  $\frac{1}{8}$  inch apart, levering out the waste after each one. One-eighth inch from the other end of the mortise, turn the chisel around so the flat side faces the cutting line and begin a new series of cuts in the other direction. Continue to pass back and forth, cutting and clearing out waste until you reach the desired depth. Finally, pare away the waste remaining at each end of the mortise. Use a lock mortise chisel to smooth the bottom of the cavity.

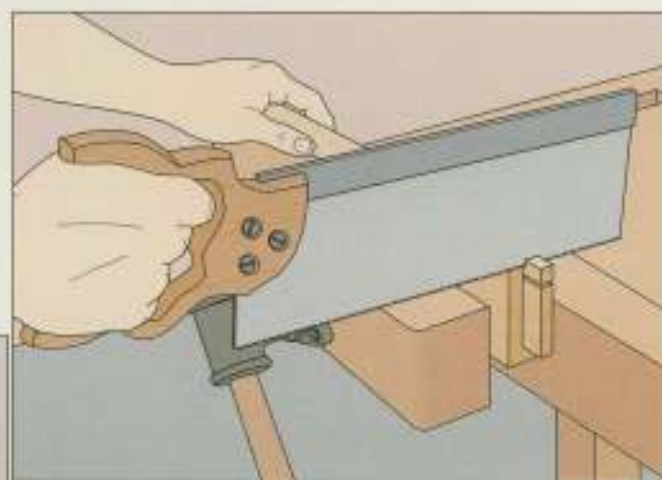
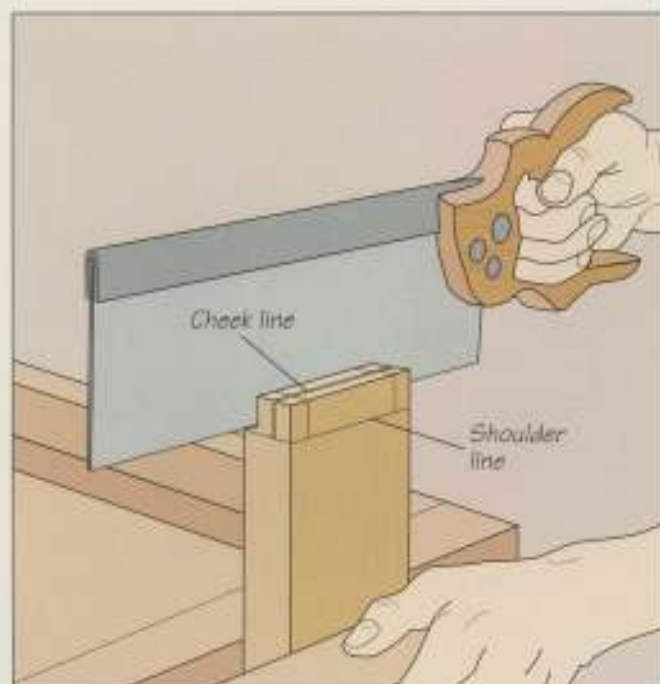




## MORTISE-AND-TENON JOINTS

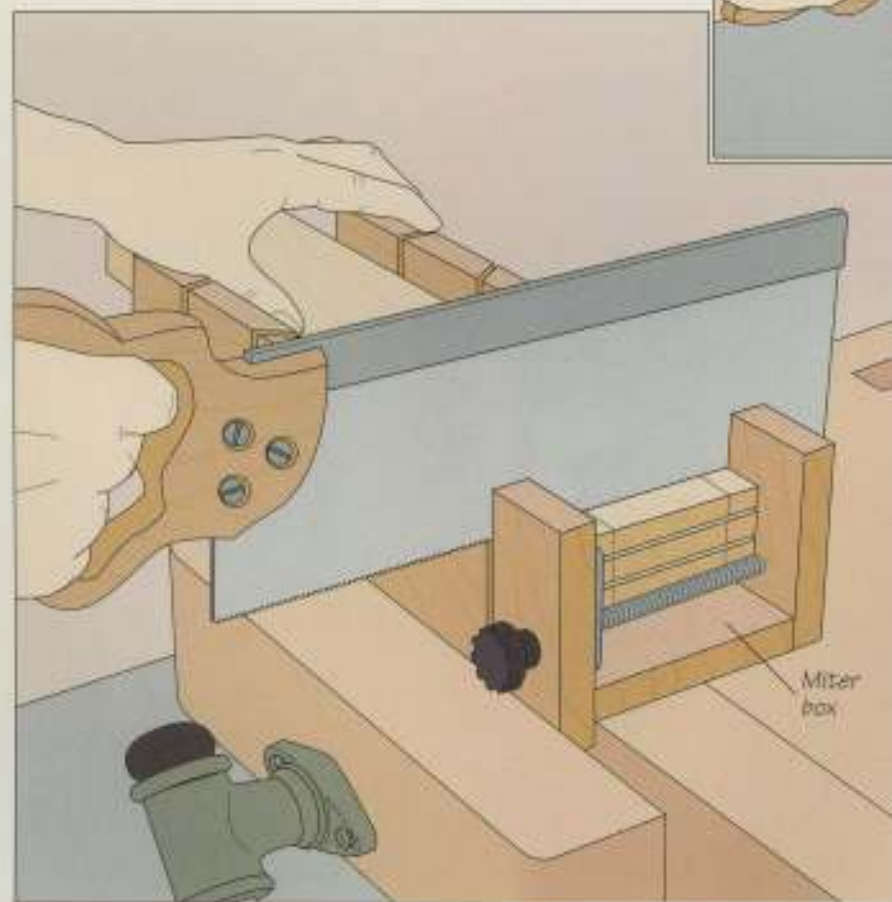
### 2 Cutting the tenon cheeks

Make a four-shouldered tenon by cutting the cheeks first, and then the shoulders. Mark a shoulder line all around the end of the workpiece and outline the cheeks with four lines that intersect on the board end. Secure the workpiece upright in a vise and cut down the cheek lines with a backsaw until you reach the shoulder line (*left*).



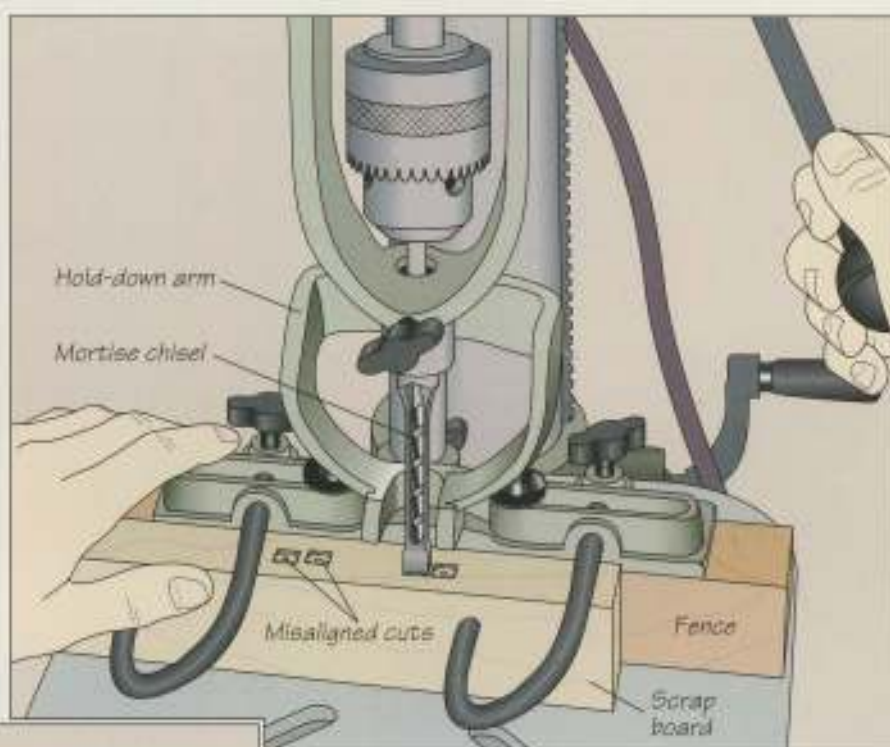
### 3 Sawing the tenon shoulders

To remove the waste from the tenon cheeks, clamp the workpiece in a miter box with the shoulder mark aligned with the 90° slot. Cut along the shoulder line on the face of the board (*left*); turn the workpiece over and repeat the cut on the other side. To cut away the waste on the edges of the tenon, secure the workpiece end-up in the vise and cut the sides of the tenon, stopping at the shoulder line. Then, with the piece edge-up in the vise, saw along the shoulder line to the tenon. Finally, turn the board over in the vise and repeat to saw away the waste on the tenon's other edge (*above*).



## CUTTING A MORTISE ON THE DRILL PRESS

**1 Setting up the mortising attachment**  
A mortising attachment consists of a drill bit surrounded by a four-sided hollow chisel that squares the hole cut by the bit. After installing the attachment on your drill press, check whether the mortise chisel will be centered on the workpiece by securing a scrap board the same width and thickness as the workpiece to the mortising attachment fence. Bore a shallow cut into the board, then turn the board around end-for-end and make a second cut next to the first. The cuts should be aligned. If not, shift the fence by one-half the amount that the cuts are misaligned and repeat the test (right). (In this illustration, the hold-down arm is raised for clarity.)



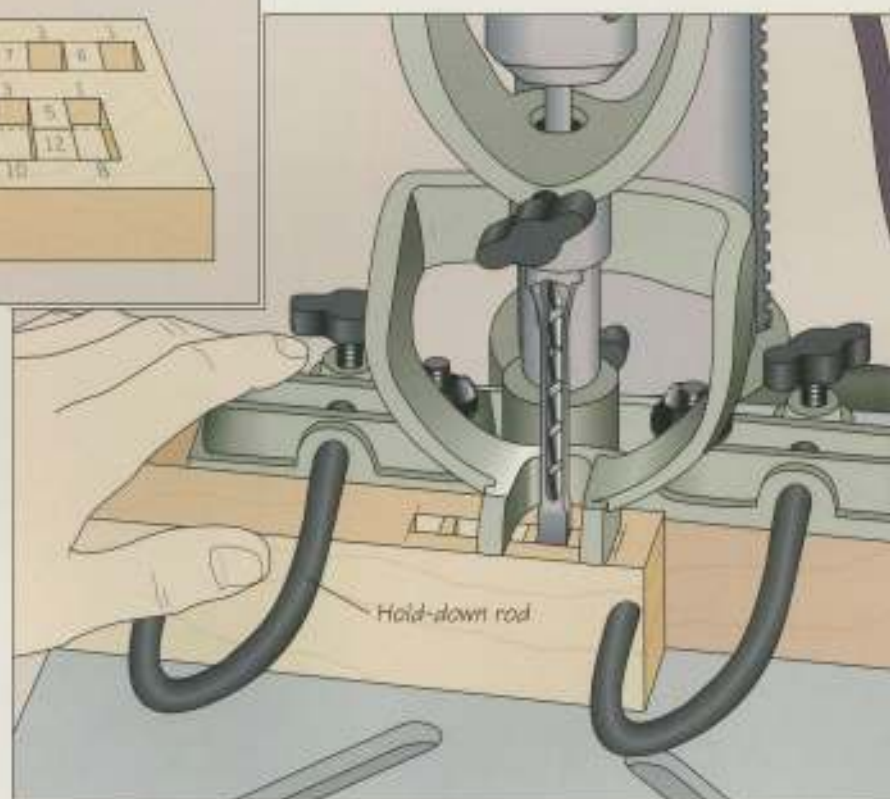
## SEQUENCE OF CUTS

Narrow mortise

Wide mortise



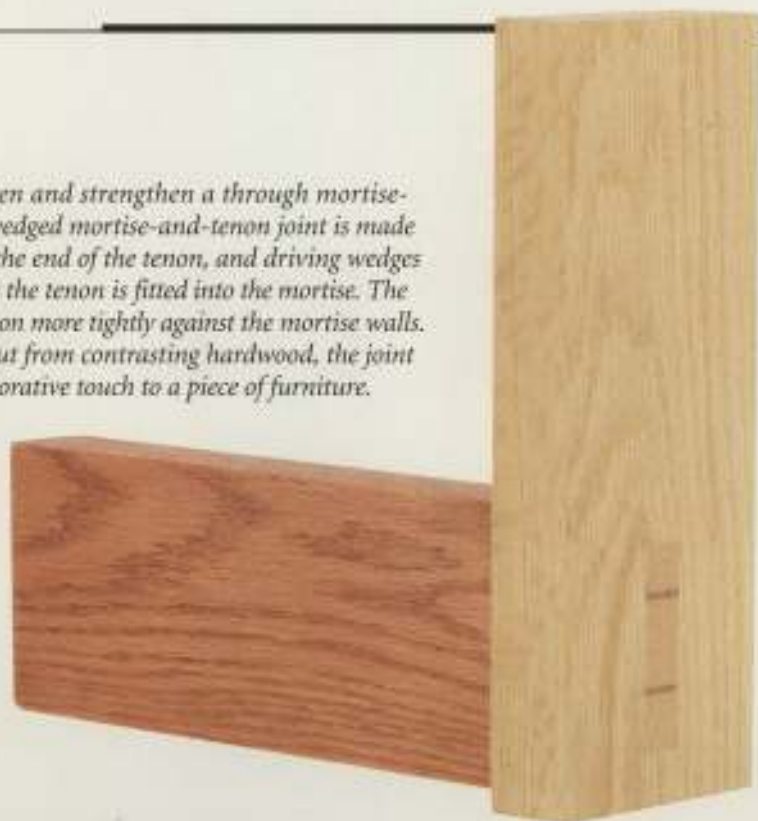
**2 Drilling the mortise**  
Set the drilling depth to the mortise depth and secure the workpiece to the fence, centering the mortise outline under the chisel. Adjust the hold-down arm and rods so the stock can slide freely along the fence. Make a cut at each end of the outline, then a series of staggered cuts, following the sequence shown above to complete the mortise. Mark a single row of cuts if you are using a chisel equal in width to the mortise, or two parallel rows if the mortise is too wide to be cut in a single pass.



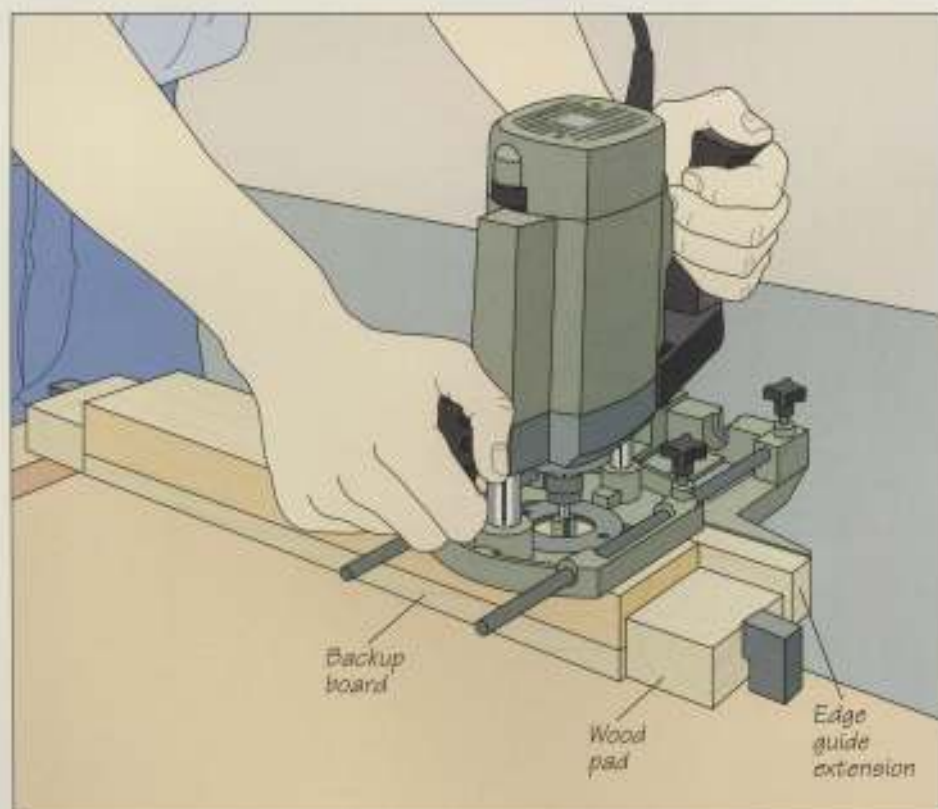


# WEDGED THROUGH MORTISE-AND-TENON JOINTS

*Wedges can tighten and strengthen a through mortise-and-tenon. The wedged mortise-and-tenon joint is made by cutting slots in the end of the tenon, and driving wedges into the cuts after the tenon is fitted into the mortise. The wedges push the tenon more tightly against the mortise walls. By using wedges cut from contrasting hardwood, the joint can lend a decorative touch to a piece of furniture.*



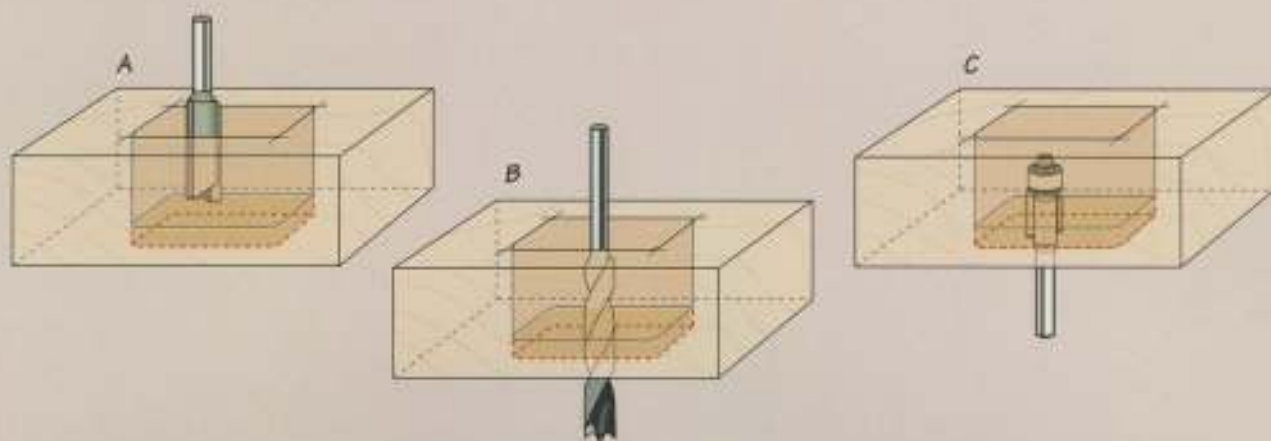
## MAKING A WEDGED THROUGH MORTISE-AND-TENON



### 1 Routing out the mortise

Secure the workpiece between two bench dogs, using wood pads to protect the stock. Since you will be cutting a through mortise, place a backup board under the workpiece to protect your benchtop. Fit a plunge router with a straight bit the same diameter as the width of the mortise, then set the depth of cut. As this is typically a deep cut, several passes will be necessary. Attach a wooden extension to the fence of a commercial edge guide to increase its bearing surface, then fasten the guide to the router base plate. Center the bit over the mortise outline and adjust the extension so it rests flush against the workpiece. Holding the router firmly, plunge the bit into the stock at one end of the mortise outline, then feed the bit to the other end. When the mortise is cut to the full depth, square its corners with a chisel.

## ROUTING DEEP THROUGH MORTISES

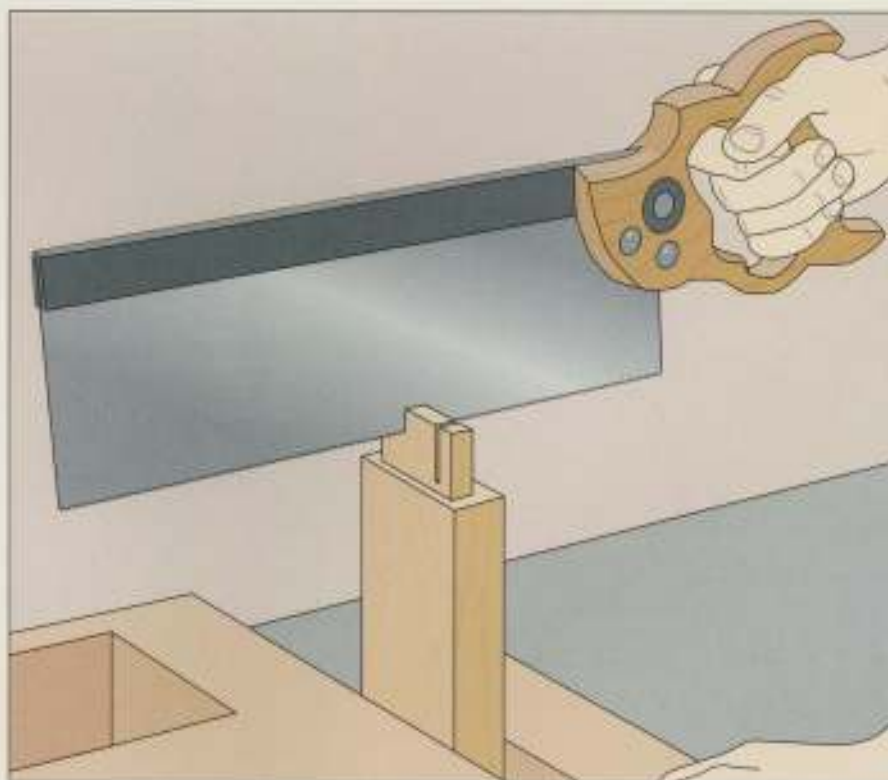


If the desired depth of a mortise exceeds your router's maximum depth of cut, use an electric drill to help complete the cavity. The illustration above shows the three steps necessary to cut a deep through mortise. Start by installing a mortising bit in the router and making as many passes as you can until you can go no deeper (A). Then use the drill with a bit that is larger than your router bit

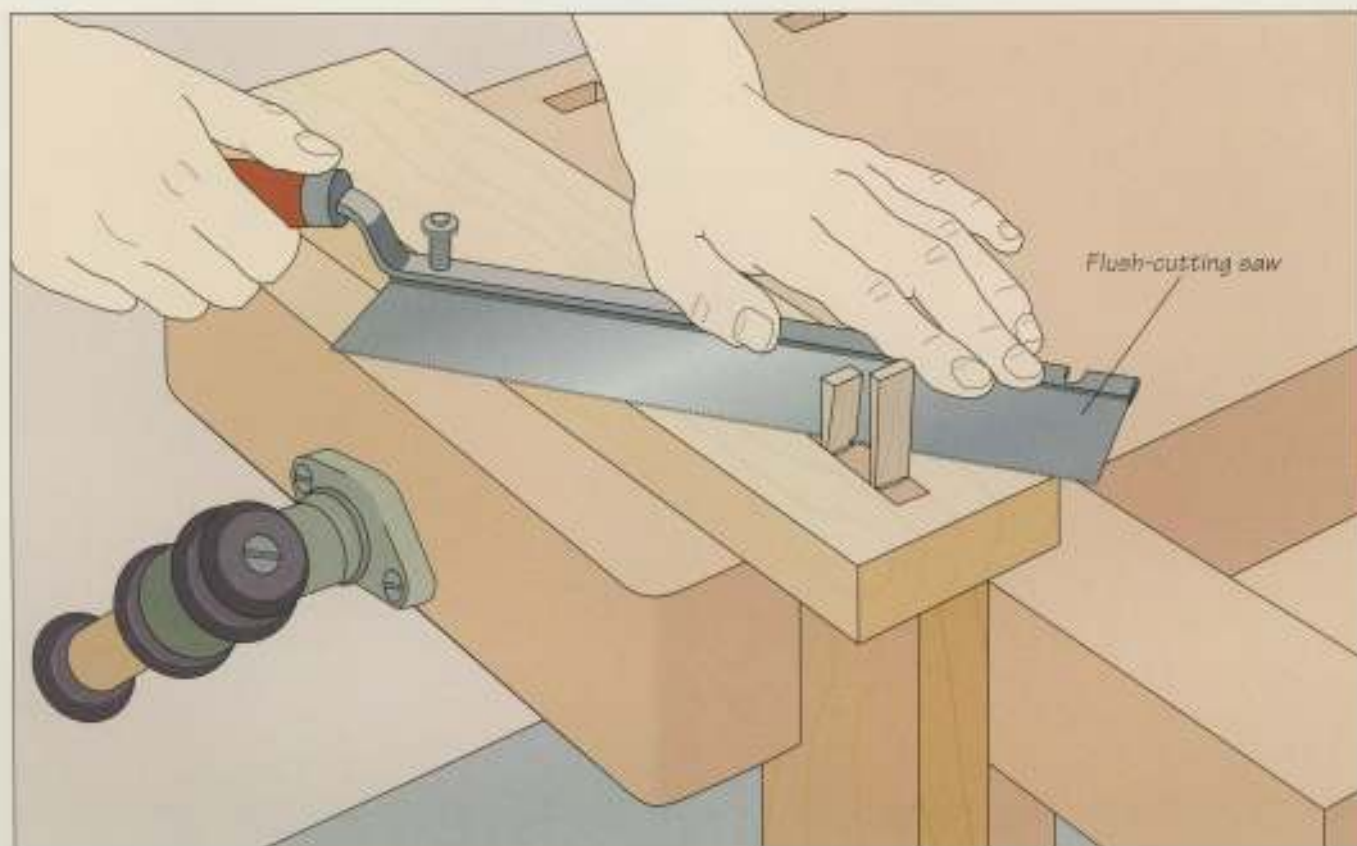
to bore a hole through the remaining waste (B). Install a piloted flush-trimming bit in the router and turn the workpiece over. Inserting the bit through the hole made by the drill, rout out the waste (C); throughout this part of the operation, keep the pilot bearing pressed against the walls of the mortise to complete the cut. Use a chisel to square the mortise corners.

## 2 Sawing the slots in the tenon

Cut a four-shouldered tenon (page 95), making sure the tenon is long enough to pass completely through the mating piece. Clamp the stock upright in a vise and use a backsaw to cut two kerfs into the end of the tenon (*right*), stopping  $\frac{1}{4}$  inch short of the shoulder; space the kerfs in from each edge of the tenon a distance roughly equal to the thickness of the tenon.







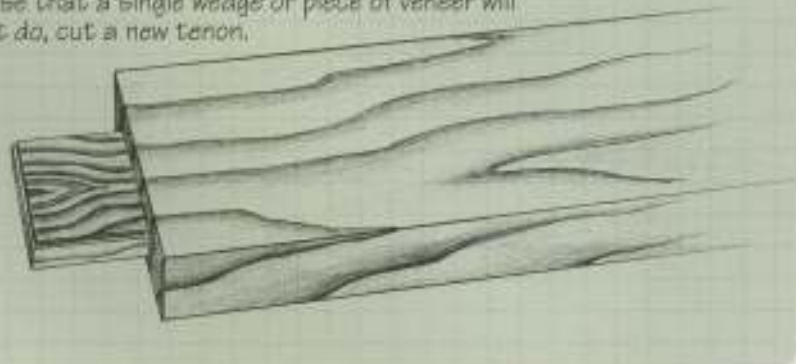
Flush-cutting saw



## SHOP TIP

### Tightening up a loose tenon

Use a strip of veneer to snug up a loose mortise-and-tenon joint. Before gluing up the joint, cut the veneer to the same length and width as the tenon. Assemble the joint with the veneer wedged in between the tenon and the mortise, or kerf the tenon along its length and insert a wedge as described above. If a tenon is so loose that a single wedge or piece of veneer will not do, cut a new tenon.



## 3 Inserting the wedges

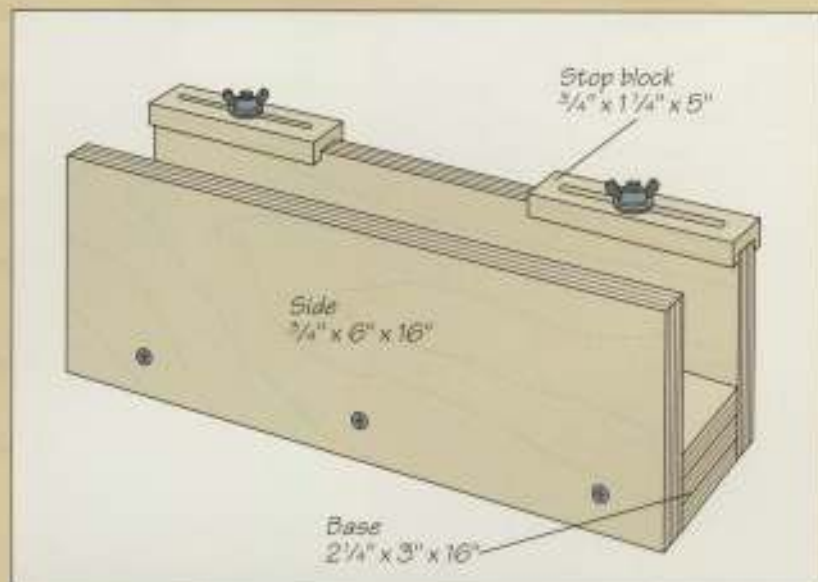
Saw two hardwood wedges to fit into the slots cut in step 2; make them as wide as the tenon, but a few inches longer, and no thicker than  $\frac{1}{4}$  inch at the broad end. Glue up the joint, then secure the pieces in a vise with the end of the tenon facing up. Apply some glue to the wedges and use a mallet to drive them into the kerfs as far as they will go; tap the wedges alternately to keep them equal. Once the glue has dried, use a flush-cutting saw to trim the wedges even with the end of the tenon (above), then sand the surface smooth.

### BUILD IT YOURSELF

#### A MORTISING JIG FOR THE ROUTER

Use the jig shown at right to secure the workpiece and guide your router as you cut a mortise. The dimensions suggested in the illustration will suit most routers. Cut the jig base and sides from  $\frac{3}{4}$ -inch plywood. Fasten three pieces together for the base. Attach the sides to the base with countersunk screws, making sure the pieces are perfectly square to each other. Fashion each stop block from solid wood, rout a groove in one face  $\frac{1}{8}$  inch deep and  $\frac{1}{4}$  inch wide, then cut a 4-inch-long slot to accept a  $\frac{1}{4}$ -inch hanger bolt. Mount the bolts 3 inches from each end of one side, slip the stop blocks in place and fix them with washers and wing nuts.

To use the jig, set the workpiece on the base with the mortise outline between the stop blocks and one surface flush against the side with the blocks. Place a shim under the stock so its top surface is butted against the blocks, then clamp the workpiece to the jig and secure the jig in a vise. To set up the router for the cut, install a straight bit the same diameter as the width of the mortise, set the depth of cut and attach a commercial edge guide to the base plate, center the bit over the mortise outline and adjust the guide so it rests flush against the opposite side of the jig. Adjust each stop block by aligning the bit with the end of the mortise outline, butting the block against the router's base plate and tightening the wing nut. After confirming the position of the blocks and edge guide, grip the router firmly, butt the edge guide against the



jig, press the base plate against one stop block and plunge the bit into the work. Hold the edge guide against

the jig as you draw the router through the cut until it contacts the other stop block (below).

