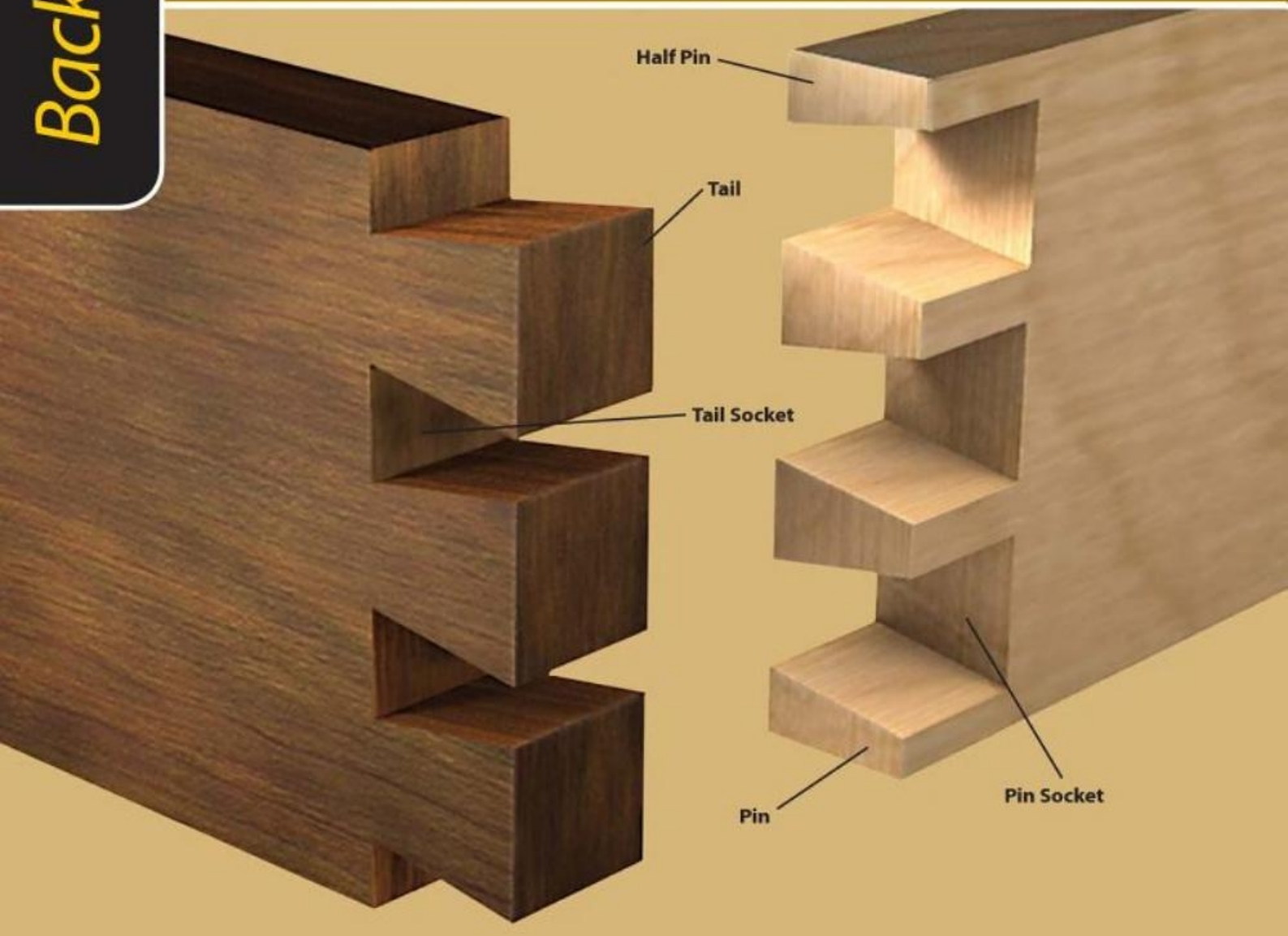
Back to Basics

Woodworker's Guide to Joinery



Straight Talk for Today's Woodworker

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Contents

What You Can Learn

Joinery Basics, p. 12

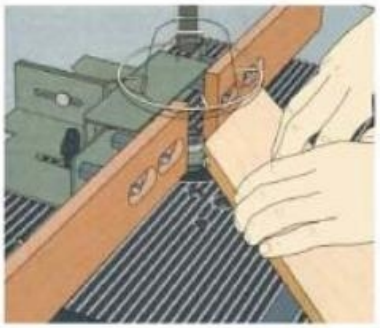
Whether it is a simple tabletop or an ornate chest, joinery will establish its worth: Strong joints will give it longevity, and their design and craftsmanship will enhance its beauty.

Butt Joints, p. 22

Affixing the edge, end or face of one board to that of another may not always produce the strongest joint but it is an excellent option for dozens of woodworking tasks.

Miter Joints, p. 48

Miter joints are preferred for their clean lines and offer more gluing area than ordinary butt joints.



Lap and Groove Joints, p. 66

This is a versatile family of joints, with the added virtue of being strong and simple.

Mortise-and-Tenon Joints, p. 116

One of the oldest methods of fastening wood, these joints offer virtually unparalleled resistance to most of the stresses that wood joints endure. Mortise-and-tenon joints make frames, doors, tables, and chairs.

Dovetail and Box Joints, p. 154

The interlocking pins and tails of the dovetail offer a practical solution to a construction problem. Dovetail and box joints make strong boxes, cabinets, and drawers.

Jigs and Joints

As a young boy, the best toys that I possessed were—in order—Tinker Toys, Lincoln Logs, an Erector set, and American Flyer electric trains. These toys prepared me for an adulthood in which I am not afraid to tackle complex mechanical problems.

As most of my power tools are older models (my table saw is a 1940s Sears that I inherited from my wife's grandfather), I must get as much accuracy as I can from my various jigs and attachments. Over the years I have found that, with a bit of time and patience, you can adjust and fine-tune many older tools and make them perform almost as well as the day they left the factory. I get a certain satisfaction out of restoring these auction and garage sale bargains to usable items.

I take delight in applying one technology to another discipline. The home-made tenoning jig in the photo, for example, works much like the cross feed on a metal lathe. It slides back and forth on ways made of walnut and features a feed screw that indexes movement to 1/64 inch. With a little thought and extra care in the finish, these jigs can become heirloom-quality and be passed down through a family with pride. I would even suggest that you sign and date your better jigs.

I find that when I am in my shop trying to figure out a problem or a better way to build a jig, my creative juices get going and time seems to fly by. Before I know it, the evening is over—and I've missed the final baseball scores on the radio.

- Lyle Kruger

Lyle Kruger is a professional land surveyor from Effingham, Illinois, who enjoys building full-scale wooden replicas of antique survey instruments.

Joinery and the Router

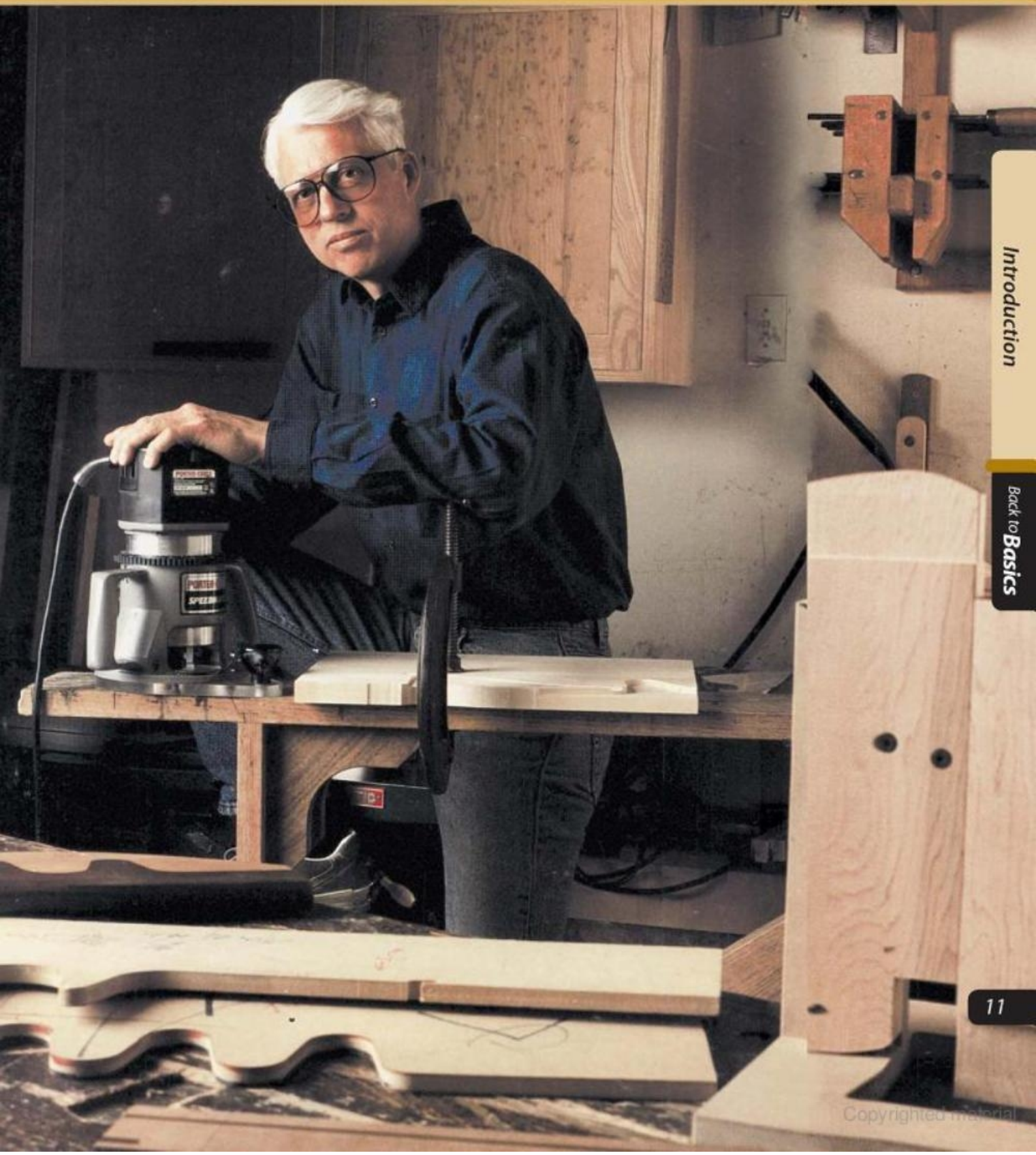
I am a designer-craftsman of contemporary furniture and cabinets. I use hardwood lumber for nearly everything I make. There are, however, occasions when I must use plywood or fiberboard, such as in drawer bottoms, door panels, or cabinet backs. While they are often essential, I don't find these materials as enjoyable to work as solid lumber, since the wood joinery methods I often use cannot be applied to them. Plywood is glued up in layers that lie in so many different planes that it cannot achieve the structure of solid wood. Solid lumber, on the other hand, consists of cells that are distinctly oriented—like a bundle of straws. This long-axis architecture, in my view, allows many joinery possibilities. No matter how complex the piece of furniture, there is always a means of joining the pieces together.

I find the electric router very handy for joinery because of its ability to accept a wide variety of jigs, fixtures, and accessories. Whether the tool is guided by a piloted cutter, an edge guide, a template collar or sub-base, or secured in a table, the router provides the kind of control that makes it ideally useful for joinery. No other single power tool can produce the same range of joints, including tongues, grooves, rabbets, tenons, mortises, dadoes, dovetails, laps, notches, fingers, and keys. Complementary template joinery—or joinery along curved lines—can only be done with a router. The tool can also be used to make the precision templates required for the process.

Because it is so useful a tool, I have collected 18 different routers. They can be coupled with any number of accessories, jigs, and cutters to expand their joint-making capabilities. Fortunately, this is usually quite simple and inexpensive. Most router jigs are easy to make and use.

- Pat Warner

Pat Warner makes contemporary furniture in Escondido, California, and works as a consultant for the router and tool bit industry.



Joinery Basics

Joinery, the foundation of wood-working, is a subtle blend of art and engineering. Whether the product is a simple tabletop or an ornate chest, its joinery will establish its worth: Strong joints will give it longevity, and their design and craftsmanship will enhance its beauty.

The need for jointmaking derives from the fact that woodworkers make demands that nature never intended. Interlocking curves of fiber link a branch to the tree trunk, while a leg is attached to a table at an abrupt 90° intersection. Thus, although a properly glued joint is stronger than wood fiber, that bond alone is seldom able to withstand the forces exerted on tables, chairs, cabinets, and doors during normal use.

Most joints need some sort of mechanical aid—a reinforcement designed to meet the stresses head-on. From that need springs the craft of joinery.

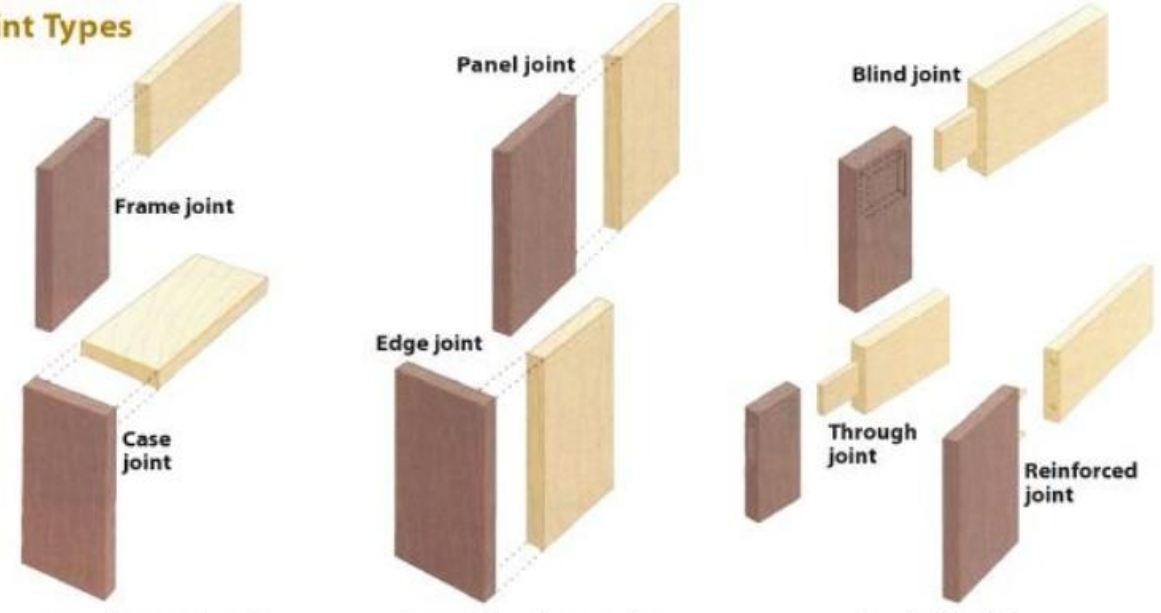
The simplest supports are nails, screws, splines, biscuits, and dowels. These require simply cutting a hole and adding wood or metal to the intersection of the pieces. Often, this is enough to satisfy structural and esthetic needs.

Sometimes—most often when furniture is involved—greater strength and beauty are called for. The solution then is to cut the intersecting pieces so that the gluing area is increased or they form an interlocking bond.

The blind and through mortise-and-tenon joints shown below at right improve the strength of a right-angle joint and increase the long-grain gluing area. The blind version also partially conceals the joint; the through version, in which the tenon passes through the mating workpiece, can be tightened by the addition of small wedges.

In addition to lending mechanical strength and gluing area to a connection, joinery must also allow for movement: swelling and shrinkage as wood absorbs and releases moisture. The best joinery relates all three needs.

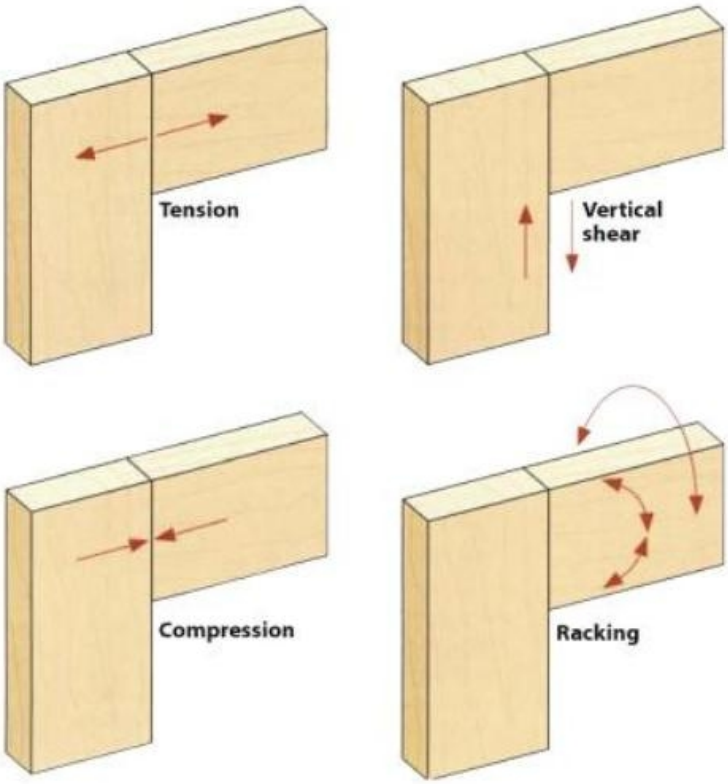
Basic Joint Types



The laminate trimmer shown at left routs out the waste between the pins of a half- blind dovetail joint. With its offset base, the trimmer allows a user to focus all downward pressure on the work surface, which helps prevent the tool from wobbling. The base rides along an edge guide, ensuring that the depth of the sockets remains uniform across the board.

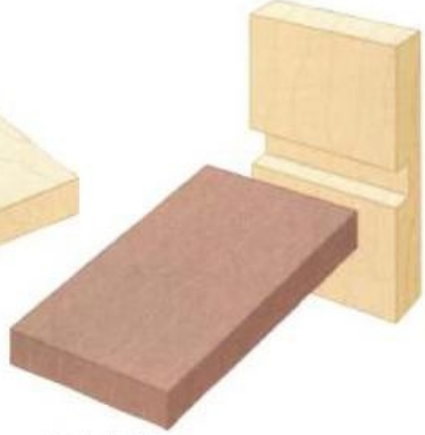
Types of Stress

Recognizing the stresses on joints
The illustration at right shows the four basic types of forces that affect joints: compression, tension, vertical shear, and racking. Compression forces a joint together, while tension pulls it apart. A typical example of tension is an overloaded shelf joined to a carcase with dado joints; the weight on the shelf will tend to pull the shelf out of the dadoes. Vertical shear occurs when the two halves of a joint slide against each other, common with butt joints. Racking, characterized by twisting and bending, is the toughest stress for a joint to endure.



Improving a Joint's Resistance to Stress

Tongue-and-groove joint
Simple, unreinforced butt joints resist compression only; they provide poor resistance to tension, shear, and racking. Replacing an edge butt with a tongue-and-groove joint makes it much more stress-resistant



Dado joint
A simple dado joint resists compression, shear, and racking, but tension can pull it apart

Stopped sliding dovetail joint
Fixing a shelf to a carcase side with a stopped sliding dovetail allows the joint to resist tension as well as compression, shear, and racking

Wood Movement

Scientists describe wood as a hygroscopic material—that is, it absorbs moisture. Long after a tree has been felled and its wood milled and made into furniture, the fibrous cells absorb and release moisture, mirroring the humidity of the surrounding air.

The consequences for the woodworker can be serious: Wood swells as it absorbs moisture and shrinks as it expels it, causing motion that accounts for most failed joints, wobbly chairs, sticking doors, and split picture frames.

Although wood movement is unavoidable, such consequences are not: An understanding of wood's characteristics will enable you to accommodate this swelling and contraction and produce joinery that is both durable and stable.

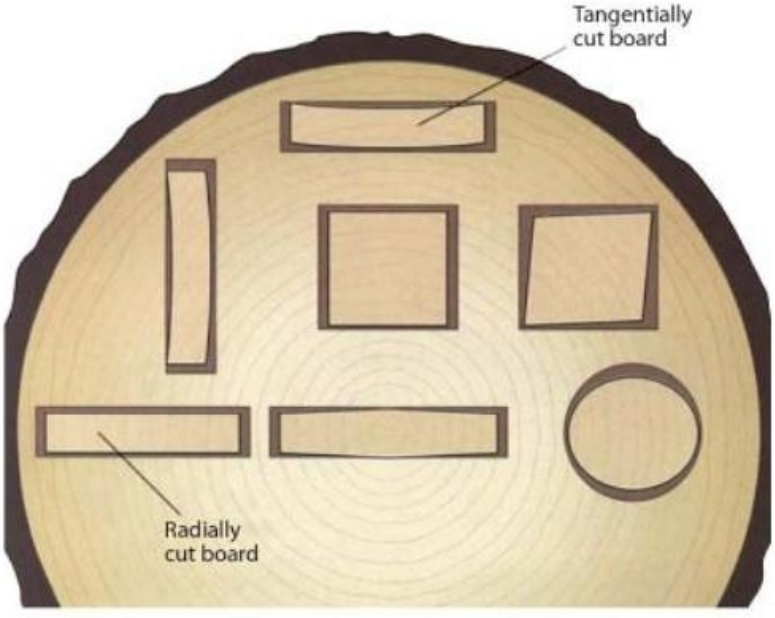
The wood of most species is characterized by growth rings, which are concentric bands perpendicular to the axis of the trunk. The manner in which the rings are exposed on a wood surface can help you anticipate how the piece will react to humidity changes. As the illustration below shows, there is more swelling and shrinkage along the growth rings than across them. The way lumber is cut from a log has a crucial effect on how much the wood will shrink and which dimension—length, width, or thickness—will be most affected.

Any piece of wood provides three views of the annual growth rings. The transverse section—or cross section—lies at right angles to the grain and is visible in the end grain of stock. The tangential and radial sections are at right angles to the transverse section. Being able to distinguish the different views of the rings on a workpiece can help you compensate for wood movement in your joinery.

Growth Rings and Movement

Anticipating wood movement

Lumber does not shrink uniformly. Tangential shrinkage—parallel to the annual growth rings—is almost twice the radial shrinkage, which occurs across the rings. This difference accounts for the warping of boards and panels as wood contracts and expands with fluctuations in moisture content. Radially cut boards, also known as quartersawn, are more dimensionally stable than tangentially cut, or plain-sawn boards because they shrink and swell less across their width. Plain-sawn boards tend to cup at the edges. Greater tangential than radial shrinkage can cause square boards to become diamond shaped and cylindrical ones to become oval, as shown by the pieces on the right-hand side of the illustration.



Logs are sawn in two basic ways, with many variations. The most common system, called plain-sawing, slices the log tangent to the growth rings. The other method, less commonly used, is called quartersawing or edge-grain sawing. It takes slices at right angles to the growth rings. Although the techniques used in each system are very different, each will produce some boards with characteristics of the other. For example, plain-sawing through the center of a log produces a piece of stock that looks much like a quarter-sawn board.

Quartersawn boards have their annual growth rings perpendicular to the face. This orientation of the growth rings accounts for the superior dimensional stability of quartersawn boards. Wood shrinks and expands roughly twice as much tangentially to the rings as its does radially. When quartersawn boards swell or shrink they do so mostly in thickness, which is minimal, whereas a plain-sawn board changes across its width. A table made from plain-sawn pine boards, for example, can change as much as 1 inch in width; a similar table made from quartersawn boards would only swell or shrink by one-quarter as much or less, depending on the species.

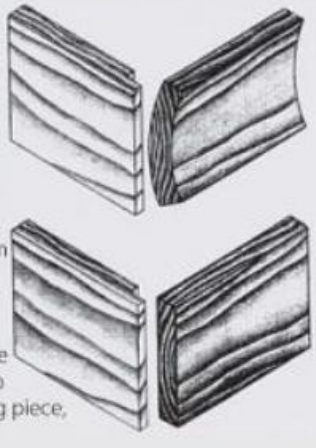
Although you may not be able to control the environment where your furniture will be used, you can make your joinery choices to compensate for wood movement. Orient the growth rings in the mating pieces of a joint so that they move together. For example, the rings of the two parts of a corner joint should be parallel to each other so that they shrink or swell in tandem. When the rings of the pieces meet at right angles, as in a mortise-and-tenon joint, make sure their tangential surfaces are aligned.

Workpieces that feature irregular grain require particular attention. A square chair leg with growth rings that run diagonally through it when viewed in cross section, for example, will eventually lose its square shape and become a diamond shape, pulling the chair frame out of square with it.

The annual growth rings in the plain-sawn oak board *(top)* appear on the face as an elliptical landscape figure. Plain-sawn stock is sliced tangent to the rings. The growth rings in the quartersawn oak board *(bottom)* appear as lines perpendicular to the face.

Shop Tip

The importance of grain alignment



A drawer glued up from plain-sawn boards illustrates how grain alignment can make or break a joint. By aligning the boards so that the annual growth rings curve inward *(top)*, the joint may separate at the top and bottom when the front cups as it dries. If the boards are aligned so that the annual rings curve outward *(bottom)*, drying of the wood will tend to push the top and bottom toward the mating piece, keeping the joint together.

Form and Function

Selecting the joinery for a project involves both structural and esthetic considerations. The curved through dovetail *(above)* blends strength and attractiveness for drawers that will be the highlight of a piece. The utilitarian dado joint *(right)* is a good choice to anchor the shelving in a modern cabinet.

Ideally, joinery should achieve a balance between form and function. Each joint must complement the overall design of a piece while resisting the stresses to which it will be subjected.

The choice of a joint will often be dictated by its function and location. Carcase corners can be joined with a host of joinery methods, but a carcase that is more likely to be visible, such as a drawer, will benefit from a visually pleasing joint like a half-blind dovetail or box joint. For other project components, the options are more limited. A frame-and-panel door, for example, may call for either blind or haunched mortise-and-tenons, while a chair with round rungs should ideally be assembled with round mortise-and-tenons.

The wood you choose will also have a bearing on your options. The chart on page 18 lists the various joints shown in this book and rates their utility with solid wood, plywood, and particle-board. A joint like the frame butt, for example, can be used with any material, but only if the connection is reinforced. (As a rule of thumb, any joint involving end grain must be reinforced in some way.) The dovetail, while it requires no reinforcement, is only appropriate with solid wood.

If you are unsure about which joint to select for a given application, choose the simplest one, particularly if it will be hidden.

Joinery Tips

- Avoid working with freshly cut lumber, as it will shrink after the joint is assembled. Use wood that has dried to a moisture content approximating the level of the environment in which the finished piece will be used.
- When designing a piece of furniture that will bear a heavy load, use larger joints or joints with larger structural members, such as twin mortise-and-tenons. This will distribute the load over a wider area and reduce stress on the joint.
- Make sure the elements of a joint are properly proportioned. If a tenon in a mortise-and-tenon joint is too thick, the mortise member will be weakened.
- When arranging the mating boards of a joint, always take into account the grain direction of the elements, and orient the pieces to compensate for wood movement.
- Cut the elements of a joint parallel to the grain. A tenon cut across the grain, for example, will not withstand shear and racking stress.
- For some joints, such as dovetails, use the completed part of the joint (the pins) to lay out the mating part (the tails) to reduce inaccuracies.
- If a joint requires reinforcement, use glue along with fasteners, dowels, biscuits, or splines.

Appropriate Joints for Wood Types

Type of Joint	Solid Wood	Plywood	Particleboard
Butt joints *(page 22)*			
Frame and case butt	Excellent (reinforce)	Good (reinforce)	Fair (reinforce)
Panel butt	Excellent	Poor	Poor
Edge butt	Excellent	Good (reinforce)	Fair (reinforce)
Face-to-face butt	Excellent	Excellent	Excellent
Scarf joint and pocket holes	Good (reinforce)	Not used	Not used
Butterfly joint	Excellent	Not used	Not used
Miter joints *(page 48)*			
Face miter	Good (reinforce)	Good (reinforce)	Good (reinforce)
Edge miter	Excellent (reinforce)	Good (reinforce)	Good (reinforce)
End miter	Good (reinforce)	Fair (reinforce)	Fair (reinforce)
Miter-and-spline	Excellent	Fair	Fair
Feather-spline	Fair	Poor	Poor
Coped joint	Good (reinforce)	Not used	Not used
Lap joints *(page 66)*			
Full lap, Half laps: T, mitered, dovetailed, keyed dovetail, angled, cross, edge, half-blind, corner, glazing bar	Excellent (reinforce)	Fair	Fair
Rabbet joints *(page 80)*			
Rabbet, shiplap, stopped rabbet, mitered rabbet, double rabbet, dovetail rabbet	Good	Fair	Fair
Tongue-and-groove joints *(page 89)*			
Through tongue-and-groove, blind tongue-and-groove, glue joint	Excellent	Fair	Fair
Dado joints *(page 100)*			
Through, blind, and stopped dado	Good	Good	Fair
Dado-and-rabbet, tongue-and-dado, double dado	Good	Fair	Fair
Lock miter	Excellent	Good	Fair
Sliding dovetail, sliding half-dovetail, stopped sliding half-dovetail	Excellent	Not used	Not used
Mortise-and-tenon joints *(page 116)*			
Blind, haunched, angled, loose, round, twin, through, wedged through, pegged through, tusk, open	Excellent	Not used	Not used
Dovetail joints *(page 154)*			
Through, blind, half-blind, curved through, outlined through, box joint, half-blind box joint, finger joint	Excellent	Not used	Not used

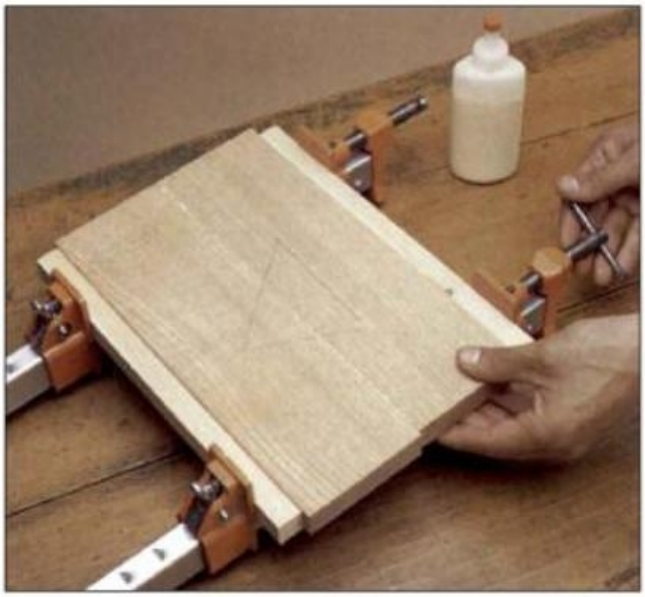
Bonding Wood

Proper bonding of mating surfaces can be achieved in three steps: preparing the surface meticulously, applying the right type and amount of adhesive, and proper clamping.

First, the mating surfaces of a joint must be made as flat and smooth as possible with a jointer or hand plane. Rough surfaces have hundreds of tiny air pockets that can cause uneven gluing. Surfaces should also be clean; oil, sawdust, grease, and dirt can weaken a glue bond. Some oily woods, such as teak and rosewood, have extractives that inhibit the gluing process, but planing or jointing these woods just before glue-up removes most of the residue from the surfaces.

While glues made from organic materials such as fish glue and hide glue have been in use for centuries, most modern adhesives are derived from synthetic compounds. Glues such as resorcinol and epoxy cure by chemical reaction, while yellow and white glue cure by evaporation of the solvent they contain. Most glues seep into the wood, locking the wood fibers together and creating a bond that is stronger than the wood itself. To select the proper adhesive for your joinery tasks, see the chart on page 20.

When applying glue, spread it evenly over both mating surfaces of the joint; it is better to apply a thin coat to both surfaces than a heavy coat to one. Avoid spreading glue with your fingers; a set of stiff-bristled brushes of different sizes can handle most gluing tasks. Some other applicators are shown below.



Over-tightening the clamps on a glue joint can squeeze out all the adhesive, resulting in a "starved" joint. Apply a thin, even layer of glue on the mating surfaces and stop tightening when a small bead of adhesive squeezes out of the joint.

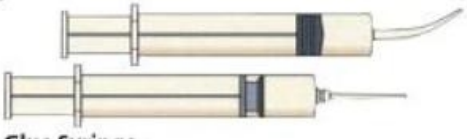
Joints should be clamped immediately after the adhesive is applied; position your clamps carefully to avoid cupping or bowing of the workpieces. Clamping presses the glue into a uniform thin film between the mating surfaces, while holding the pieces until curing takes place.

Gluing Accessories

Glue brush
Long handle make brush ideal for delicate work; to prevent rust stains, linen-wound ferrule has no metal parts

Putty knife
For scraping away excess glue. Plastic type less likely to mar wood

Printer's brayer
Rubber roller evenly spreads a thin film of glue over a wide area; can be cleaned by repeatedly rolling it over a scrap board



Glue Syringe
For applying glue in awkward places; available with flexible or curved tip which can be cut back for faster flow

Plate joiner glue applicator
Holds glue bottle upside-down so that adhesive remains near tip, keeping it ready for application; nozzle is shaped to spread glue evenly on sides of slots cut by plate joiner

Joinery Adhesives

Type	Characteristics	Uses
White glue	Polyvinyl-acetate based; not toxic or flammable • Strong bonding; working time 3 to 5 minutes • Setting time about 30 to 45 minutes; cures fully in 24 to 72 hours • Dries clear and colorless • Does not sand as well as yellow glue	General woodworking
Yellow glue	Aliphatic-resin based; not toxic or flammable • Better immediate adhesion for faster grab than white glue; working time 3 to 5 minutes • Setting time about 30 to 40 minutes; cures fully in 24 to 72 hours • Dries opaque (faded yellow); more heat-resistant for better sanding properties than white glue	General woodworking
Epoxy glue	Resin and hardener must be mixed prior to use; not flammable but may be toxic • Strong, waterproof bonding; working time 5 minutes to 2 hours (depending on type) • Setting time 5 minutes to 2 hours (depending on type); cures fully in 24 hours	Bonding acidic woods such as oak; use on exotic woods that bond poorly with other glues
Fish glue	Protein-based; not toxic or flammable • Average bonding; working time 60 to 90 minutes • Setting and curing time 12 hours • Sandable, dries an opaque color, resists solvents • Not water-resistant: Glue bond can be softened with water for disassembly	Furniture construction, luthier work, antique restoration and tasks that require a long working time
Hide glue	Protein-based; available in granular or liquid form; not toxic or flammable • Strong bonding, working time 3–5 minutes • Setting time 1 hour; cures fully in 24 hours • Sandable, dries a dark color • Not water-resistant, glue bond can be softened with water for disassembly	Cabinet construction, antique restoration, veneering, and fine woodworking
Casein glue	Milk-based, comes in powdered form; not toxic or flammable • Average bonding; working time 15 to 20 minutes • Setting time 15 to 20 minutes, cures fully in 8 to 12 hours • High resistance to water, dries an opaque color, sands cleanly, stains acidic woods	Oily woods that bond poorly with other glues, such as teak, yew, and lemonwood; laminating
Plastic resin	Urea-formaldehyde-based, available in powdered form; not flammable but toxic • Strong bonding, working time 20 minutes • Setting time 4 to 6 hours; cures fully in 3 days • Water resistance higher than that of aliphatic glues, does not stain acidic woods, sands cleanly	Veneering, laminating, and edge-gluing hardwood

Removing Excess Glue

Scraping away adhesive

Once all your clamps have been tightened, use a putty knife to remove as much of the squeezed-out glue as possible after it sets but before it cures. The moisture from adhesive left on the surface will be absorbed by the wood, causing swelling and slowing drying time; hardened glue can also clog sandpaper, dull planer knives, and repel wood stain. Once the adhesive has dried, use a paint scraper to remove any squeeze-out that remains *(left)*.

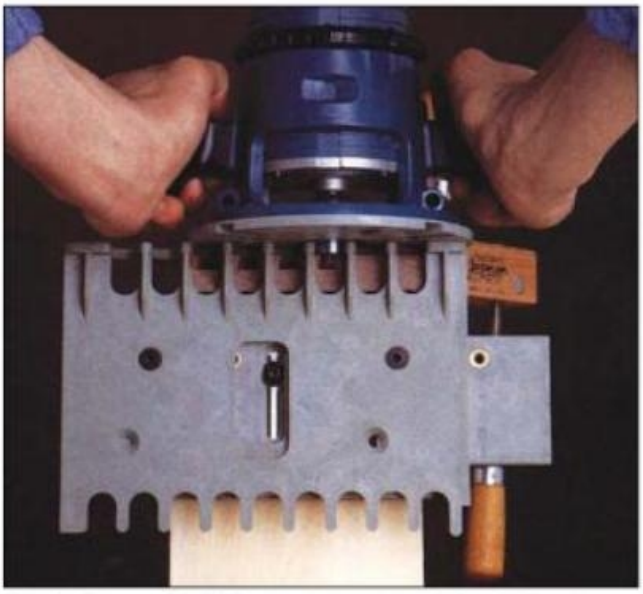
Router Joinery

The router's ability to plunge into wood and cut precise, clean, straight-edged grooves makes it an excellent tool for the demanding task of joinery. Equipped with a battery of specially designed bits, jigs, and other accessories, the router can cut dozens of joints, ranging from the utilitarian rabbet to the most elaborate of dovetails.

The mortise-and-tenon is the most popular method of assembling the frame in frame-and-panel construction. Many commercial jigs are available to help you cut this joint with a router. Some are essentially positioning jigs for centering the router bit on the edge of a workpiece *(page 126)*. Other models are used to cut the joints for the rails and stiles of a frame. Shop-built jigs for routing mortises *(page 127)* and tenons *(page129)* can also be made inexpensively. Another common frame-and-panel joint—the cope-and-stick *(page 148)*—offers strength and a decorative flourish.

Dovetail joints are best cut with the help of a variety of commercial jigs. Whether you cut the half-blind variety *(page 172)*, a common drawer joint, or the traditional through dovetail *(page 160)*, these jigs will help you produce the joint with unerring precision.

Joints can be either functional or decorative—or both. The sliding dovetail *(page 100)* and glue joint *(page 94)*, for example, are strong joints that remain invisible once they are assembled. The dovetail spline *(page 182)*, on the other hand, is primarily a visual detail. The butterfly key joint *(page 45)* fulfills both roles, reinforcing edge-to-edge butt joints while embellishing the surface with its double-wing motif.



Paired with a multi-joint jig, a router makes quick work of carving the pins of a dovetail joint.

Some joints, perhaps because they require long or repetitive cuts, are best produced on the router table. The box joint *(page 184)* and tongue-and-groove *(page 92)* are good examples.

Butt Joints

Of all the joints used to assemble boards, the butt joint is certainly the most straightforward. Affixing the edge, end, or face of one board to that of another may not always produce the strongest joint. However, a properly reinforced butt joint is an excellent option for dozens of woodworking tasks, from joining smaller boards into a wide panel to assembling carcases and frames.

The simple butt joint contains no interlocking parts, relying instead on the glue bond for its strength. The solidity of that bond is determined by the grain orientation of the mating boards. Gluing long grain to long grain, as in panel, edge, and face-to-face joints *(page 24)*, produces a solid connection, requiring no reinforcement. All other butt joints involve end grain; this porous surface provides a much less effective gluing surface than an equivalent area of long grain. Therefore, end grain joints must be reinforced.

Nails and screws can be used for reinforcement, but cabinetmakers try to avoid them for two principal reasons: Additional work is required to conceal the fasteners, and neither does as good a job joining end grain as some of the alternatives. Screws are considered superior for one application, however, and that is the task of fastening a tabletop to its supporting rails. The technique, which involves drilling angled pocket holes, is detailed on page 40.

Most other joinery needs are filled by dowels, compressed-wood wafers or "biscuits," or splines, which can also serve to align parts of a joint that do not require reinforcement. Each demands mastery of a specialized technique—but the procedures are simple and they allow the quick assembly of strong, attractive joints in which the mechanical parts can be hidden from view.

At least one butt-joining technique—the butterfly key joint—is not meant to be hidden; in fact it is used as much for decoration as for strength. In this joint a double-dovetail key—the butterfly—is cut from a contrasting wood and used to tie together two edge-joined boards. The butterfly demands patience, but a well-set key can be a striking feature of a tabletop. The steps to making one are shown on page 45.

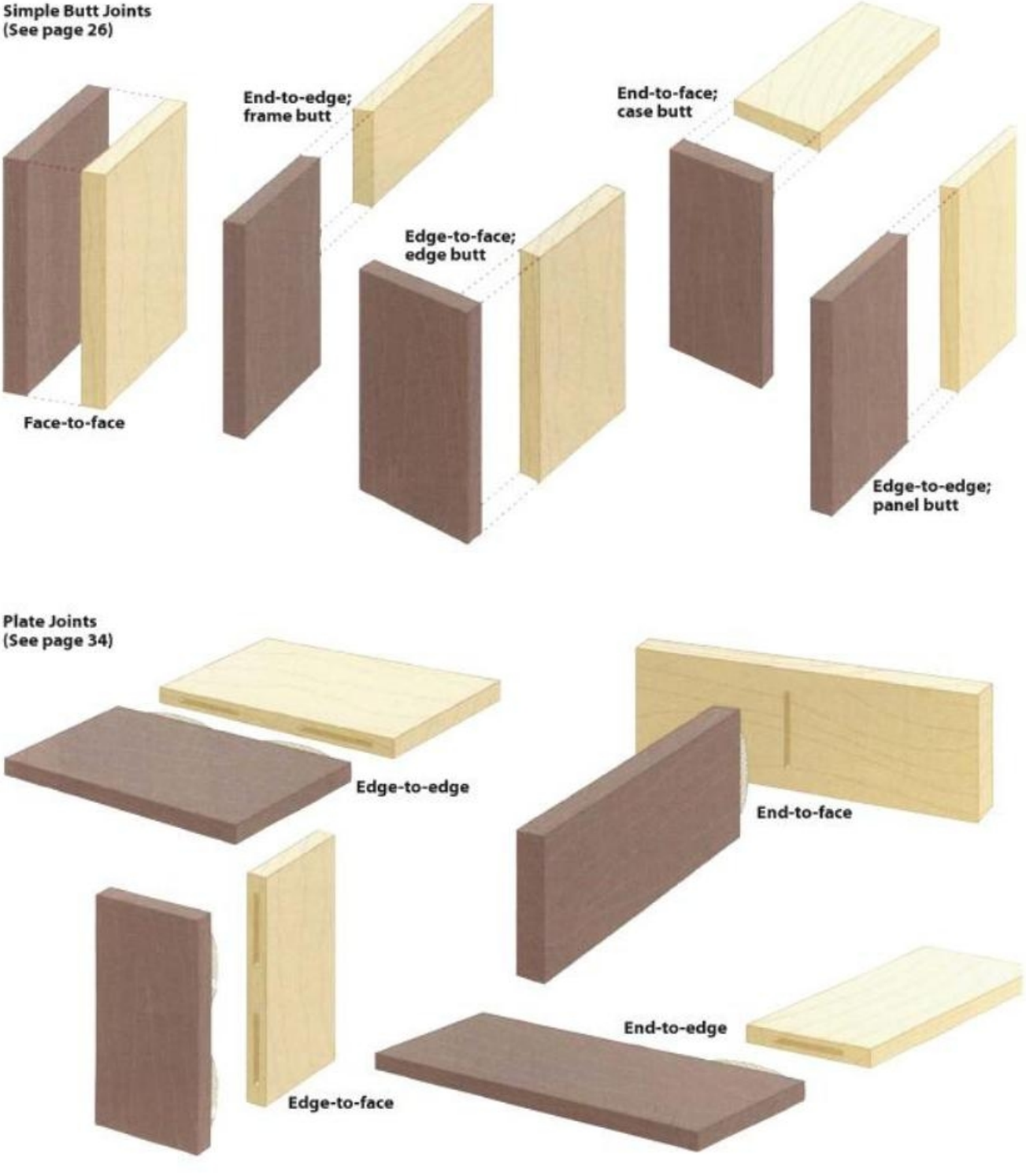
At the other end of the form-to-function scale is the use of threaded rods to reinforce such workaday surfaces as butcher blocks, workbenches, and countertops. These are often built up of face-glued stock, as shown on page 29, and the rods serve to stabilize the heavy slab when room humidity changes.

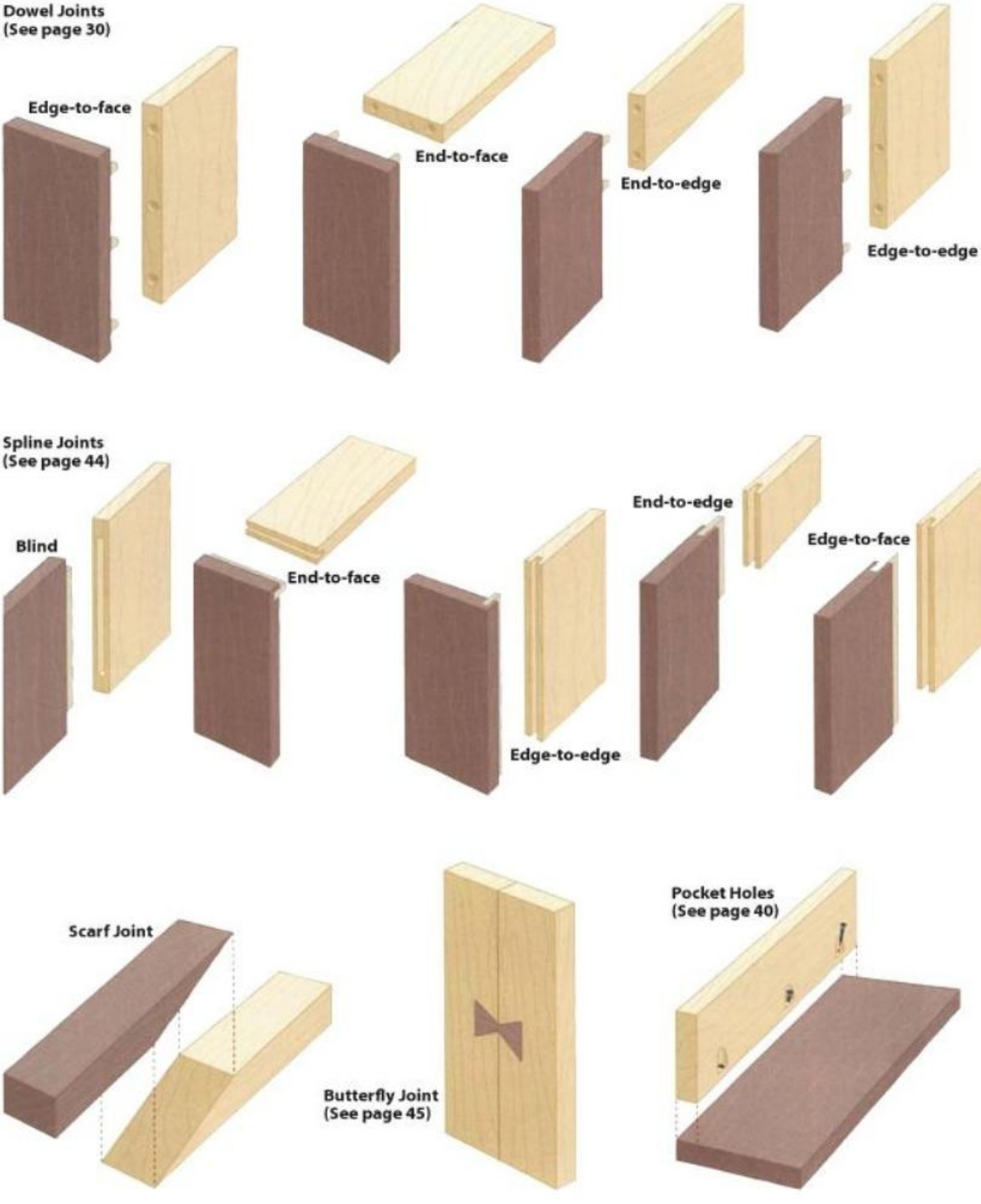
Doweling techniques are explained starting on page 31, biscuit joinery begins on page 35, and the correct use of splines is detailed on page 44.

The commercial jig shown above cuts accurate pocket holes with a minimum of setup time. With the workpiece clamped in the jig, the router-like cutter is pivoted into the face of the board to cut the pocket hole.

Biscuits provide effective butt joint reinforcement. Here, the oval wafers are used to join the sides of a carcase. The glue causes the biscuits to expand in their slots, creating an exceptionally strong joint.

A Catalog of Butt Joints





Making Butt Joints

Lumber is seldom available in planks wide enough for a tabletop or a carcase panel; sometimes it cannot be found thick enough for a specific task—a table leg, for example. Often, when you can find such stock, it is prohibitively expensive so woodworkers can glue individual boards together. Panels are constructed from edge-to-edge butt joints, as shown below. Leg blanks are made by face gluing boards *(page 27)*. Provided the mating surfaces have been jointed smooth and square, and the proper gluing and clamping techniques are followed, the results are strong and durable.

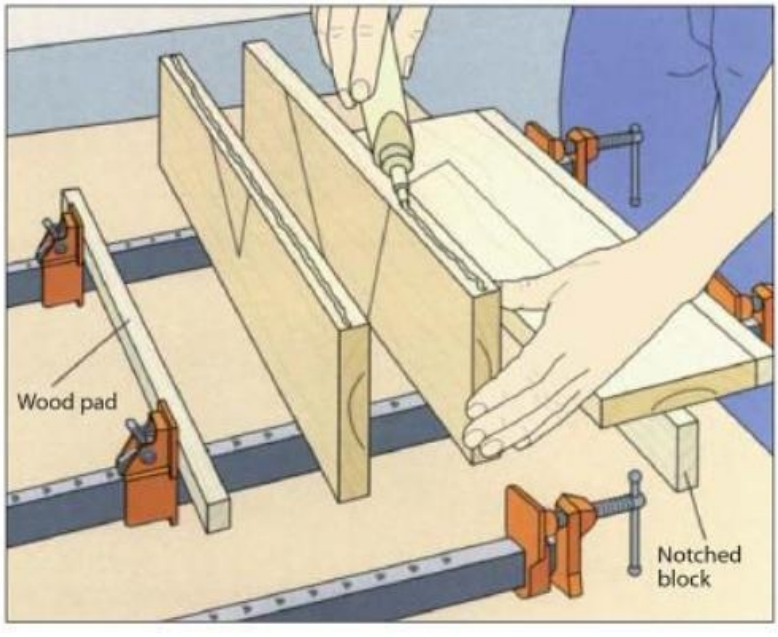
Before edge gluing boards, arrange the stock so the face of the panel will be visually interesting. The panel should create the illusion of a single piece of wood rather than a composite. To minimize warping, arrange the pieces so that the end grain of adjacent boards faces in opposite directions *(page 27)*. Use a pencil to mark the end grain orientation on each board.

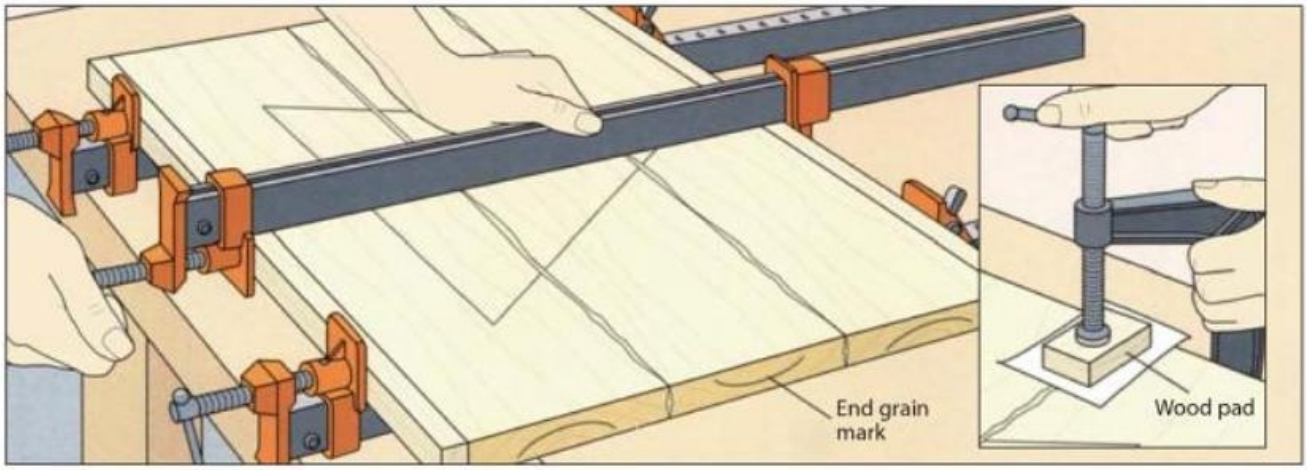
A jointer produces a smooth, straight, even edge. Gluing jointed boards together edge-to-edge will form a panel that is every bit as strong as a single piece of lumber.

Edge Gluing

Applying the glue

Set two bar clamps on a work surface and lay the boards on top. Use as many clamps as you need to support the pieces at 24- to 36-inch intervals. Keep the bars upright by placing them in notched wood blocks. Arrange the stock to enhance its appearance, making sure the end grain of the boards runs in alternate directions. With the pieces butted edge-to-edge, mark a triangle on the stock to help you rearrange the boards at glue up. Next cut two protective wood pads at least as long as the boards. Leaving the first board face down, stand the other pieces on edge with the triangle marks facing away from you. Apply a thin glue bead to each edge *(right)*, then use a small, stiff-bristled brush to spread the adhesive evenly.

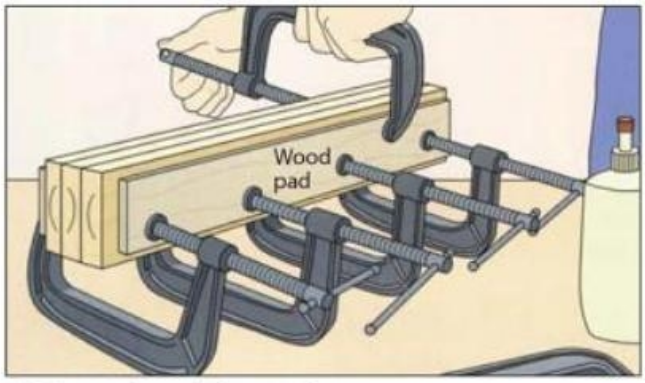




Tightening the clamps

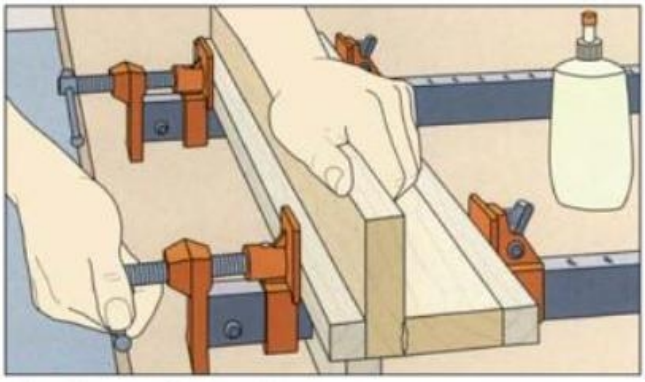
Set the boards face down and line up their ends, making sure the sides of the triangle align. Tighten the clamps under the boards just enough to press them together. Install a third clamp across the top center of the stock. Finish tightening the clamps *(above)* until there are no gaps between the boards and a thin bead of glue squeezes out of the joints. To level adjacent boards that do not lie perfectly flush with each other, use a C clamp and a wood pad centered over the joint near the end of the boards; use a strip of wax paper to prevent the pad from sticking to the boards. Then tighten the clamp until the boards are aligned *(inset)*.

Face Gluing



Gluing up boards face-to-face

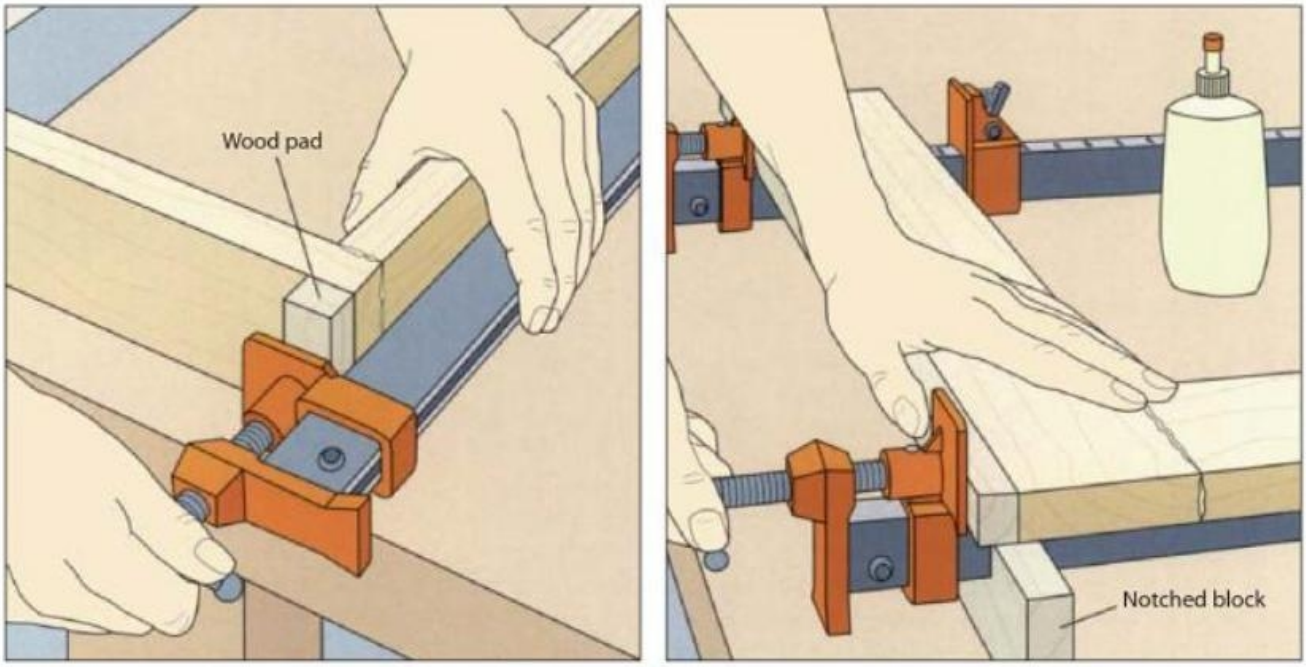
Cut your stock slightly longer and wider than necessary to enable you to square the blank if the boards shift during glue-up. Lay out the boards face-to-face, alternating the end grain of the pieces and arranging the stock to maximize grain and color. Spread glue on one mating surface of each joint, then use C clamps spaced at 3-to 4-inch intervals to hold the pieces together. Protect the stock with wood pads. Tighten the clamps just enough to press the boards together. Turn the assembly over so it sits on the first row of clamps and install a second row along the other edge *(above)*. Finish tightening all the clamps.



Clamping an edge butt joint

Set two bar clamps on a work surface and lay the boards on top, one face down and one on edge. Use notched blocks and wood pads. Spread some glue on the mating edge and board face. Hold the upright piece flush against the bar while tightening the clamps a little at a time until adhesive squeezes out of the joint *(above)*. Install as many additional clamps as necessary between the first two to close any gaps between the boards.

Clamping Techniques for Three Butt Joints



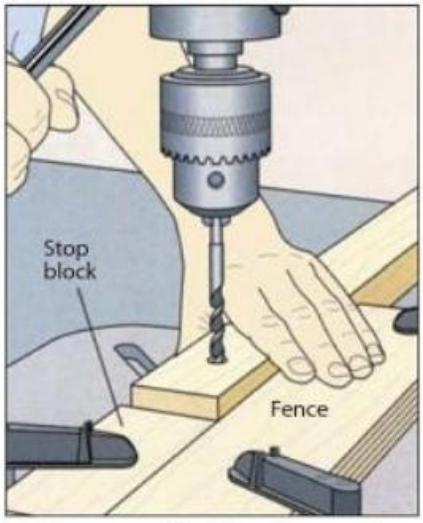
Gluing up a joint with end grain

Since both joints shown above involve gluing along end grain, you will need to reinforce the connection; use one of the methods presented later in this chapter, such as dowels, biscuits, or splines. Spread glue on the contacting surfaces, then use bar clamps to hold the joint together. For the case butt joint *(above, left)*, set the clamp on its side and the boards on edge on a work surface. Tighten the clamp as you hold the stock snug up against the bar and keep the joint square. For a frame butt joint *(above, right)*, set two bar clamps upright in notched wood blocks as you would for gluing up a panel *(page 27)*. (The second clamp serves to keep the boards level.) Lay the boards face down on the clamps, making sure the stock is well supported. Apply the adhesive, butt the pieces together, and tighten the clamps while holding the boards in alignment. For both setups, use wood pads to protect your stock.

Through Bolts

Through bolts are an effective means of reinforcing workbench tops or butcher blocks made by face gluing boards. In addition to helping to align the boards, the bolts will reduce the possibility of splitting or warping as the wood's moisture content fluctuates from season to season.

Reinforcing Butt Joints with through Bolts



Gluing up and bolting the panel

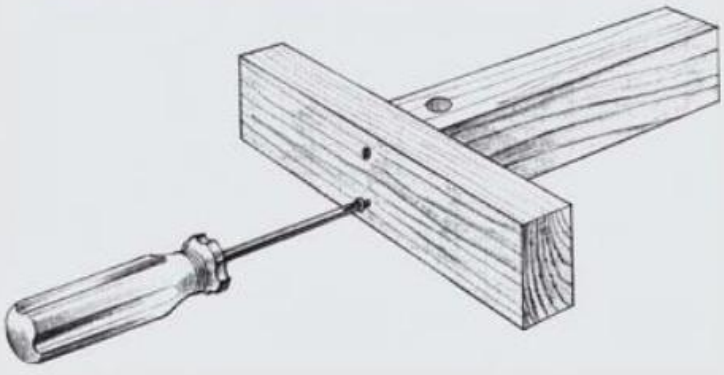
Mark three holes for the bolts on the face of one board, placing one a few inches from each end and one in the middle; center the marks between the edges. Install a bit in the drill press that is slightly larger than the bolts and align the bit with the middle mark. Clamp a stop block against the end of the board and a wood fence against its edge. Use this setup to drill the end holes in all the boards *(above, left)*. Use a similar setup to bore the middle holes. Counterbore the two face pieces to accommodate the nuts. Prepare the bolts by threading a nut on one end of each threaded rod; strike the end of each rod with a hammer and punch to jam the nut in place. Stand the front piece on edge and lay all the others face up on a work surface. Squeeze some glue on the boards and spread it evenly with a brush *(above, right)*. Press the board faces together, keeping their ends aligned. Feed the bolts through the holes, slip on the remaining washers and nuts, and give an initial tightening. Use bar clamps to press the boards together as in the photo above. Finish tightening the bolts with a socket wrench and add a third clamp across the top of the assembly.

Dowel Joints

Dowels can transform a weak butt joint into solid joinery. In edge gluing *(right)*, the wooden pins help align the boards. In frame *(above, left)* and case *(above, right)* butt joinery, the dowels reinforce the relatively weak bond between end grain and long grain. Dowel joints generally hold up well to shear stress—when the pieces are being pushed past each other; they are less effective at resisting tension—when the pieces are being pulled apart *(page 14)*.

Shop Tip

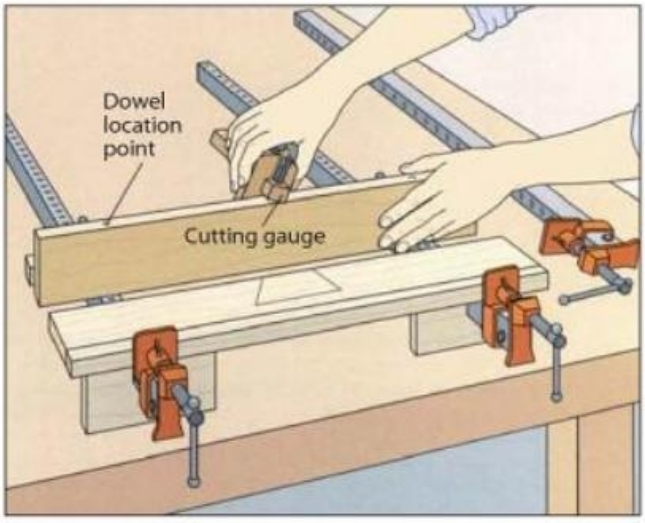
Using a dowel to strengthen a butt joint
Screws do not hold well in end grain, so a fastener on its own is seldom strong enough to keep an end-to-face butt joint together. To reinforce the connection, bore a ⅜-inch-diameter hole vertically through the end grain piece about ½ inch from its end. Glue a dowel in the hole and let the adhesive dry. Then drive your screws through the mating piece into the dowel. The screws will be well anchored in the long grain of the dowel.

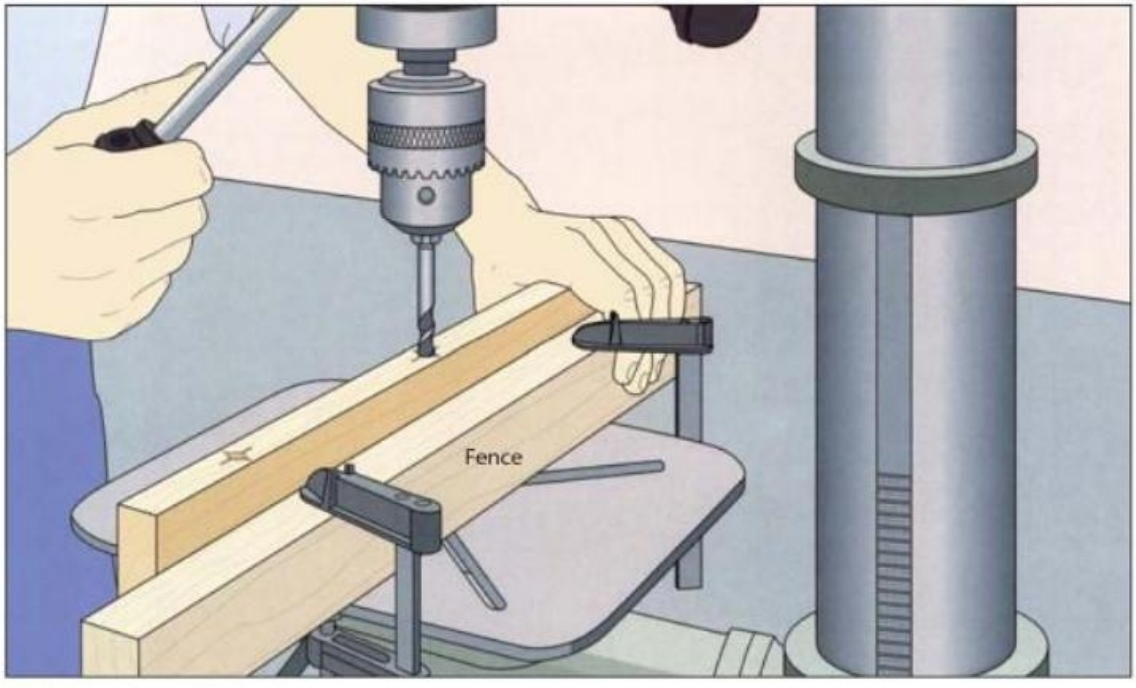


Edge Gluing with Dowel Joints

Marking the dowel holes

Arrange your stock on bar clamps as for edge gluing *(page 26)*. Leaving one board face down, stand the other pieces on edge. To ensure that the dowels are precisely centered, mark lines across the edges of the boards—one about 4 inches from each end and one in the middle. Then adjust a cutting gauge to one-half the thickness of the stock and use it to mark the center of the edge at each dowel location point *(right)*. The intersecting lines will accurately place the dowels. For longer stock, you may want to mark additional dowel holes.



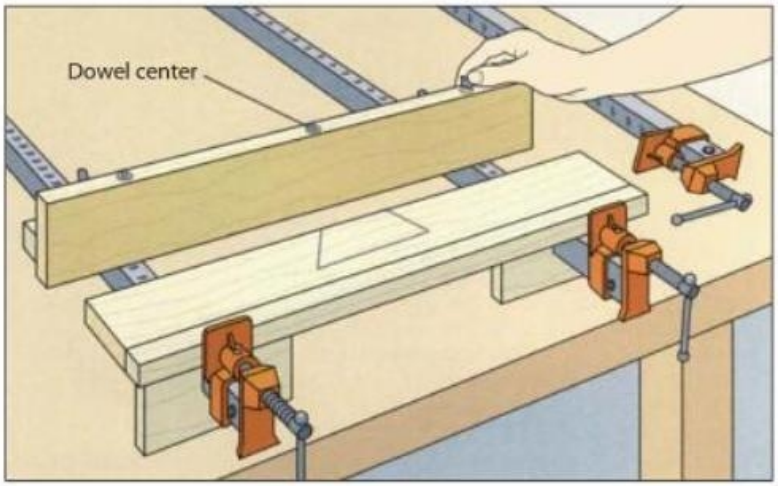


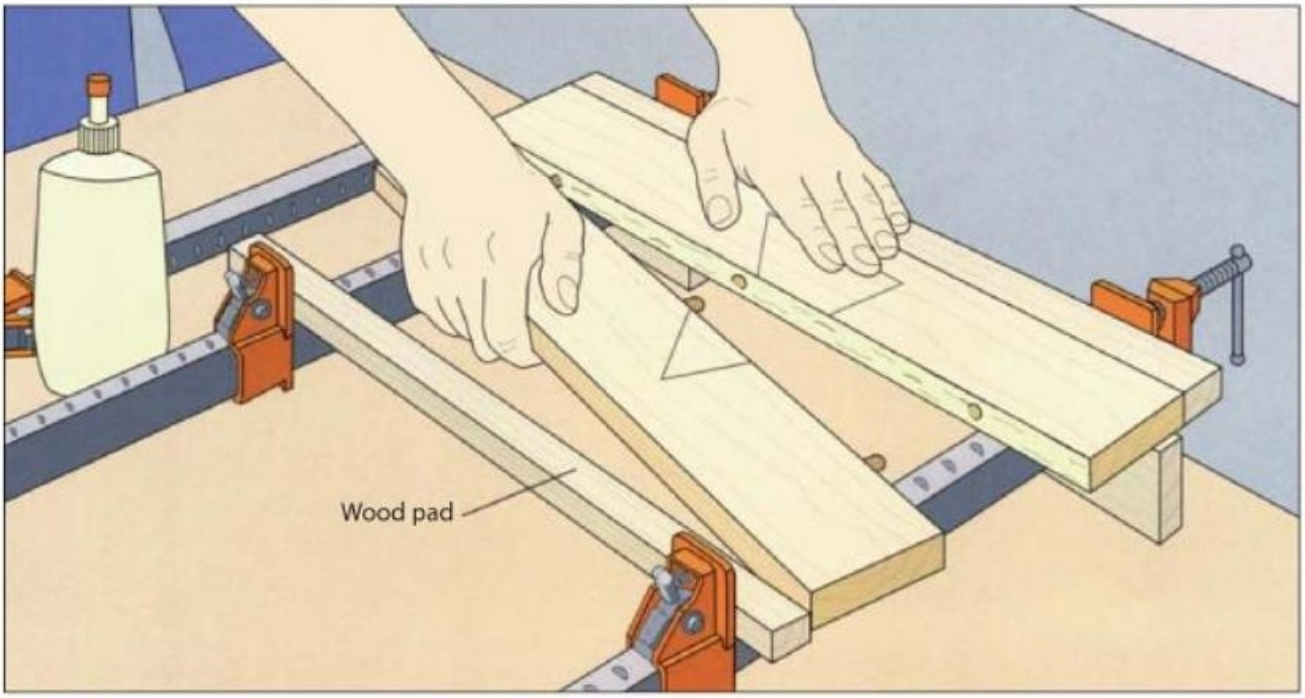
Boring the dowel holes

To avoid splitting your stock with the pins, use grooved dowels that are no more than one-half the thickness of the boards. Fit a drill press with a twist or brad-point bit the same diameter as the dowels, then set the drilling depth to 1/16 inch more than one-half the length of the dowels. Clamp a fence to the drill press table to help keep the board edges perpendicular to the bit as you bore the holes. Then, holding the workpiece flush against the fence, position one marked point directly under the bit and bore the hole. Repeat to drill the remaining holes *(above)*.

Pinpointing the mating dowel holes

Insert dowel centers the same diameter as the dowels in each of the holes *(right)*, then lay the boards on the clamps with the triangle marks facing up. Align the marks and press the board edges together. The pointed ends of the dowel centers will pierce the edge of the adjacent board, providing starting points for the mating dowel holes. Bore these holes to the same depth as earlier.





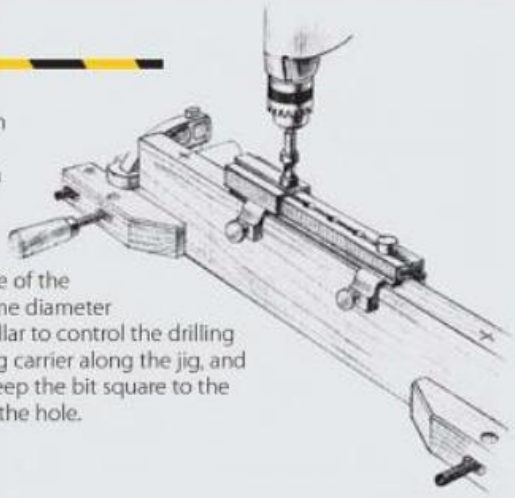
Gluing up the boards

Arrange the boards on bar clamps, using wood pads and notched blocks, as you would for edge gluing *(page 26)*. Apply a thin glue bead on the edges to be joined and spread it evenly. Use a stick to dab a small amount of adhesive in the bottom of each dowel hole. Do not spread glue directly on the dowels; the moisture will cause them to swell. Insert the dowels and use a hammer to tap them into final position. Avoid pounding, which can cause a board to split. Clamp the joint until the glue is cured.

Shop Tip

Doweling jig

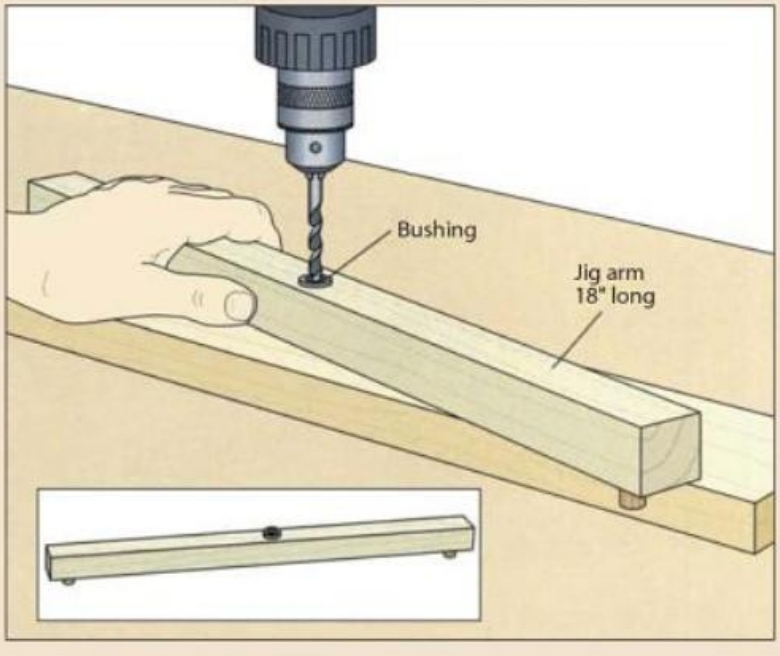
The commercial doweling jig shown here automatically centers dowel holes on the stock and spaces them at Intervals you choose. Clamp the workpiece in handscrews, then secure the board to a work surface. Clamp the jig onto the edge of the stock. Fit your drill with a bit the same diameter as the dowels, then install a stop collar to control the drilling depth. Slide the rectangular bushing carrier along the jig, and insert the appropriate bushing to keep the bit square to the board. Holding the drill firmly, bore the hole.



Center-Drilling Jig

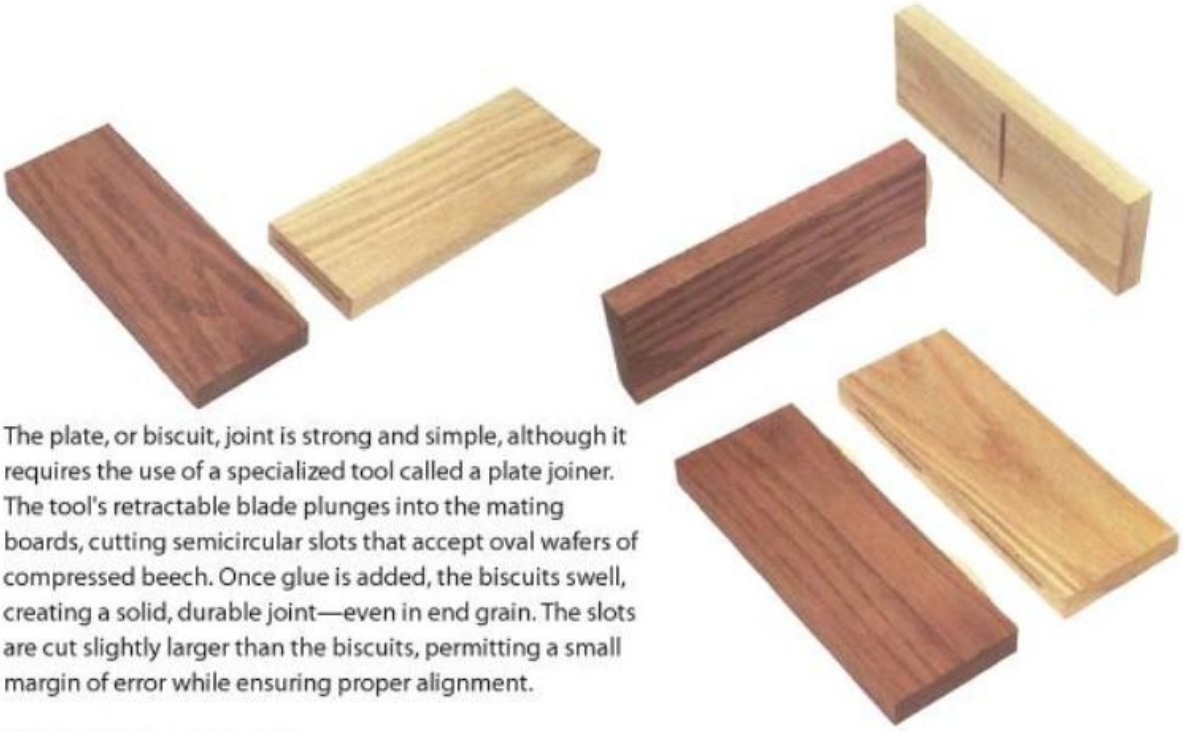
This simple jig will let you bore holes that are always centered on a board's face or edge. Cut the 18-inch arm from 2-by-2 stock. Mark the center of the top face of the arm and bore a hole for a guide bushing *(inset)*. The bushing should be slightly larger than the holes you plan to drill. Size the hole so the bushing will fit snugly, then press it in place.

Turn the arm over and mark a line down its middle. Mark points on the line roughly 1 inch from each end equidistant from the center, then bore a ⅜-inch hole halfway through the arm at each mark. Dab some glue in the holes and insert grooved dowels. They should protrude by about ⅜ inch. To use the jig, place it on the workpiece so that the dowels butt against opposite edges of the stock. Fit the drill bit into the bushing and bore the hole *(right)*.



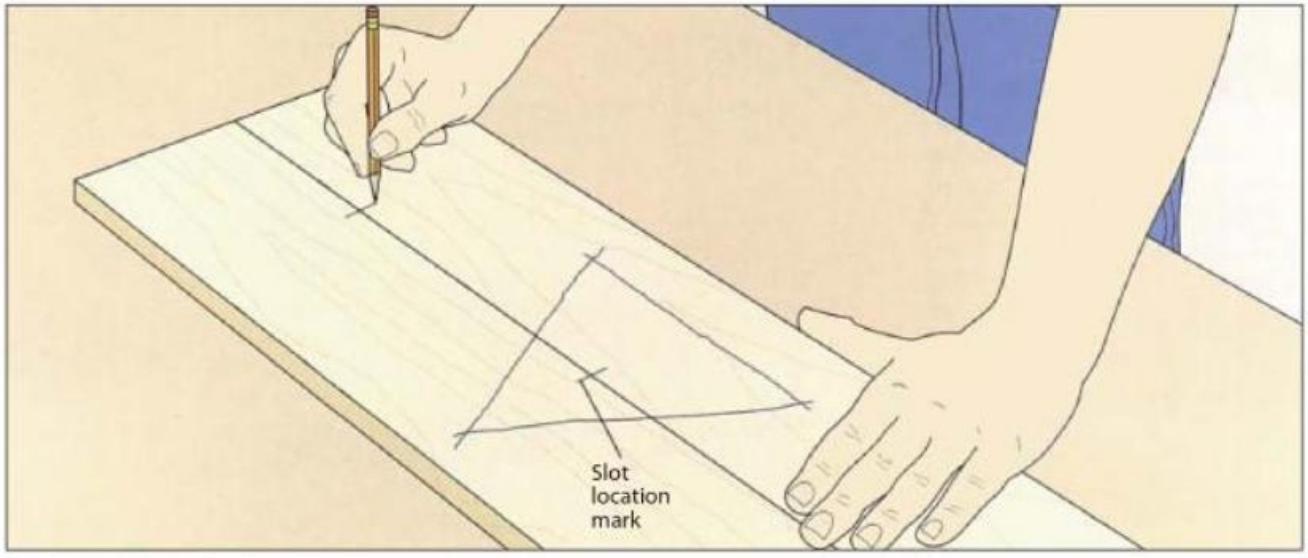
For holes on a board edge, clamp the stock edge-up and set the jig on the stock with the dowels flush against opposite faces of the board.

Plate Joints



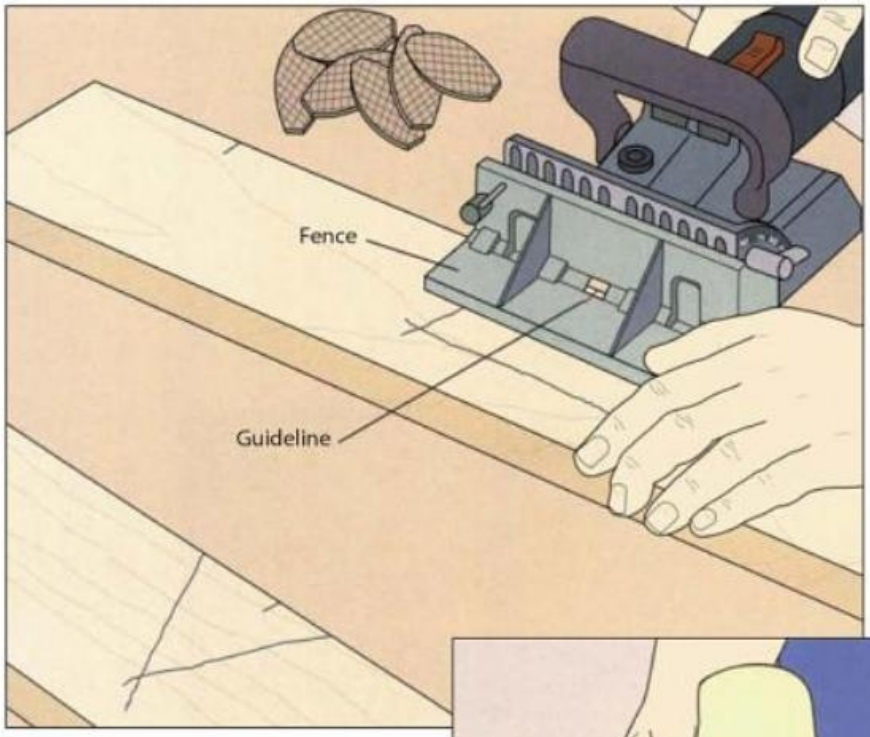
The plate, or biscuit, joint is strong and simple, although it requires the use of a specialized tool called a plate joiner. The tool's retractable blade plunges into the mating boards, cutting semicircular slots that accept oval wafers of compressed beech. Once glue is added, the biscuits swell, creating a solid, durable joint—even in end grain. The slots are cut slightly larger than the biscuits, permitting a small margin of error while ensuring proper alignment.

Edge Gluing Boards



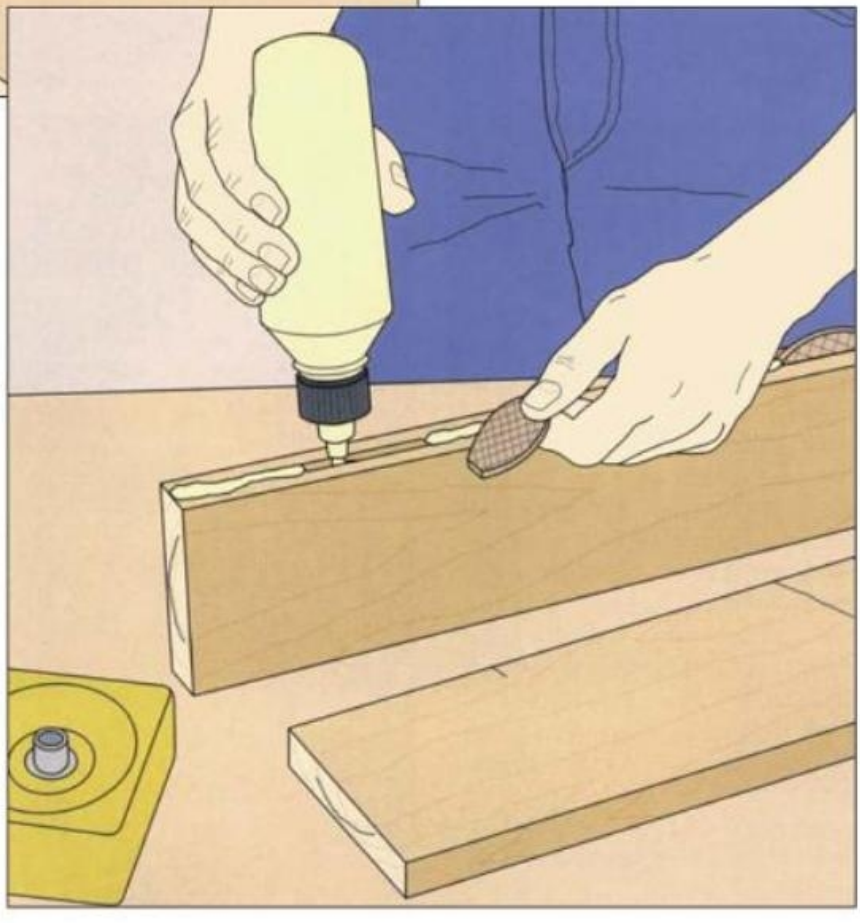
Marking slot locations

Arrange the boards to be joined and mark a triangle on the surfaces as in edge gluing *(page 26)*. Then mark center lines for the slots across the board seams *(above)*. Start at least 2 inches in from each end and add a mark about every 8 inches.



Cutting the slots

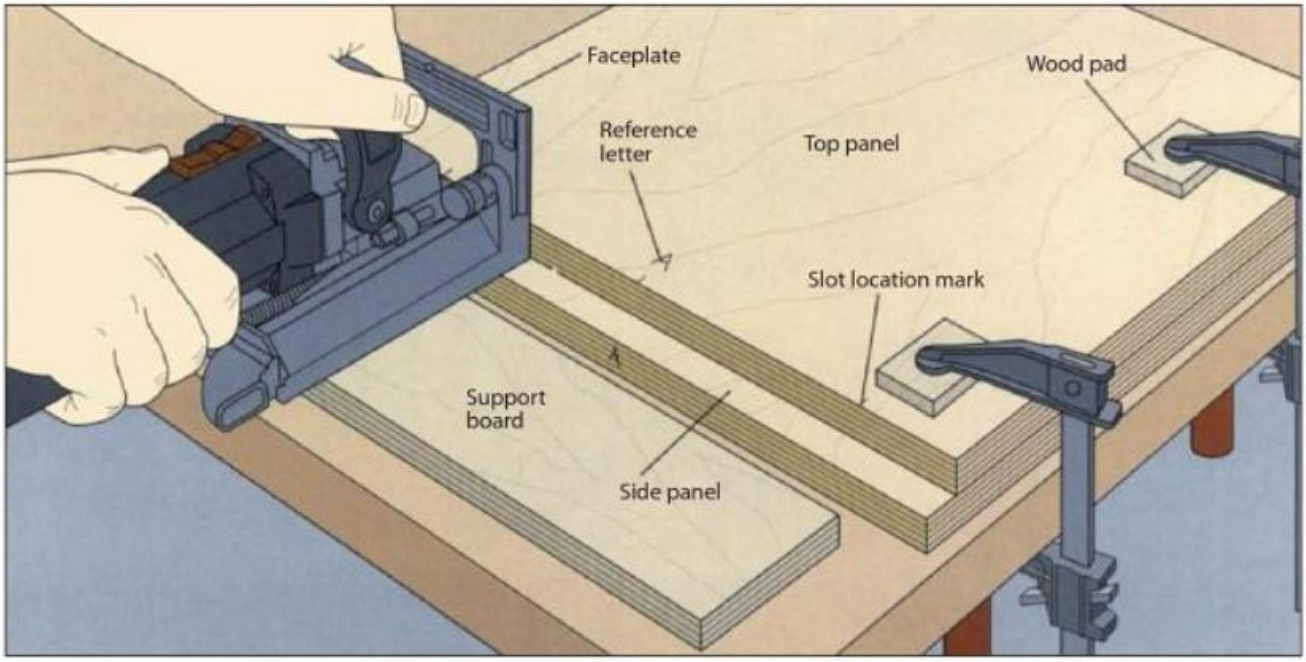
Set the plate joiner's depth of cut to suit the biscuits you are using and adjust the fence to center the slots in the board edges. Laying the fence on top of the stock, align the guideline on the faceplate with a slot location mark on the workpiece. Turn on the tool and plunge the blade into the board to cut the slot *(left)*. Repeat the procedure at the other slot location marks. With thin stock, the tool's base plate may touch the work surface, shifting the alignment of the slots. To prevent this, position the workpiece at the edge of the table so the base plate does not rest on the tabletop.



Inserting the biscuits and gluing up the boards

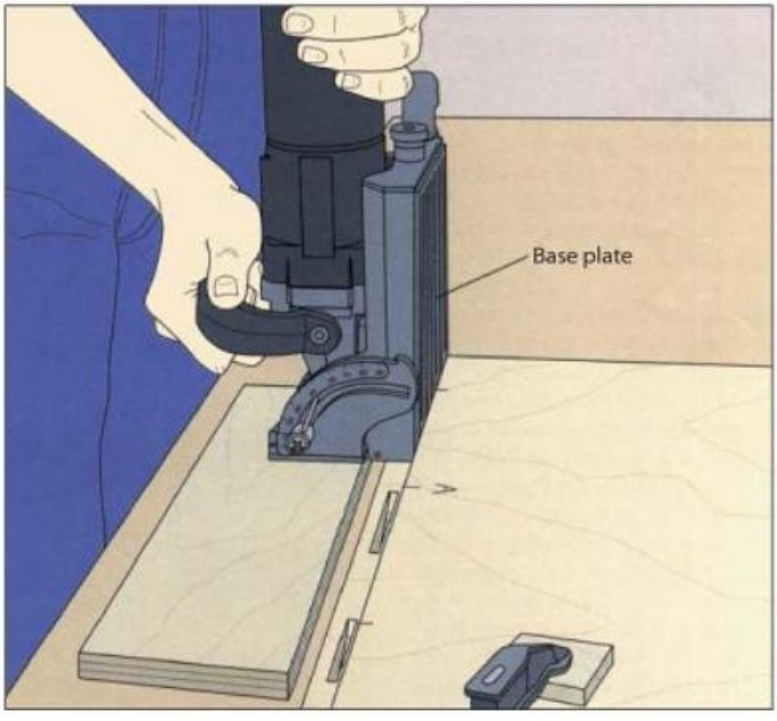
Once all the slots have been cut, leave the last board face down and stand the others on edge with the slots facing up. Apply a bead of glue along the board edges and in the slots, inserting biscuits as you go *(right)*. (If you are working with long boards it is better to wait until all the adhesive has been applied before inserting the biscuits to prevent them from swelling before you have time to complete glue up.) The bottle shown in the illustration is specially designed to apply adhesive evenly on the sides of the slots; if you are using a standard glue bottle, spread the glue with a small wooden stick. Spread the adhesive evenly on the board edges, then fit the boards together quickly to prevent the biscuits from swelling prematurely. Hold the boards together with bar clamps as in edge gluing.

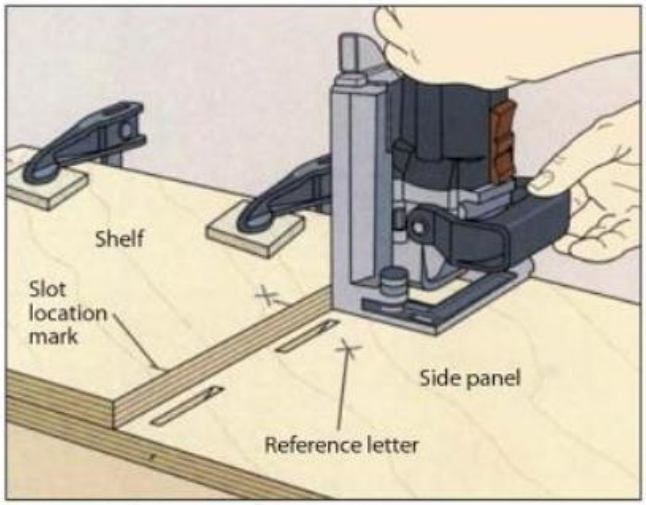
Assembling a Carcase with Plate Joints

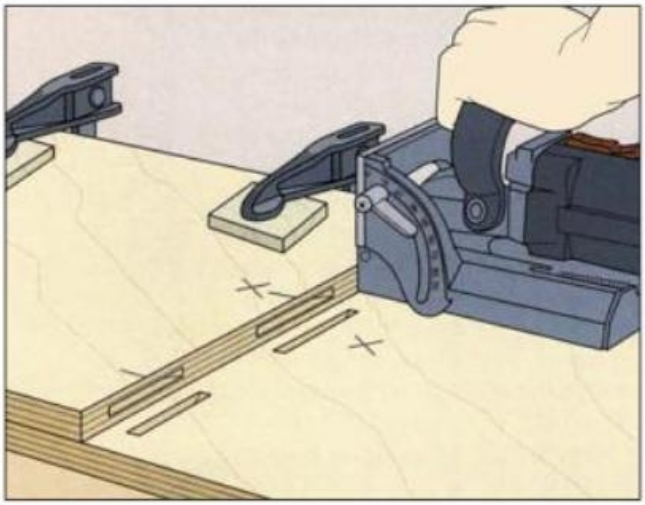


Cutting the slots at the corners

With the setup shown here, you will be able to cut all the slots for one carcase corner without moving the panels. Set one of the side panels outside-face down and lay the top piece outside-face up on top of it, using reference letters to identify the carcase corners. Offset the top panel by the stock thickness, then clamp the pieces in place. Place a support board the same thickness as the stock in front of the panels, then mark the slot locations on the top panel. Setting the plate joiner on the support board, align the guideline on the faceplate with a slot location mark on the stock. Grip the joiner with both hands and cut the slot *(above)*. Repeat the process at the other marks and then, turning the plate joiner on end, align the guideline in the center of the tool's baseplate with a slot mark *(right)*. Push the tool down to cut the grooves in the side panel; repeat the clamping and cutting procedure for the other carcase corners.

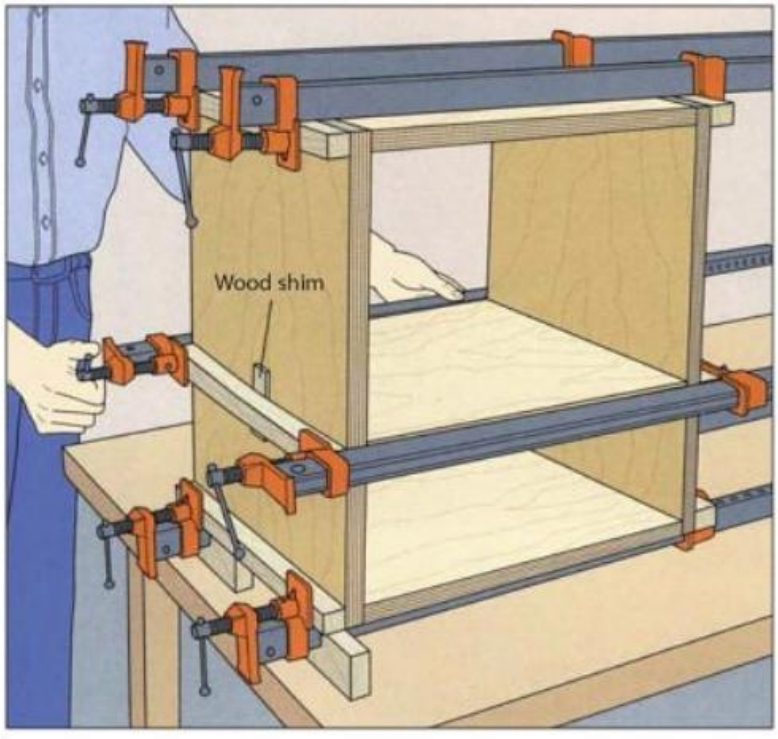






Cutting slots for a shelf

Mark slot location lines at both ends of the shelf. Mark lines across the inside face of both side panels where you wish to position the shelf, then set the shelf atop one side panel, aligning its edge with the reference line. Clamp the workpieces in place. Cut the slots in the panel by holding the tool's base plate against the shelf and aligning the guideline in the center of the plate with the location marks on the shelf *(above, left)*. Use the guidelines on the tool's faceplate to align and cut the slots in the shelf *(above, right)*. Reposition the shelf on the other side panel and repeat the procedure.



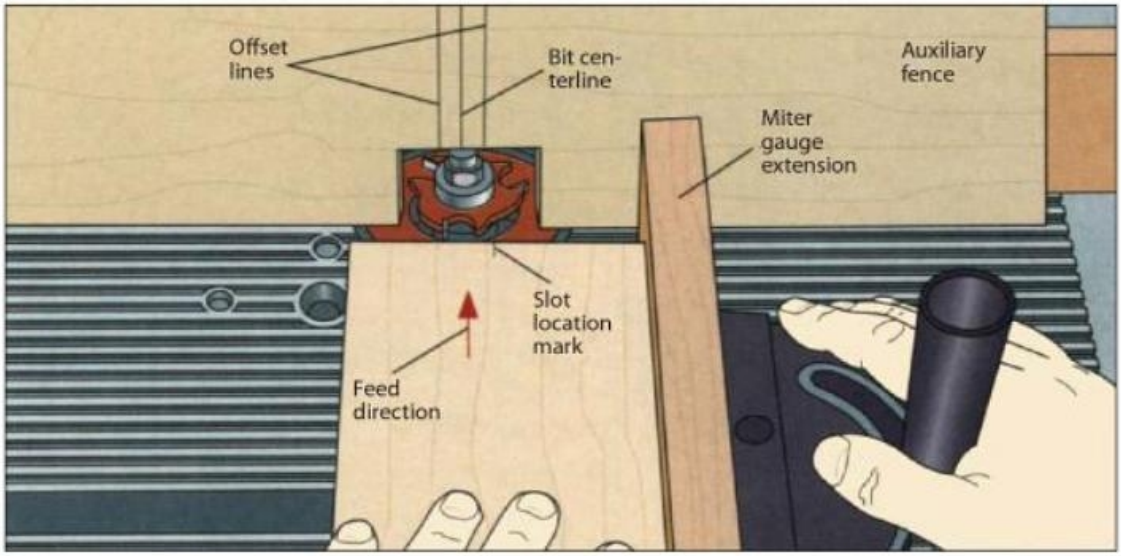
Gluing up the carcase

Once all the slots have been cut, set the panels and shelf on the work surface outside-face down. Apply glue and insert biscuits into their slots and along their edges as for gluing up boards *(page 35)*. Assemble the carcase, fitting the top and bottom panels and the shelf onto one side and then adding the other side. Install two bar clamps across the top and bottom, using wood pads to protect the stock. Close the shelf joints with bar clamps at the front and back of the carcase, placing a ¼-inch-thick wood shim under each pad to maintain clamping pressure at the middle of the shelf. Tighten the shim clamps a little at a time until there are no gaps between the contacting surfaces and a small bead of glue squeezes out of the joints *(left)*.

Plate Joint

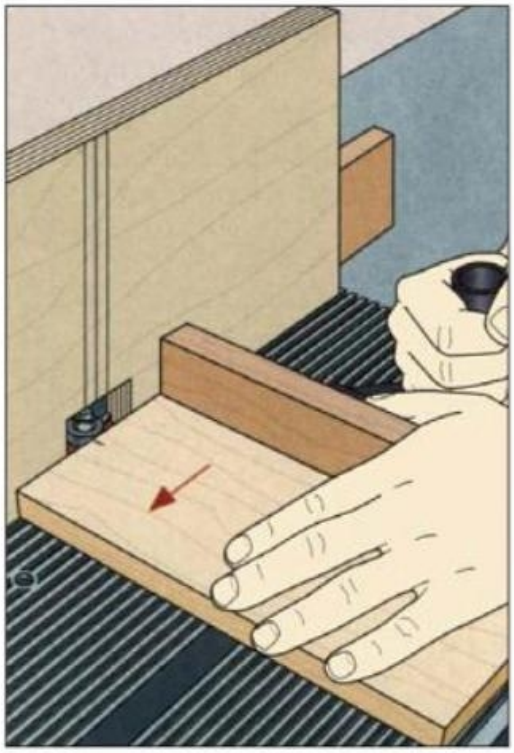
Fitted with a three-wing slotting cutter and mounted in a commercial biscuit joiner attachment, a router cuts semicircular slots for wood biscuits. Glued into two mating slots, the biscuits form a strong and durable plate joint—without the expense of a plate joiner. You can also cut the same joint on a router table with a simple shop-made setup, as shown below and on the following page. In fact, a table-mounted router can cut all the same joints as a biscuit joiner, including edge-to-edge, edge-to-face, and end-to-face joints. One exception is an edge-to-face joint in the middle of a panel, such as would typically be needed to install fixed shelves in a bookcase.

Routing Biscuit Slots



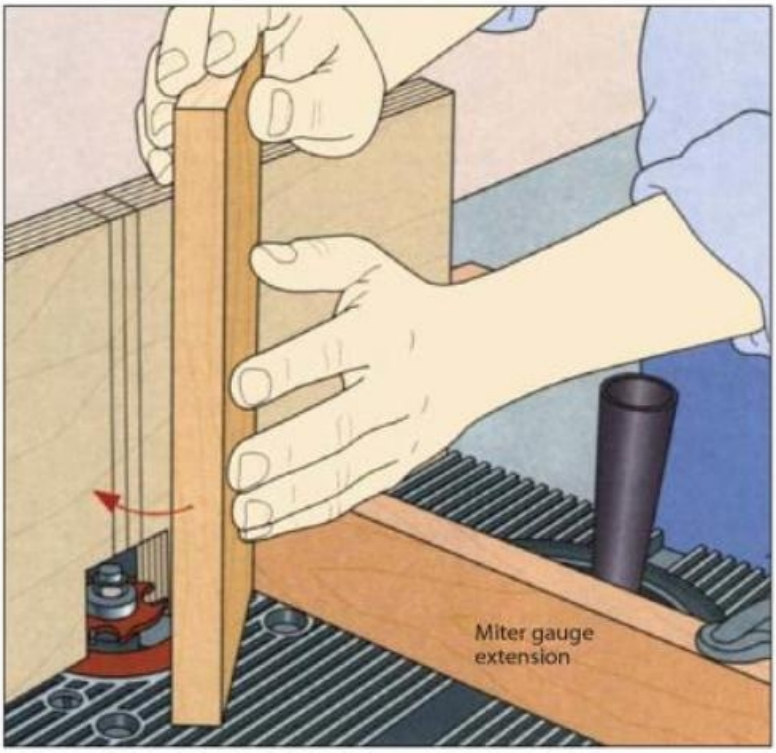
Plunging the workpiece into the bit

To rout biscuit slots for an end-to-face plate joint, as shown above, start by slotting the end grain. Set up for the cut as you would for a double dado *(page 108)*, installing a three-wing slotting cutter in the router and an auxiliary fence on the router table. Also screw a board to the miter gauge as an extension. Since the wood biscuits are longer than the bit diameter, you will need to feed the workpiece along the fence after plunging the bit into the stock. Draw a line across the fence centered above the cutter and mark the slot location on the workpiece centered between the edges. Measure the difference between the biscuit length and cutter diameter, and mark lines on each side of the centerline on the fence, offsetting each one by one-half the measured difference. To start the slot, butt the edge of the workpiece against the miter gauge extension with the end clear of the bit and align the slot location mark with the offset line on the infeed side of the fence *(above)*. Then slide the board along the extension, plunging the end grain into the cutter.



Completing the slot

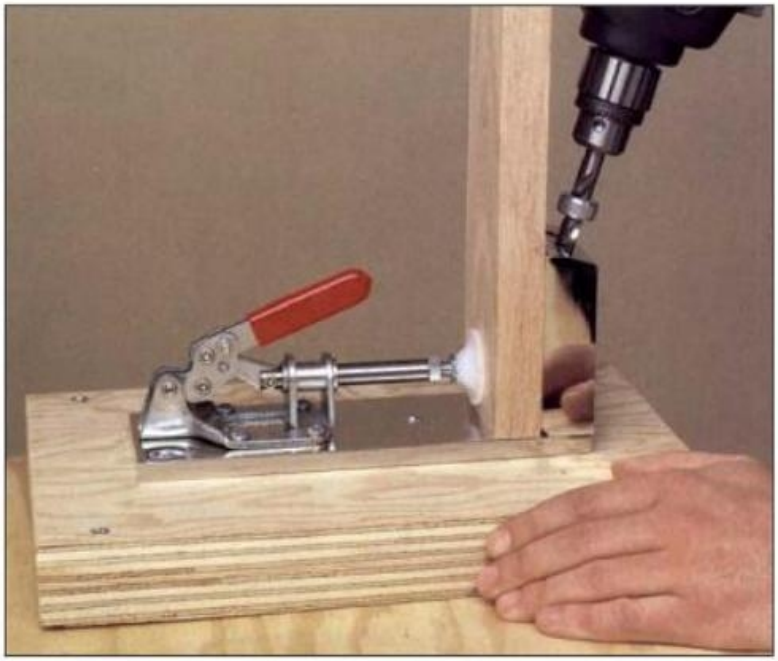
Once the board end is flush against the fence, slowly slide the miter gauge forward, holding the workpiece against both the extension and the fence *(above)*. Pivot the stock away from the fence—without lifting it off the table—once the slot location mark aligns with the offset line on the outfeed side of the fence.



Slotting the face of the mating board

Mark the slot location on the inside face of the workpiece (near the top end so you can see the mark when the board is flush against the fence). Hold the workpiece against the fence with the location mark aligned with the offset line on the infeed side of the fence, then butt the miter gauge against the edge of the board and clamp it in place. With the workpiece clear of the cutter, turn on the router. Pressing the edge of the board against the miter gauge, pivot the inside face toward the fence *(above)*, plunging the bit into the stock. Once the board is flush against the fence, slowly slide it forward, keeping it pressed against the fence. Stop feeding the workpiece once the slot location mark aligns with the offset line on the outfeed side of the fence. Then turn off the router and pivot the board away from the fence.

Pocket Holes

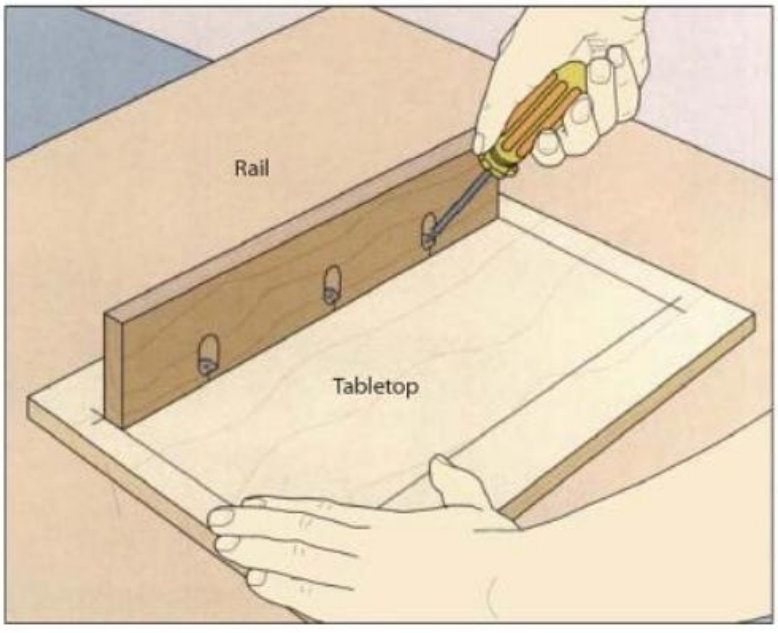


Pocket holes are commonly used with screws for attaching a tabletop to the supporting rails. Drilled at an angle, they solve the problem of having to screw straight through 3- or 4-inch-wide stock; they also conceal the fasteners. One of the many pocket hole jigs available, the model shown at right clamps the workpiece in position and features a bushing that keeps the drill bit at the correct angle. The combination bit shown bores a clearance hole for the screw shank and countersinks the hole for the head in one operation. A stop collar attached to the bit regulates the drilling depth.

Reinforcing a Butt Joint with Pocket Holes

Joining rails to a tabletop

Bore the pocket holes through the rails, using an electric drill with a commercial jig like the one shown above, or a drill press and a shop-made jig *(page 41)*. Space the holes about 4 inches apart. If you are using a drill with a special combination bit, the holes can be bored in a single operation. Otherwise, bore the holes in two steps with two different brad-point bits: Start with one slightly larger than the diameter of the screw heads, so they can be recessed as shown, and then bore the other a little larger than the screw shanks to allow for some movement. Once all the holes have been cut, set the table-top face down on a work surface and mark lines on its underside to help you position the rails. Align a rail with one of the lines and drive the screws to attach the board to the top *(right)*. Repeat for the other rails.



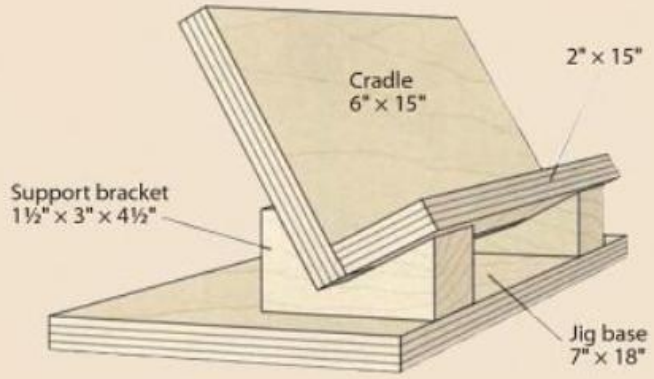
A Pocket Hole Jig

To bore pocket holes on the drill press, use a pocket hole jig *(right)*, shop-made from ¾-inch plywood and two small pieces of solid stock. Refer to the illustration for suggested dimensions.

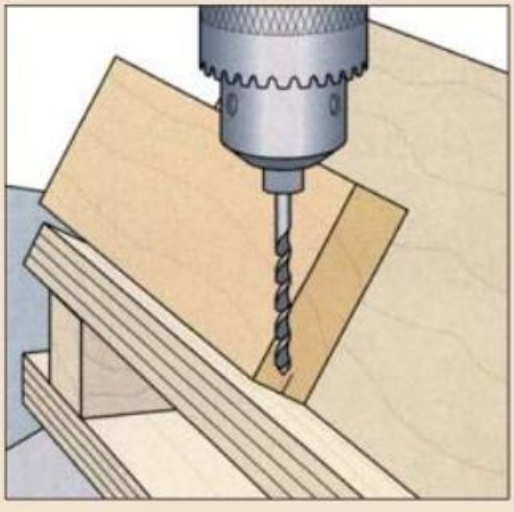
Screw the two sides of the cradle together to form an L. Then cut a 90° angle wedge from each support bracket so that the wide side of the cradle will sit at an angle of 15° from the vertical. Screw the brackets to the jig base, and attach the cradle on top of the brackets.

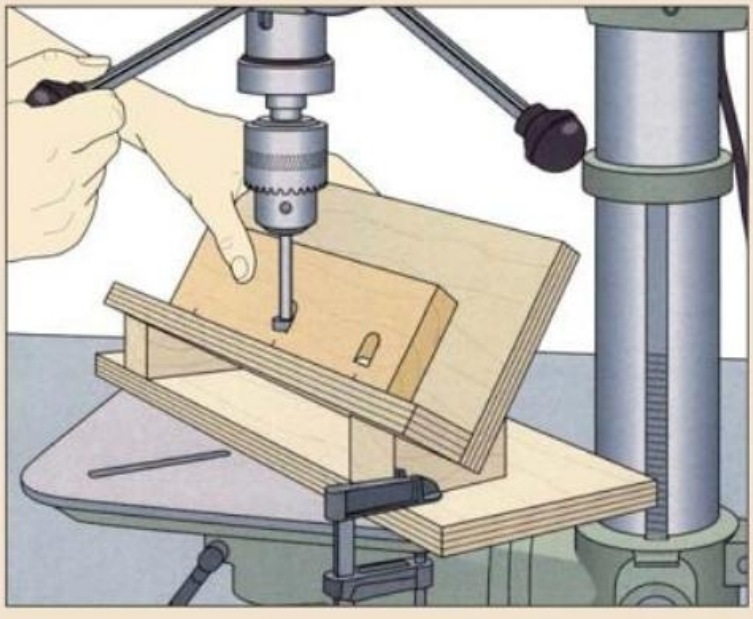
To use the jig, seat the workpiece in the cradle with the side to be drilled facing out and its top edge sitting in the V of the cradle. Bore the holes in two steps with two different bits as you would with an electric drill. In this case, a Forstner bit and a brad-point bit are shown. The Forstner bit cuts a flat-bottomed hole ideal for recessing screw heads.

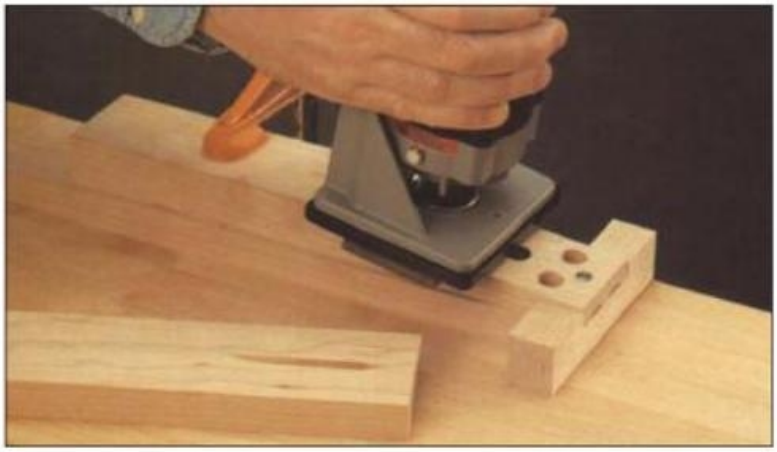
First, install the brad-point bit in the drill press and set the jig on the tool's table. With the machine off, lower the bit and position the jig to align the bit with the center of the bottom edge of the workpiece *(below, left)*. Clamp the jig to the table and replace the brad-point with the Forstner bit.



Holding the workpiece firmly in the jig, feed the bit slowly to bore the holes just deep enough to recess the screw heads *(below, right)*. To complete the pocket holes, reinstall the brad-point bit and bore through the workpiece.

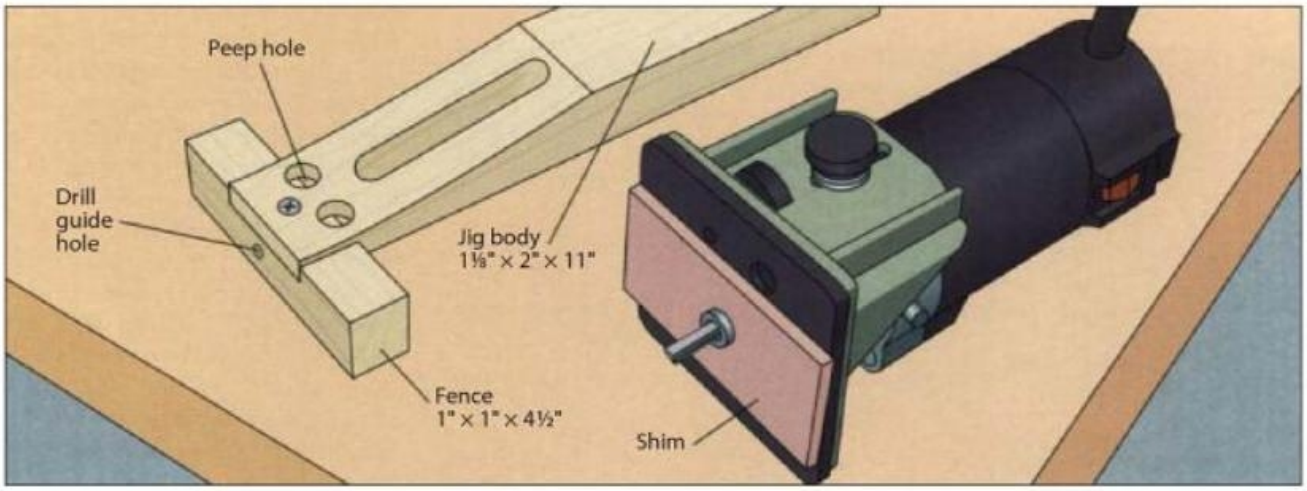






A laminate trimmer slides along a shop-built jig to rout a recess, or "pocket," for a screw in the face frame rail shown at right. Pocket holes are commonly used with screws for joining face frame members or attaching a tabletop to its supporting rails. Because they recess the fasteners below the surface of the workpiece, pocket holes solve the problem of having to screw straight through 3-or 4-inch-wide stock; they also conceal the fasteners. The jig shown, designed by Patrick Spielman, features a slot that allows a laminate trimmer to rout the screw recesses.

Using a Shop-Made Pocket-Hole Jig

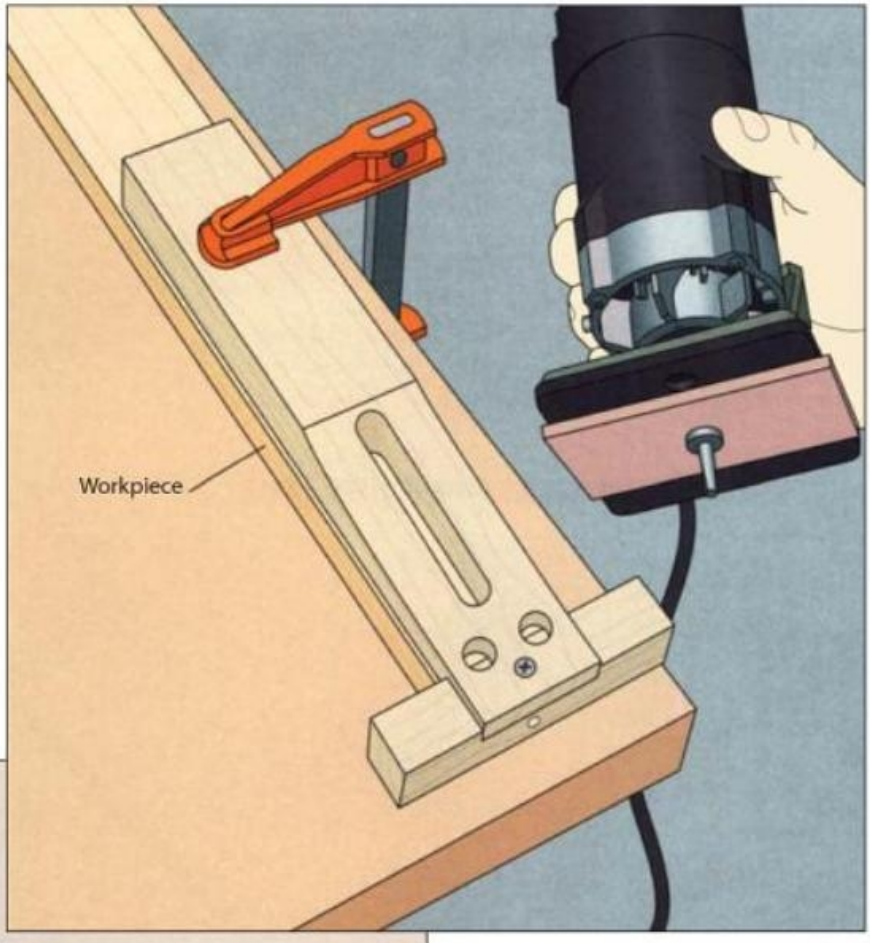


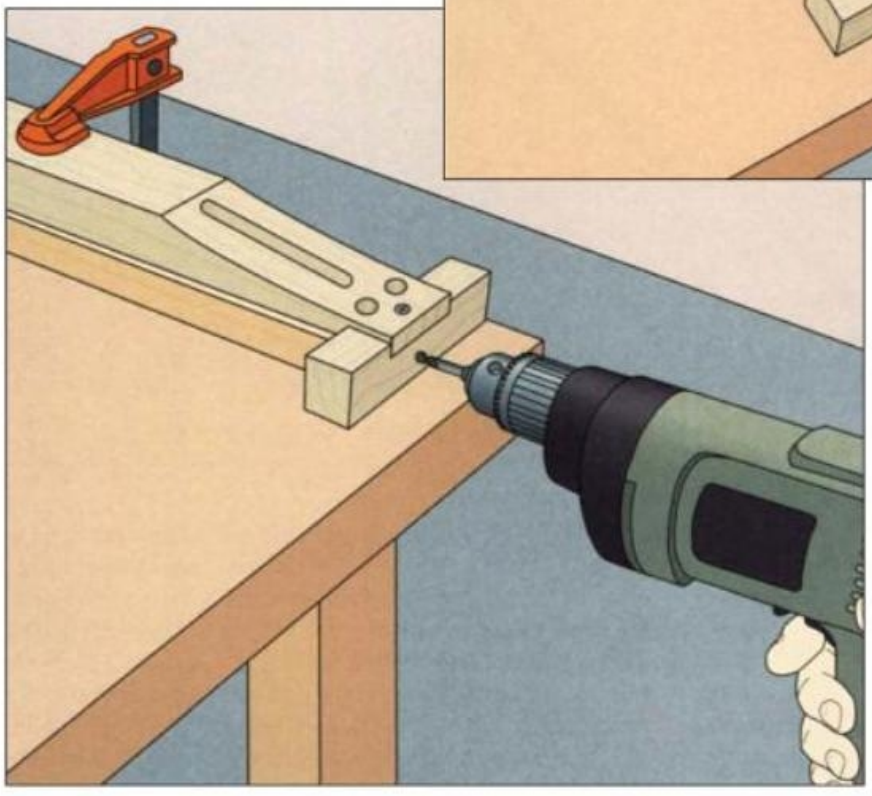
Making the pocket-hole jig

Cut the jig body and fence from hardwood, then taper the top face of the body in a gentle concave curve, starting the cut 5 inches from one end. Now rout a ½-inch-wide, 3½-inch-long slot through the body, centered on the tapered face, as shown above. Drill two peep holes through the body near the tapered end; the holes will help you align the workpiece with the jig. Notch the top of the fence to accommodate the body, then glue the pieces together so the end of the body is flush with the outside edge of the fence. Once the adhesive has cured, bore the 3/16-inch-diameter guide hole through the fence; align the bit with the slot in the body as you drill the hole. Screw the body to the fence, making sure the fastener does not intersect with the guide hole. Finally, drive two brads into the inside edge of the fence, leaving their heads protruding, then snip off the heads with pliers; the pointed ends of the brads will help you position the workpiece against the fence. To prepare the laminate trimmer for the jig, cut a narrow shim from ¼-inch hardboard as long as the tool base is wide, drill a hole through it for the bit and template guide you will use, and fix it to the base of the trimmer with double-sided tape. (The shim will allow the router to ride smoothly along the slightly curved surface of the taper.)

Routing the pocket

Install a cutter and template guide in the laminate trimmer; the cutter diameter should be slightly greater than the heads of the screws you will be using to join the workpieces. Then set the stock on a work surface, place the pocket-hole jig on top and, with the brads securing the workpiece flush against the fence, clamp the assembly in place. Holding the trimmer above the jig with the bit centered over one end of the slot, turn on the tool and plunge the bit into the stock until the hardboard shim is flat on the jig body. Then feed the tool along the jig to the other end of the slot to finish the cut, pressing the template guide against the inside edges of the slot through the cut *(right)*.





Drilling the pilot hole

To complete the pocket hole, you need to drill the pilot hole for the screw used to secure the joint. Fit the bit into the guide hole in the jig fence and bore the hole *(left)*. The bit should emerge from the top of the workpiece, centered in the pocket you routed before.

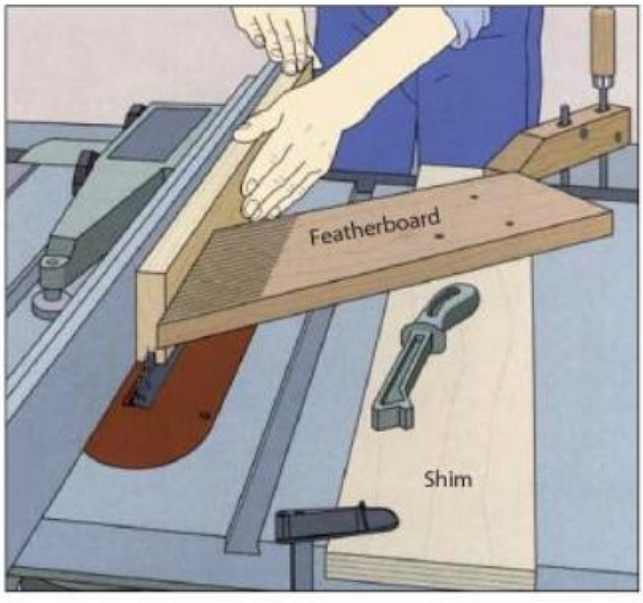
Spline Joints

Splines are thin strips of wood commonly used to align and reinforce butt joints, like the edge, case, and panel joints shown above *(clockwise from top left)*. Made from plywood or solid wood no more than ⅓ the thickness of the stock, splines extend into grooves cut in both mating surfaces. Solid-wood splines should be cut with the grain running across their width, rather than lengthwise, to provide maximum strength. The width of the grooves should equal the thickness of the splines; their depth should be slightly more than one-half the width of the splines to allow for excess glue.

Reinforcing a Butt Joint with a Spline

Cutting grooves and inserting splines

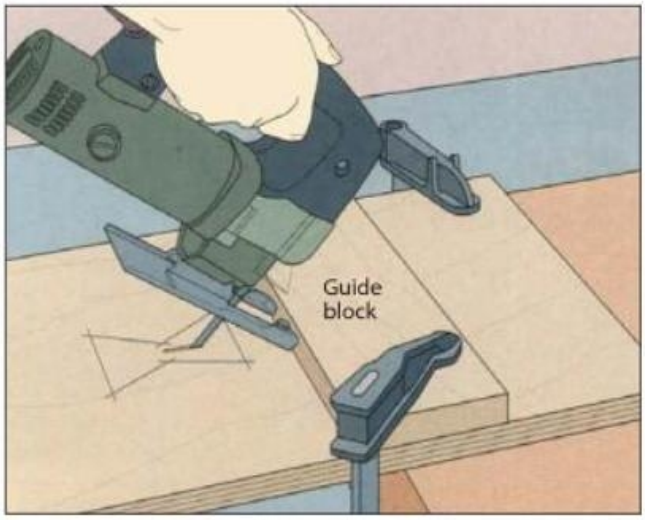
Mark the thickness of the spline on the leading end of one board. Install a dado head of the appropriate width on the table saw and set the depth of cut. Align the marks on the workpiece with the dado head, then butt the fence against the face of the stock. To secure the workpiece during the cut, clamp a shim to the table and screw a featherboard on top. The shim will allow the featherboard to support the middle of the workpiece. Turn on the saw and feed the board into the dado head, keeping the workpiece firmly against the fence *(right)*. If you are working with narrow stock, use a push stick to complete the pass. Repeat the cut on the mating board, then spread some glue in the grooves, insert the spline, and clamp the boards as in panel *(page 27)* or edge butt gluing *(page 26)*. **(Caution: Blade guard removed for clarity.)**

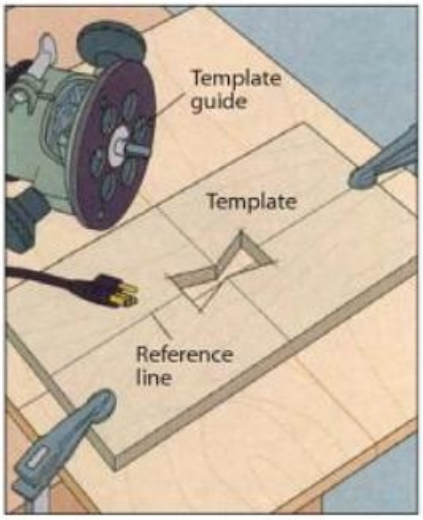


Butterfly Key Joints

Also known as a double dovetail, the butterfly key joint serves to strengthen panel joints. If it is cut from a contrasting hardwood, the key adds a decorative element. There are several methods for making the joint, but here, the keys are fashioned on a table saw and the recesses for the keys are plowed with a router.

Making a Butterfly Key Joint



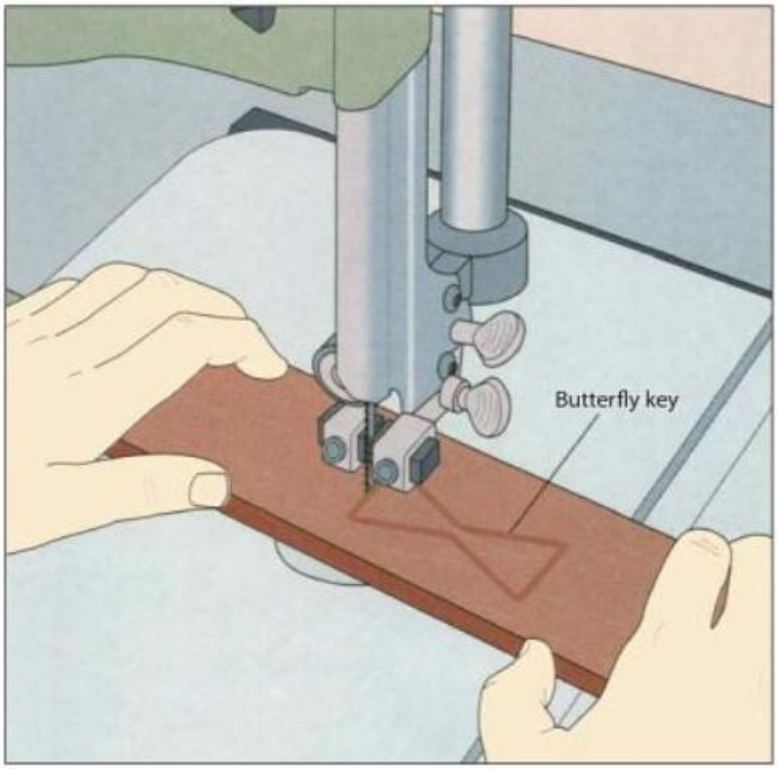


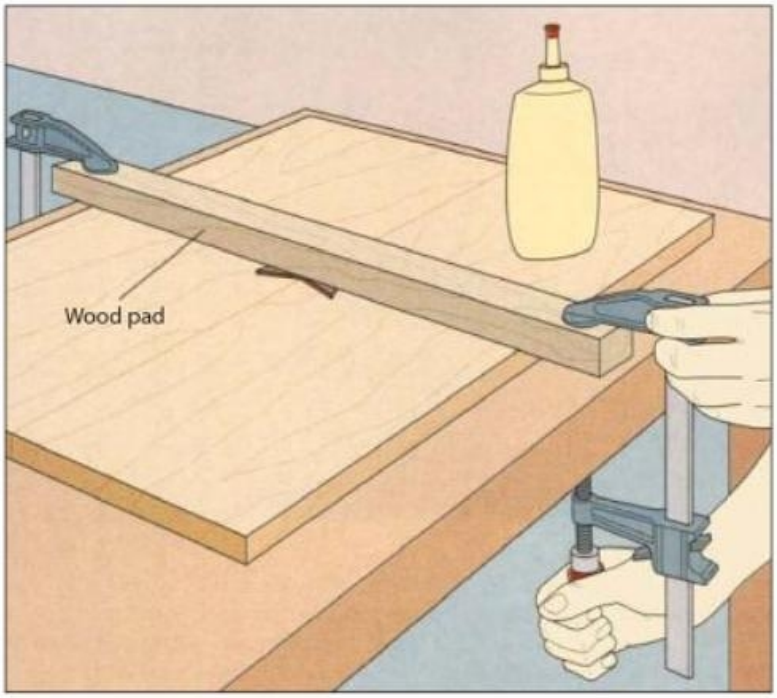
Routing the recess

Rout the recess for a butterfly key using a router guided by a template. To make the template, draw the pattern of the key on a piece of plywood that is smaller than your panel. Use a jig saw to cut out the pattern: Clamp a guide block to the template and plunge the saw blade into the stock within the outline while keeping the tool's base plate butted against the block *(above, left)*. Turn off the saw, remove the block and cut out the waste. Carefully sand the edges of the pattern since the router will transfer any imperfections from the template to the recess. Mark intersecting reference lines for the location of each key on the workpiece and template. Then clamp the template atop the stock, aligning the reference lines *(above, right)*. Install a straight bit and template guide in the router; set the depth of cut to no more than one-half the thickness of the workpiece. Rout out the recess, riding the template guide along the edges of the pattern throughout the operation. Square the corners of the recess with a chisel.

Cutting the key

Clamp your template atop a hardwood board; the stock should be at least ¼ inch thicker than the depth of the recess you routed earlier. Set the cutting depth on the router for a 1/16-inch-deep cut, then make a light scoring cut around the template. Cut out the key on the band saw, aligning the blade with the outside edge of the scored recess *(right)*. Keep your hands clear of the blade as you make the cuts.





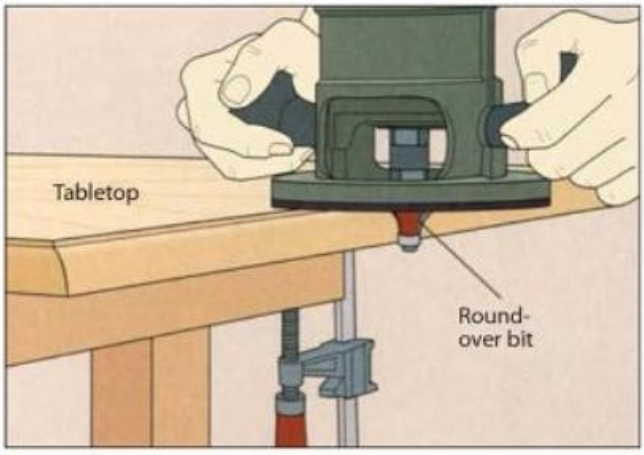
Gluing the key in the panel

Test-fit the key in the recess. If necessary, use a chisel to trim its edges. Once you are satisfied with the fit, spread glue in the recess and insert the key. To focus the clamping pressure, lay a wood pad across the workpiece and clamp both ends *(left)*. Tighten each clamp a little at a time until a thin glue bead squeezes out from under the key. Once the glue has dried, gently sand the surface to trim the key flush with the surrounding wood.

Rule Joints

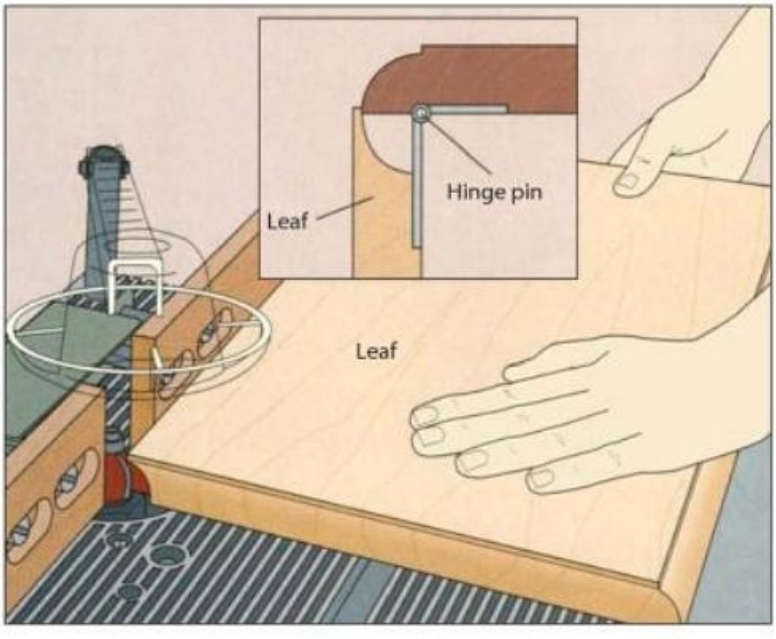
A common feature of drop-leaf tables, the rule joint consists of two matching hinged pieces. The leaf has a cove cut along its edge that mates with the tabletop's rounded-over edge. When the leaf is down, the decorative edge is visible.

Making a Rule Joint



Making the cut in the tabletop

Clamp the tabletop to a work surface with the edge to be shaped extending off the surface. Install a piloted round-over bit and adjust the cutting depth to allow you to reach the final depth in at least two passes. As you make the cut, press the bit pilot against the stock throughout the pass *(above)*. For a smooth finish, make your final pass a slow and shallow one.



Shaping the leaf and installing the hinge

Install a piloted cove bit whose diameter and profile match the one used before, then mount the router in a table. Align the fence with the bit pilot so that the width of cut will equal one-half the cutter diameter. Set the depth of cut to reach your final depth in several passes. Feed the leaf into the bit, bracing its edge against the fence *(left)*. After each pass, test-fit the pieces; continue cutting until the tabletop and leaf mesh with a slight gap between the two. Finish the joint by installing a rule-joint hinge on the undersides of the pieces: Position one hinge leaf against the tabletop and the other against the leaf so the hinge pin is aligned with the start of the round-over cut on the tabletop *(inset)*. Outline and then rout mortises for the hinge leaves in the tabletop and the leaf. Screw the hinge in place.

Miter Joints

Miters are among the commonest of joints. Builders use them when trimming around windows and doors; cabinetmakers usually miter carcase corners and picture frames because the miter conceals end grain. Although frames and boxes usually demand 90° corners, a miter joint may be any angle. All are equally simple to make, so long as the rules of mitering are followed: Each intersecting end must be cut exactly at one-half the total angle of the corner. Thus, the two pieces forming a 90° angle are cut at 45° each; those forming a 45° angle are cut at 22½°.

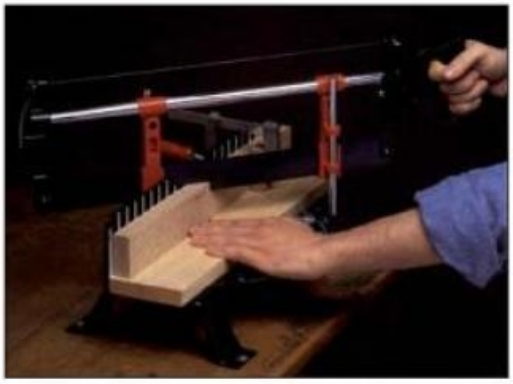
There are two types of miter joints: face miters and edge miters. Face miters *(page 53)* are cut across the faces of the pieces, and are often used to connect stiles and rails in frame-and-panel construction or join the members of a picture frame. Edge miters *(page 60)* can be made along the edges of the workpieces or across the end grain—also known as end miters or bevel miters. Because edge miters conceal the mating surfaces, they are used extensively in plywood carcase construction.

Miter joints are not only preferred for their clean lines. Because they offer more gluing area than ordinary butt joints, they are stronger. Still, any end-grain miter must be reinforced with splines, dowels, glue blocks, or biscuits.

Inserting splines is the method most commonly used to provide reinforcement *(page 56)*. Consisting of nothing more than strips of hardwood or plywood, splines are glued into grooves that are cut in both halves of a joint. The result is a strong, durable bond—even though its intention may be more decorative than functional, like the feathered spline demonstrated on page 58.

The angles of a miter joint can make it difficult to align during assembly; use special clamps and jigs like those illustrated on page 51 to make the glue-up process easier. And, properly made, the reinforcements themselves can assure proper alignment.

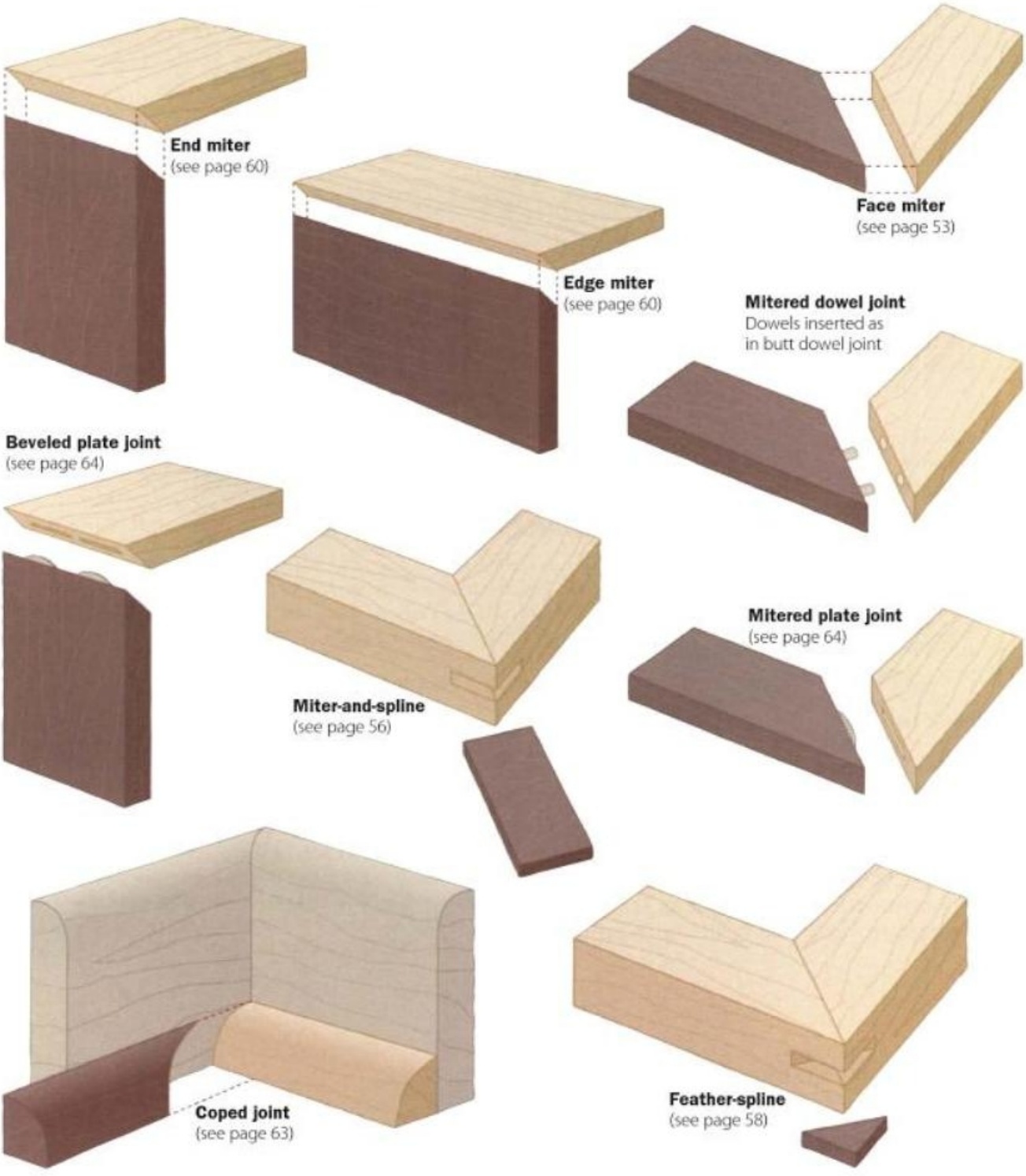
Whether reinforced or not, the success of every miter joint depends on accurate cutting. The table saw miter jig on page 54 is designed to ease that task. But whether you are using a table saw, radial arm saw, or a backsaw with a miter box, careful measurement and proper setup will produce strong, attractive joints that will last for years.



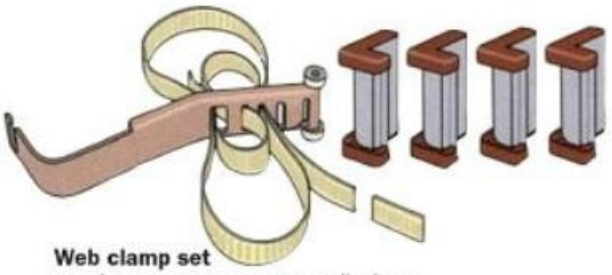
A miter box is invaluable for making accurate angle cuts. The commercial model shown above comes with its own saw, a solid metal base, and legs that can be fastened down to a work surface for added stability.

Making an octagonal carcase like the table support shown at left calls for a series of identical bevel cuts. For the eight pieces to fit properly, each edge must be cut at an angle of 22½° so that the total of all the angles adds up to 360°.

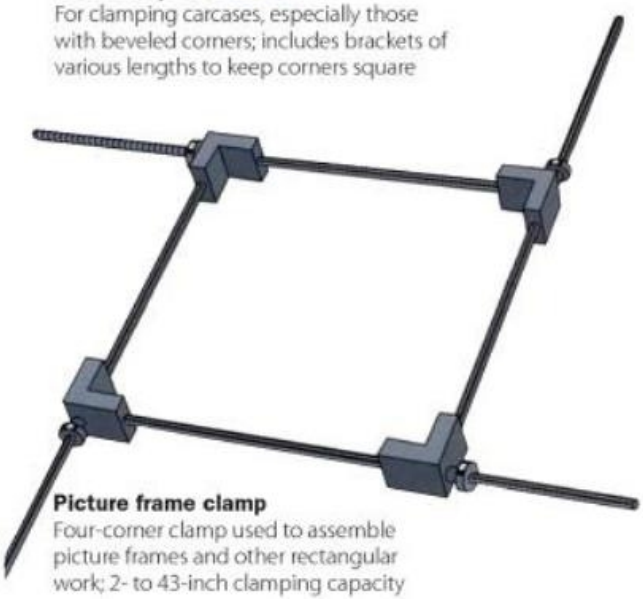
Common Miter Joints



Jigs and Accessories

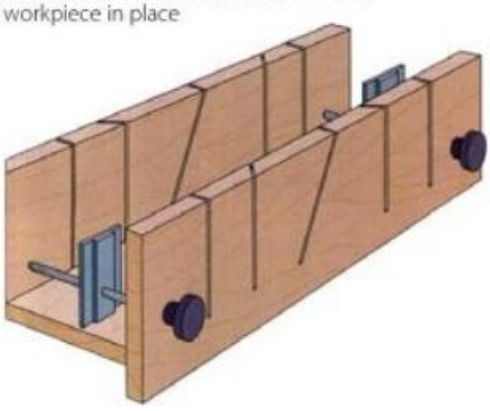


Web clamp set
For clamping carcases, especially those with beveled corners; includes brackets of various lengths to keep corners square



Picture frame clamp
Four-corner clamp used to assemble picture frames and other rectangular work; 2- to 43-inch clamping capacity

Miter box
Used with a backsaw to cut miters and bevels. Model shown features slots for straight cuts, 45° miter cuts, and 45° bevel cuts; clamps at each end hold workpiece in place



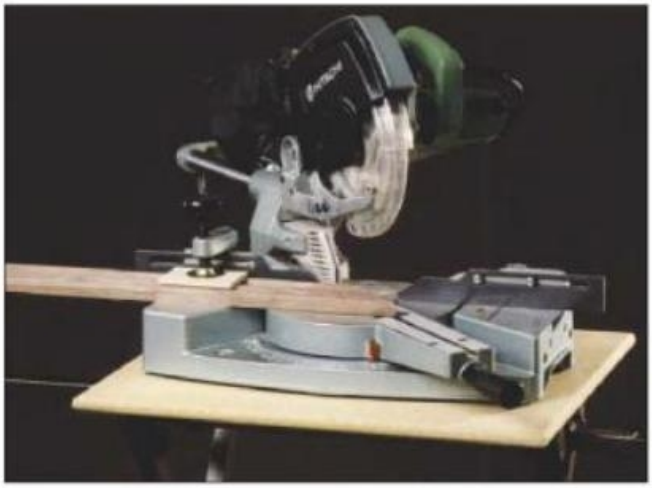
This commercial miter box, which comes with its own handsaw, can be adjusted to make a cut at any angle between 0° and 90°. For maximum convenience, the jig is fastened to a plywood base, which is then clamped to the work surface.

Corner clamp
Clamps miter joints up to 3 inches wide so that adjoining pieces are kept at right angles to each other; four clamps are required to glue up frame in one operation

Web clamp
Also known as strap clamp; used to apply equal pressure around the circumference of a piece as when clamping a carcase assembled with several beveled pieces. Typically features a 1-inch-wide, 15-foot-long nylon strap with a ratcheting buckle, four corner brackets, and a wrench

Making Miter Joints

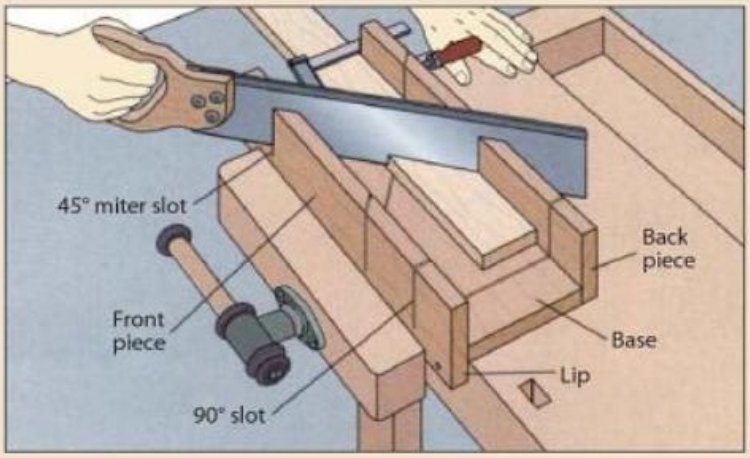
Resist the temptation to cut miters freehand; the slightest error will result in gaps that are esthetically and structurally unsound. If you are making a standard 45° cut, use a combination square to set up your table saw or radial arm saw; or use a miter box with a backsaw. For a miter or bevel cut at any other angle, adjust your saw using a sliding bevel and a protractor. Make test cuts on a scrap board, then check your results. Through use, the slots in a wooden miter box can become out-of-square or too wide, resulting in a poorly fitting joint; you can achieve a good fit by sawing one half of a joint face up and the mating piece face down.



A sliding compound saw is set up to miter a length of molding. It is a good idea to mount the saw on a portable miter stand, which enables you to work at a comfortable height. The model shown features support arms that can be adjusted to extend 4 feet on each side of the blade to accommodate long workpieces

A Miter Box

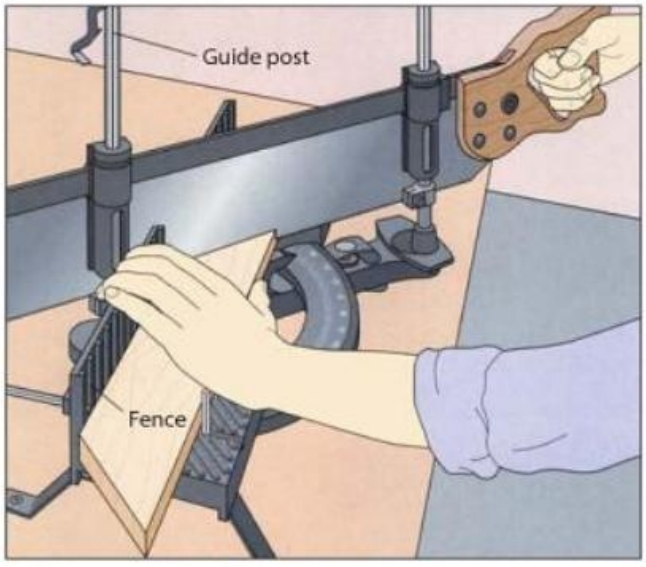
Cut three 15-inch-long pieces of hardwood or ¾-inch plywood for the base and the front and back pieces. Make the base wide enough for the stock you will be sawing. Rip the front and back pieces so that the depth of the box will be ½ inch less than the width of your backsaw blade from its teeth to the bottom of the spine. Cut the front piece 1 inch wider than the back piece to form a lip at the bottom of the box. Screw the front and back pieces to the base so that the top edges of the box are level. Use a combination square to mark cutting lines for the slots on the box's top edges. Lay out a 90° angle slot 3 inches from one end, and a 45° angle slot 3 inches from the other end. Outline a second 45° slot in the opposite direction between the first two slots. Make the cuts with a backsaw, using blocks clamped to either side of the cutting lines to guide the blade.



To use the box, secure the lip in a vise, then set the workpiece on the base, aligning the cutting line with the appropriate slot; clamp the board to the back piece. Start the cut by pulling the blade toward you a few times, then finish with push and pull strokes *(above)*.

Face Miters

Face miter joints are a popular choice for picture frames; they hide end grain and direct the eye toward the center of the frame.



Making a Face Miter Joint

Cutting the miter

To use the commercial miter box shown, secure the legs to a work surface. Swivel the saw assembly until the pointer indicates the miter angle you need; check the angle. Raise the saw assembly on the guide posts and slip the workpiece under the blade and on the base of the miter box. Align the cutting line with the blade and butt the board against the fence, then lower the blade onto the workpiece. Holding the stock firmly, make the cut as you would with a shop-made miter box *(left)*.

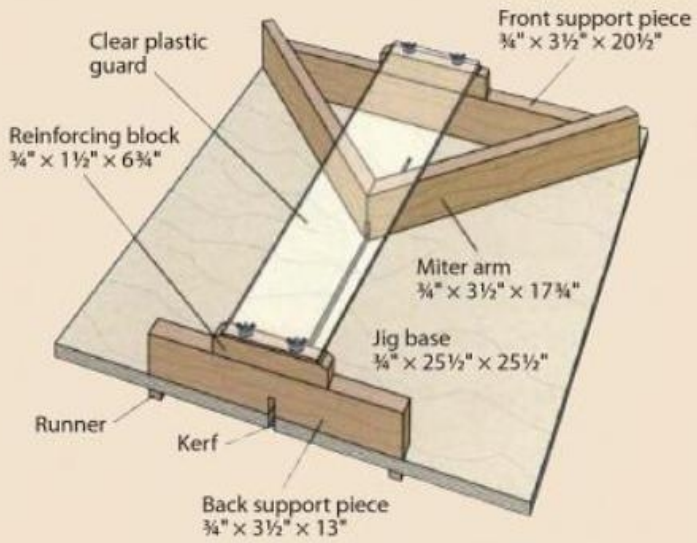
Clamping the joint

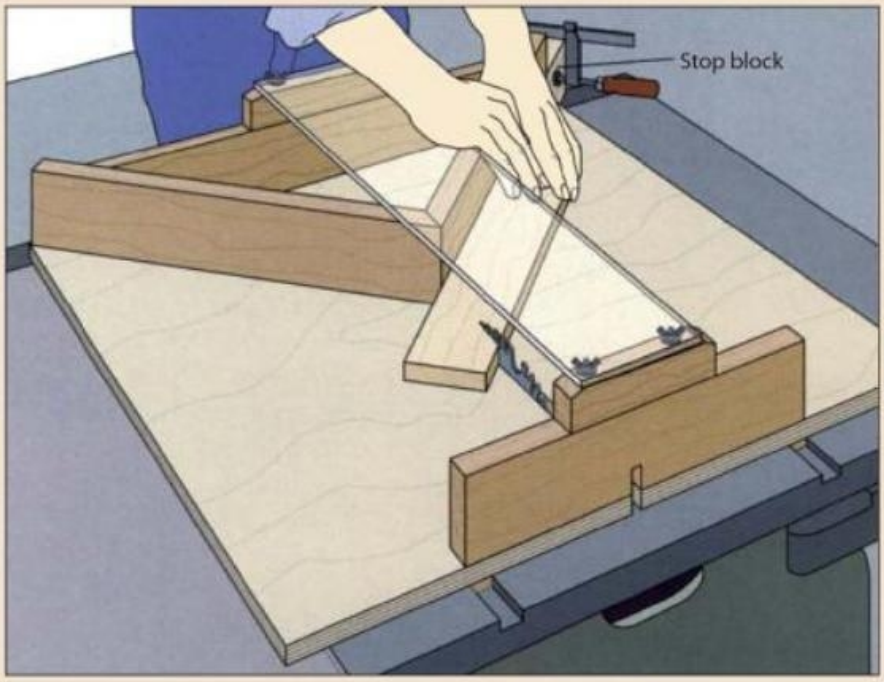
Apply adhesive on the contacting surfaces of the joint. If you are using corner clamps for glue up, you will need an individual clamp for each corner of the frame. Fit adjoining boards in the clamps and tighten the two screws alternately until the joints are tight *(right)*.

A Miter Jig for the Table Saw

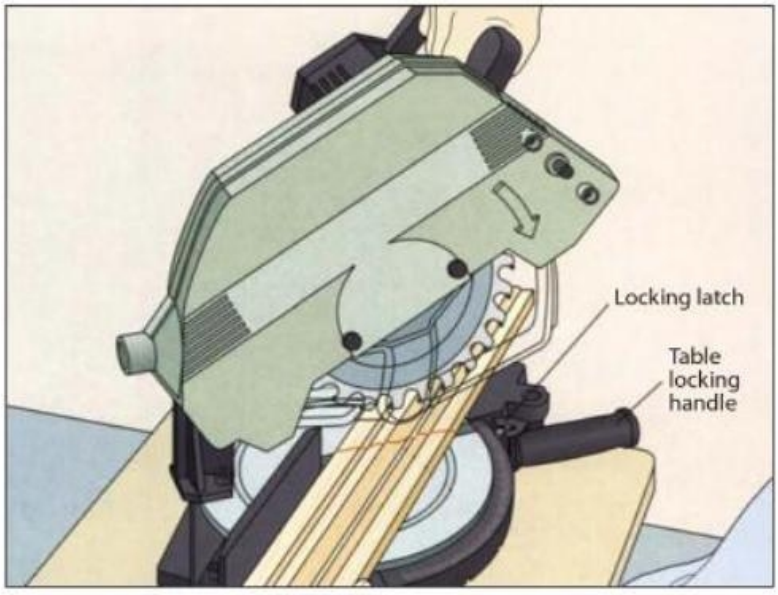
Making miter cuts on long, wide, or heavy workpieces can be tricky. The shop-built miter jig at right makes the task easier. Refer to the illustration for suggested dimensions.

Cut two 25-inch-long hardwood runners the same width as the saw's miter gauge slots. Bore clearance holes for screws into the undersides of the runners, 3 inches from each end and every 6 inches in between. Place the runners in the slots, then slide them out to overhang the back end of the table by about 8 inches. With the blade lowered below the table, position the jig base squarely on the runners, its edge flush with their overhanging ends; then screw the runners to the base, countersinking the screws. Slide the runners and the base off the front end of the table and drive in the remaining screws. Attach the back support piece along the rear edge of the jig, centered between the runners. Then, with the runners in the miter gauge slots, raise the blade and make a cut through the support piece and three-quarters of the way across the base. Turn off the saw and lower the blade. Next, place the miter arms at 90° to each other in the middle of the jig, centered on the kerf. Screw the arms and the front support piece in place. Attach the reinforcing blocks to the support pieces and fasten a clear plastic blade guard to the blocks with hanger bolts, washers, and wing nuts.



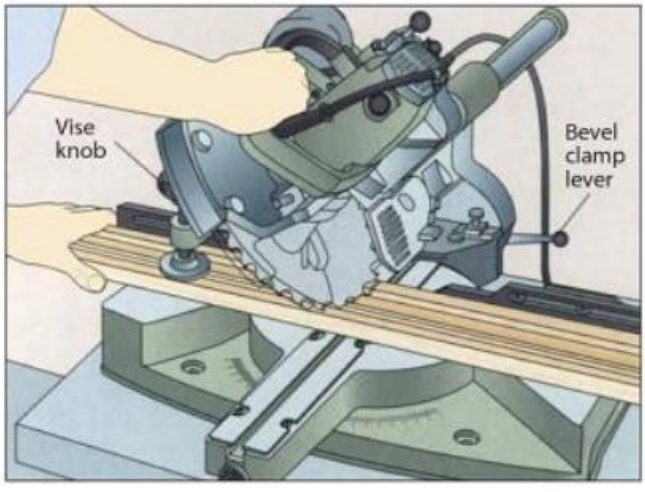


To use the jig, fit the runners into the miter gauge slots. Slide the jig toward the back of the table until the blade enters the kerf. Butt the workpiece against the left arm of the jig, align the cutting line with the saw blade, and clamp a stop block to the arm at the end of the board. Cut the miter, holding the workpiece firmly against the arm and stop block *(left)*. Make the mating cut the same way using the right arm of the jig.



Making a miter cut

Adjust the saw to the desired miter angle. On the model shown at left, turn the table locking handle counterclockwise, depress the locking latch, and swing the table left or right until the pointer indicates the appropriate angle. Turn the handle clockwise to lock the table. Set your workpiece on the table and align the cutting mark with the table slot. The model shown features a laser beam to help you line up the cutting mark. Holding the workpiece firmly against the table and fence, turn on the saw by squeezing the handle trigger and bring the saw down slowly *(left)*. Once the cut is completed, release the trigger and lift the handle until the blade clears the workpiece.

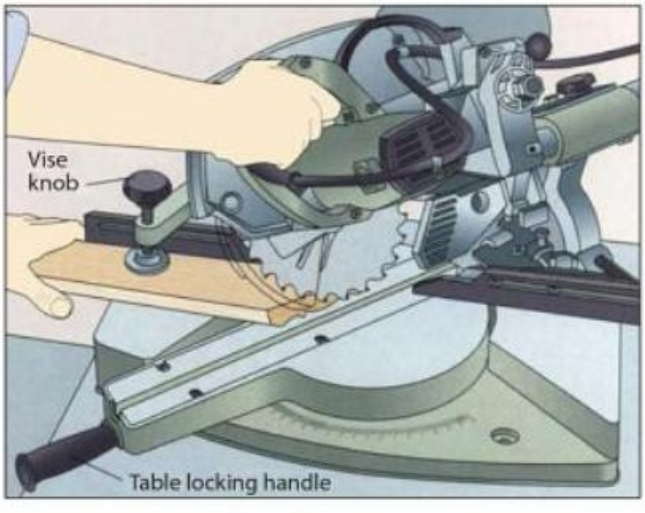


Making a bevel cut on a sliding compound saw

Adjust the saw to the desired bevel angle. On the model shown, loosen the bevel clamp lever, tilt the blade assembly to the left, and set the bevel to the required angle. Tighten the clamp lever. Set the workpiece against the fence, aligning the cutting line with the blade, and secure it in place using the vise knob. To make the cut, grip the handle and slide the blade assembly forward. Squeeze the trigger in the handle, bring the handle down, and slide the saw blade back to cut the workpiece *(left)*.

Making a compound cut on a sliding compound saw

Adjust the saw to the desired bevel and miter angles. On the model shown, start by setting the bevel angle *(above)*. To set the miter angle, loosen the table locking handle and swing the table to the left or right to the desired angle. Set the workpiece against the fence, aligning your cutting line just to the waste side of the blade. Clamp the workpiece in place using the vise knob. Make the compound cut *(right)* as you would a bevel cut.



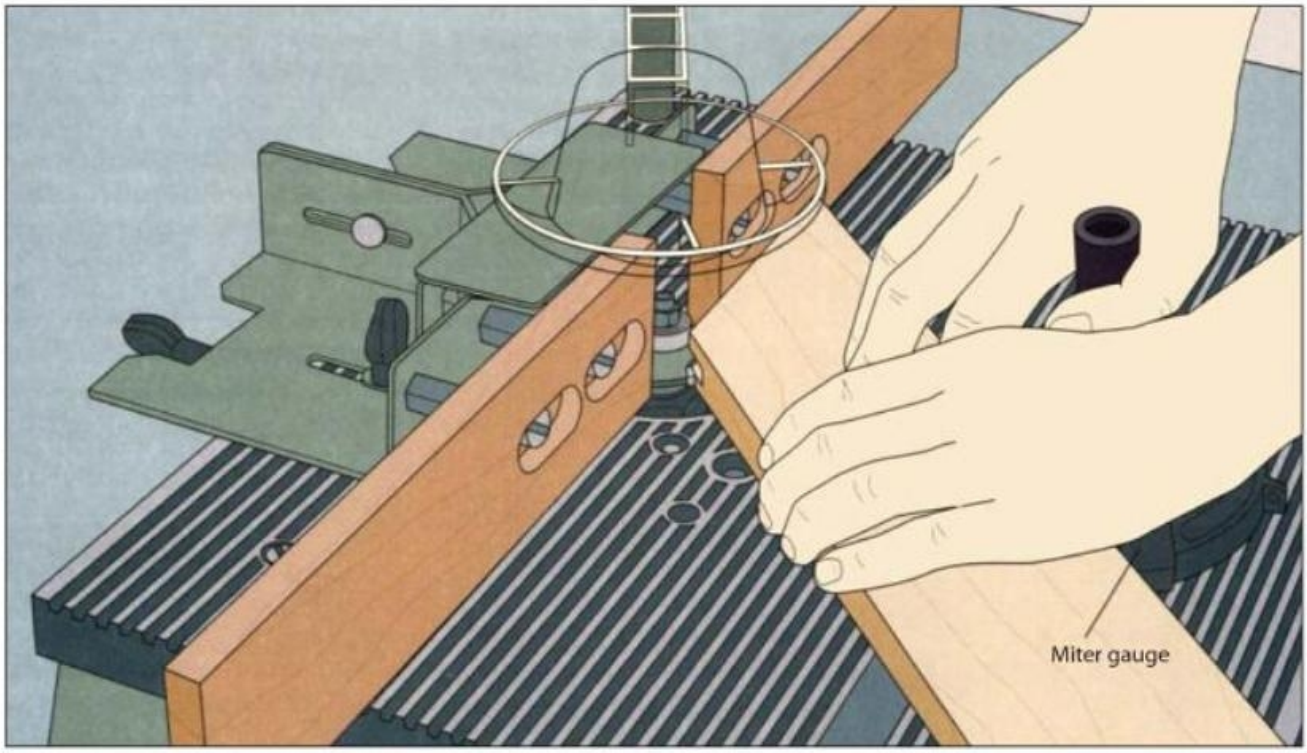
Miter-and-Spline Joints

The miter-and-spline is basically a face miter with a spline glued into grooves cut in the mitered ends. For maximum strength, the spline should be cut so that its grain runs across its width, rather than lengthwise, or be made from plywood.

Two Ways of Routing a Miter-and-Spline Joint

Using a straight bit

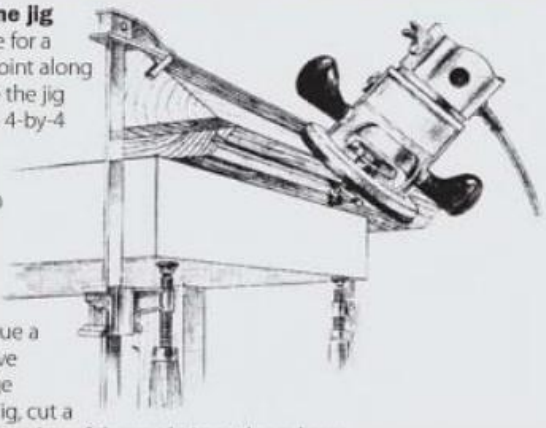
Make 45° miter cuts in each workpiece. Install a straight bit in your router and mount the tool in a table. Set the cutting depth so the groove you cut will accommodate one-half the width of your spline. To secure the workpiece, clamp a featherboard to the table in line with the bit. Rest the featherboard on a shim so the stock will be held flat against the fence; clamp a support board at a 90° angle to the featherboard to apply extra pressure. Rout the spline grooves by feeding the workpiece on end into the bit, keeping its face flush against the fence *(right)*. Once all the grooves have been made, cut a spline for each joint; make it twice as wide as the groove depth, less 1/32 inch for clearance. For maximum strength, use plywood or solid wood with the grain running across the width of the spline, rather than lengthwise.



Using a three-wing slotting cutter
You can also rout the grooves for miter-and-spline joints by using a three-wing slotting cutter and feeding the stock face-down into the bit. Position the fence in line with the bit pilot, making the cutting width equal to one-half the bit diameter. To set the depth of cut, place the workpiece flat on the table and center the bit's tooth on the edge of the stock. Feed the workpiece into the cutter with a miter gauge, holding the edge of the board flush against the gauge and one mitered end flat along the fence *(above)*.

Shop Tip

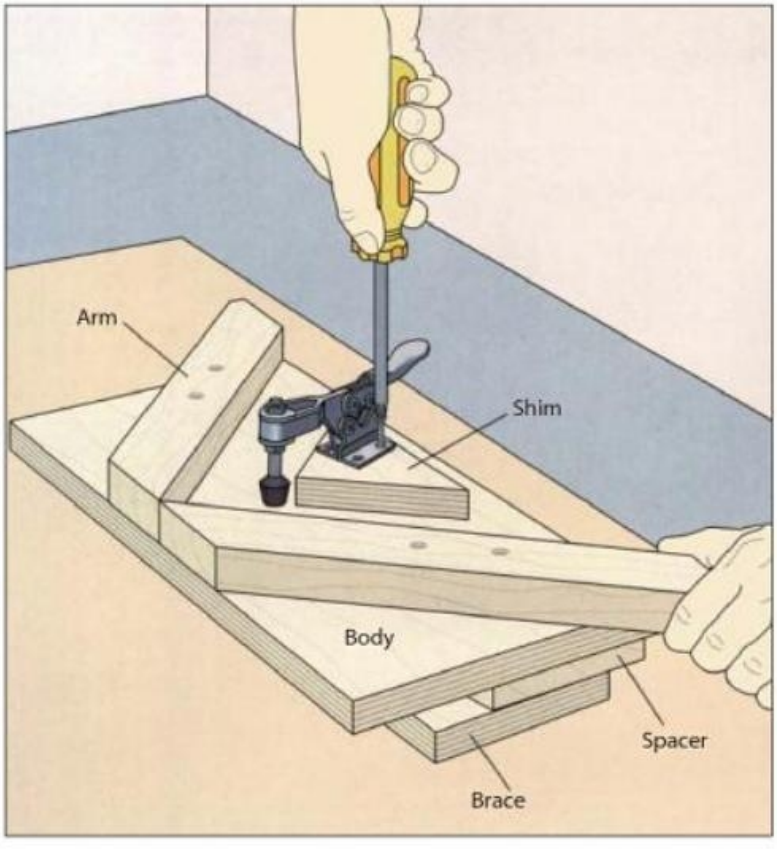
A miter-and-spline jig



To rout the groove for a miter-and-spline joint along a board edge, Use the jig shown here. Cut a 4-by-4 longer than your workpiece, then rip it diagonally. In one piece, joint the cut surface and rout a groove down its middle, then glue a spline in the groove to serve as an edge guide. To use the jig, cut a 45° bevel along the edge of the workpiece, then clamp the stock and the jig to a table with the edge of the workpiece slightly overhanging the jig. Use the router fitted with a straight bit to trim the beveled edge, then install a three-wing slotting cutter and repeat to rout the groove, keeping the bit pilot against the stock.

Feather-Spline Joints

The spline in a feather-spline joint serves more of a decorative role than a structural one. In contrast to the miter-and-spline, the groove for the feather spline is cut after the corner is glued up.



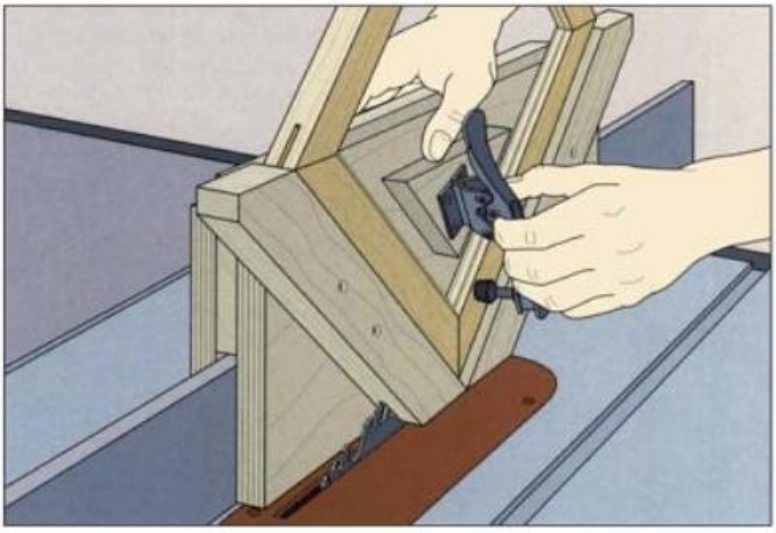
Making a Feather-Spline Joint

Making the jig

You can cut the grooves for a feather-spline joint on the table saw using the fence-straddling jig shown at left. The jig feeds the corner of a mitered frame across the table and squarely into the blade. Cut the body and brace from ¾-inch plywood and the arms from 1-by-2 stock. Make the body, spacer, and brace about 16 inches long and the arms 12 inches long; the body should be about 5 inches wide. (The thickness of the spacer and the width of the brace depend on the dimensions of your saw's rip fence.) Attach the spacer to the body and the brace to the spacer so the jig slides freely along the fence without wobbling. To prepare the arms, cut 45° miters at both ends and screw them to the body so that they are perpendicular to each other; check that the joint between them forms a 90° angle. To complete the jig, screw a shim to the body and fasten a toggle clamp to the shim *(left)*. Make certain there are no screws close to the bottom of the jig where the blade could strike one.

Cutting the grooves

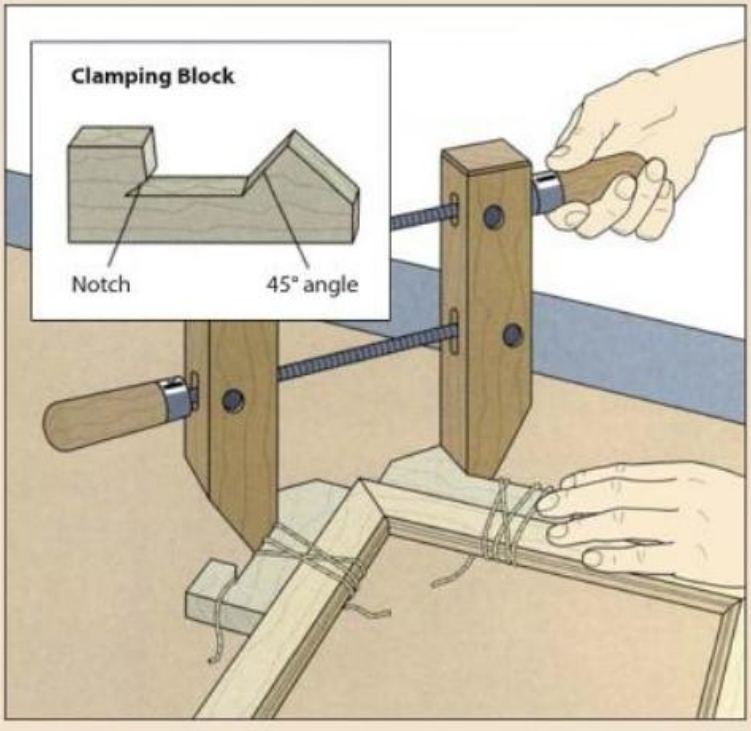
To use the jig, place it astride the fence and position the two so the cut will be made in the middle of the workpiece. Slide the jig along the fence to cut grooves through the mitered ends of the arms. Turn off the saw and pull the jig back to the front of the table. Seat the frame in the jig so a corner is butted against the center of the V formed by the arms and clamp the workpiece in place. Feed the stock into the blade *(right)*, holding the jig with both hands. Cut triangular splines to fit in the grooves. Spread a little glue in the grooves and insert the splines. Once the glue has cured, cut and sand the projections flush with the frame.



Miter Clamping Blocks

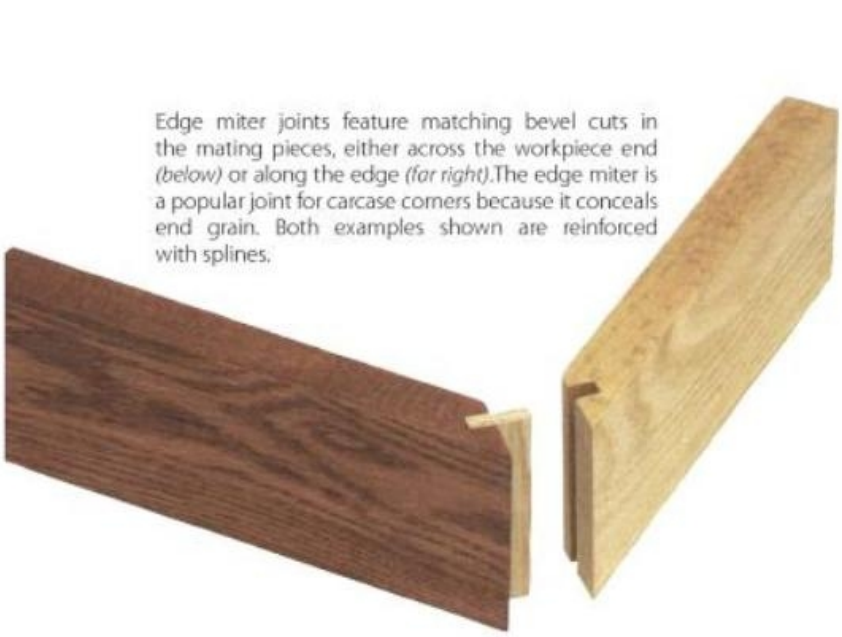
You can glue up mitered corners without special clamps, instead using handscrews and the special blocks shown at right. You will need one clamp and two blocks for each corner. Use stock the same thickness as your workpiece for the blocks; on one edge, cut the 45° angle and the V-shaped notch *(inset)*.

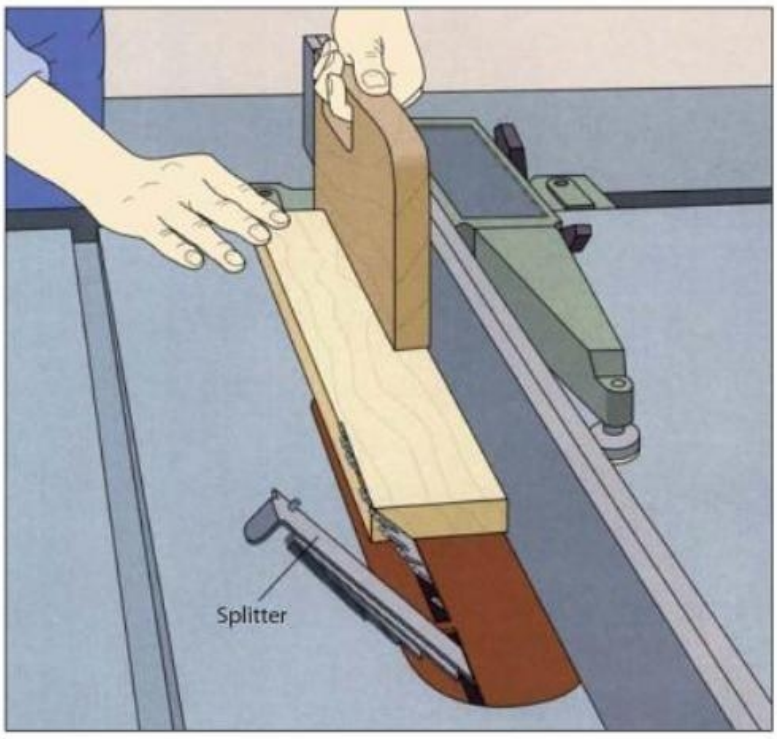
To use the blocks, apply glue to the contacting surfaces and press them together. At each corner, use string to tie the blocks snugly to the edges of the frame, securing the loose end in the notch. Set the jaws of the hand-screw against the 45° angle edges of the blocks and tighten the clamp *(right)* until there are no gaps between the mitered ends and a thin bead of glue squeezes out of the joint. To keep the frame square, tighten the hand-screws a little at a time, checking the corner with a combination square.



Edge Miter Joints

Edge miter joints feature matching bevel cuts in the mating pieces, either across the workpiece end *(below)* or along the edge *(far right)*.The edge miter is a popular joint for carcase corners because it conceals end grain. Both examples shown are reinforced with splines.



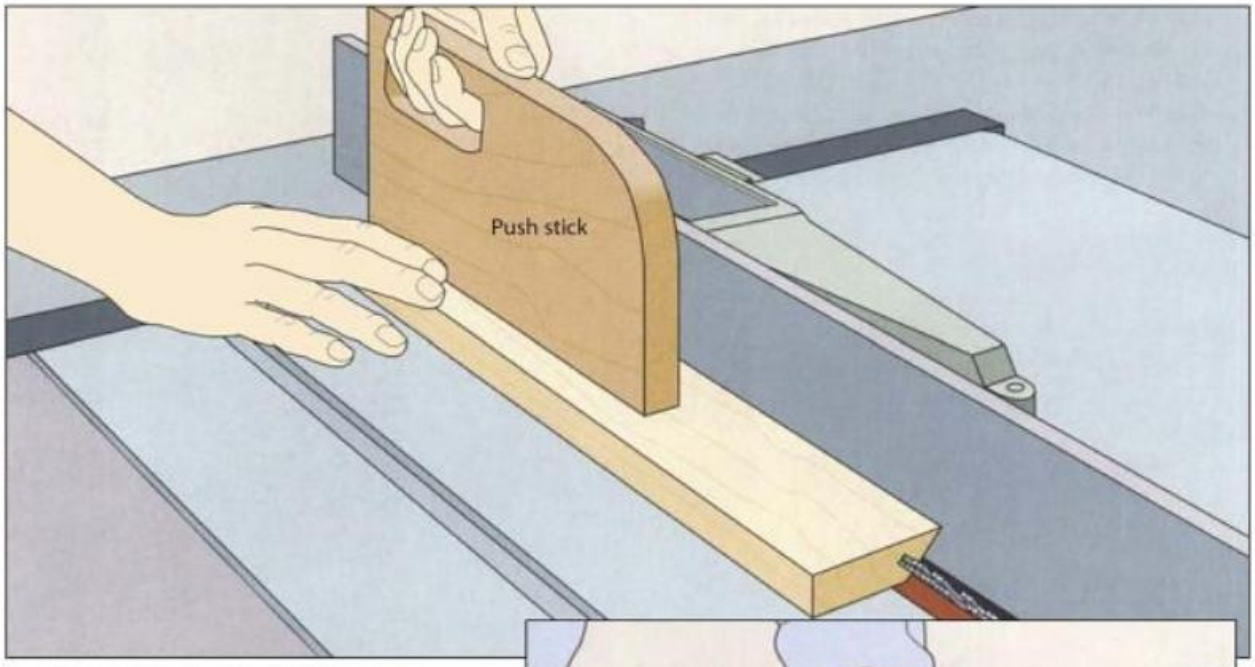


Cutting an Edge Miter Joint

Making the bevel cut

To cut a standard edge miter joint on the table saw, set the blade angle at 45° and position the rip fence for the width of cut, ensuring that the blade teeth are pointing away from the fence. Raise the splitter to keep the kerf open while the cut is being made, which will prevent binding and kickback. Feed the workpiece into the blade, using a push stick to keep the board flat on the saw table *(left)*. **(Caution: Blade guard removed for clarity.)** To cut the bevel across the end of a board, move the fence aside and feed the workpiece into the blade with the miter gauge. Once all the bevel cuts have been made, reinforce the joints with splines *(page 61)*, glue blocks *(page 62)*, or biscuits *(page 64)*.

Reinforcing Edge Miters with Splines

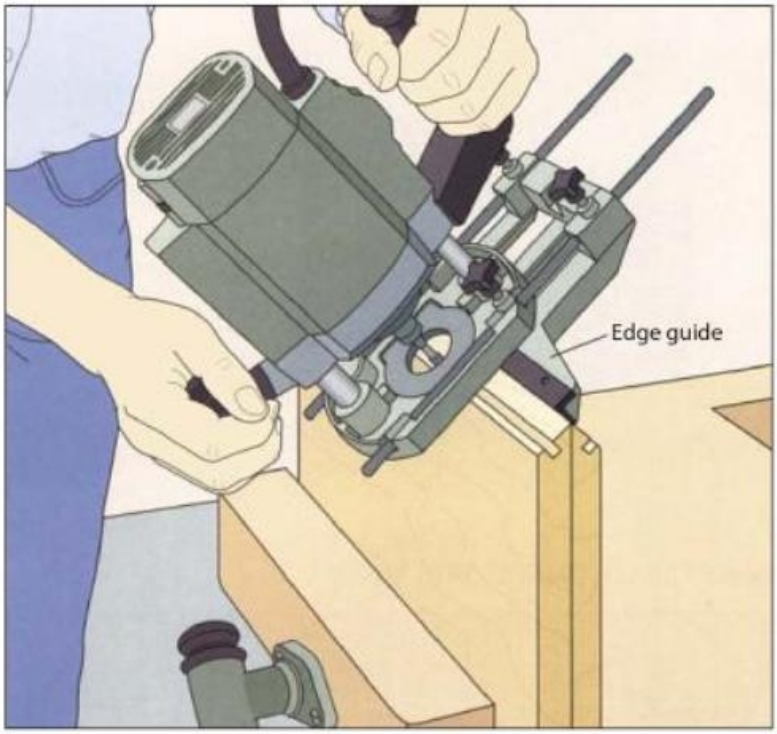


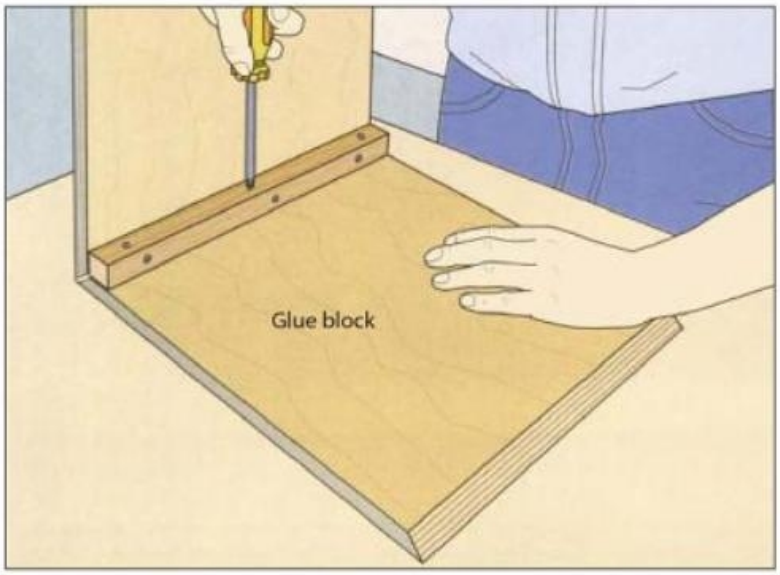
Cutting the grooves on a table saw

Install a dado blade, adjusting it to cut a groove the same width as the thickness of your splines—often ¼ inch. Set the blade angle at 45° and make the cutting depth slightly more than one-half the width of the splines—often ¾ inch. Align the mitered edge of the workpiece with the dado head so the groove will be closer to the inside corner of the joint to ensure that the cut will not penetrate the top face of the board. Butt the rip fence against the workpiece. With the saw unplugged, rotate the dado head by hand to make certain that it clears the fence. If not, attach an auxiliary wood fence, reposition the rip fence accordingly, and make a relief cut. Cut the groove as you would a bevel, using a push stick to apply pressure on the table *(above)*. To cut a groove across beveled end grain, set up the dado head and fence as you would for a cut along the edge. Then feed the workpiece with the miter gauge *(right)*, keeping the board flush against the gauge and the fence. Fashion splines and glue up the joint as you would a miter-and-spline joint *(page 56)*.

Routing grooves

You can also cut the grooves for a spline-reinforced edge miter using a router fitted with a commercial edge guide. Secure the mating pieces in a vise, beveled surfaces facing out, making sure that their ends and edges are flush. Install a straight bit as thick as your splines and set the cutting depth at slightly more than one-half the spline width. Attach an edge guide on the router and align the bit over one of the beveled edges so the groove will be closer to the inside corner of the joint. Then butt the guide fence against the other beveled edge and fix it in place. Rout the groove by riding the base plate flat on the edge to be cut while pressing the guide fence against the mating piece. Turn the router around and repeat the cut in the other piece *(right)*.





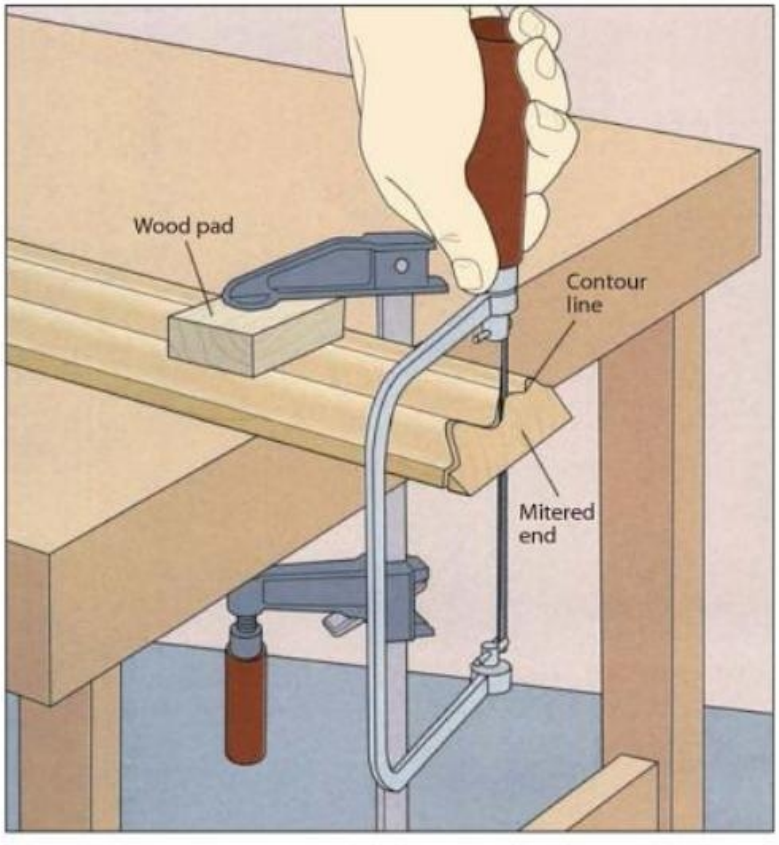
Reinforcing Edge Miters with Glue Blocks

Making and attaching glue blocks

Use 1-by-1 stock as long as the joint. Before assembling the carcase, screw a block to one piece, aligning the edge of the block with the inside edge of the bevel. Spread glue on the beveled surfaces, press the boards together, then attach the block to the other piece *(left)*. Repeat with the remaining corners of the carcase, using bar clamps if necessary to hold the assembly square.

Coped Joints

Coped joints are often used to connect two pieces of contoured molding at inside corners. They are superior to standard miters for concealing slight inaccuracies in the fit of the pieces. Coping is a two-step operation. First, a standard 45° bevel cut is made at the end of one piece. This reveals a contour line, which can then be followed with a coping saw.



Cutting a Coped Joint

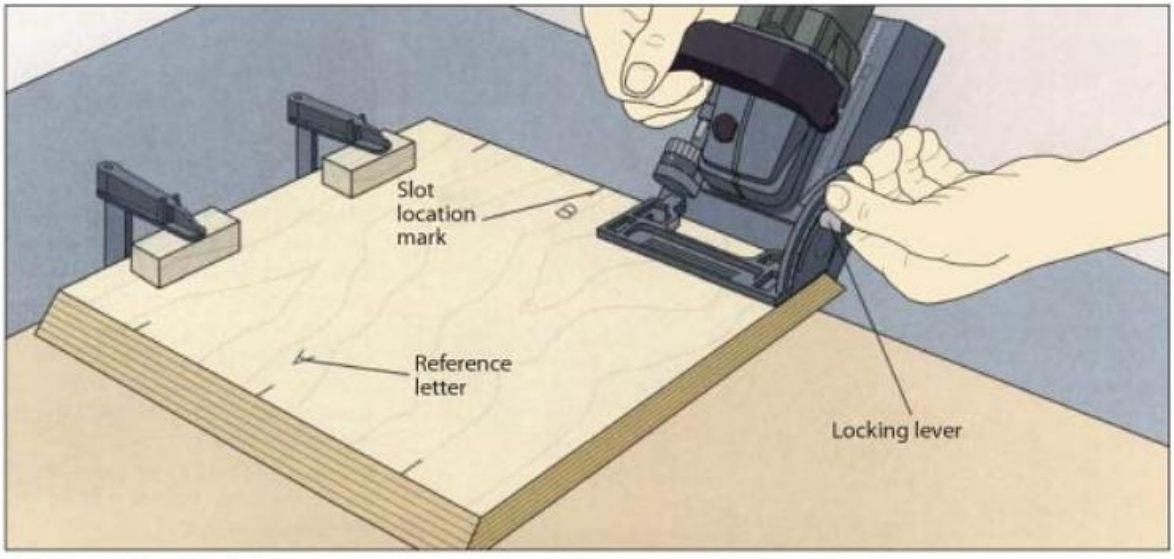
Coping contoured molding

Cut the end of a piece of molding at a 45° angle to reveal the contour line on the face. To make the coped cut, clamp the molding face-up on a work surface, protecting the workpiece with a wood pad. Install a narrow blade on a coping saw, making sure that the teeth are facing the handle so that the saw cuts on the pull stroke. Cut along the contour line carefully with the saw blade held perfectly upright *(left)*. For a tight fit, undercut the joint slightly, so that only the front of the board contacts the face of the mating piece. If the blade binds in the kerf, make occasional release cuts into the waste to let small pieces fall away. Position the coped end against the face of the mating piece to test the fit. Smooth out any slight irregularities with a round file or fine sandpaper wrapped around a dowel.

Mitered Plate Joints

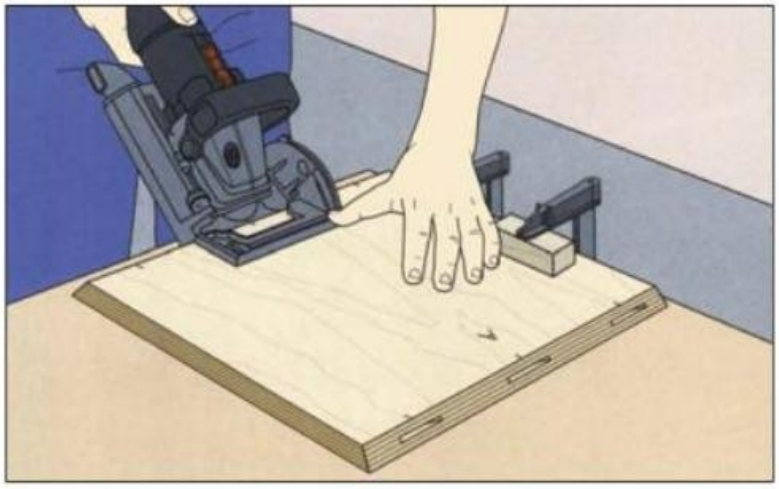
Plate joinery is a simple way to fasten boards or panels together, whether the joining surfaces are mitered or beveled. Once glue is added, the biscuits swell, creating a strong, durable joint.

Joining Beveled Corners with Biscuits



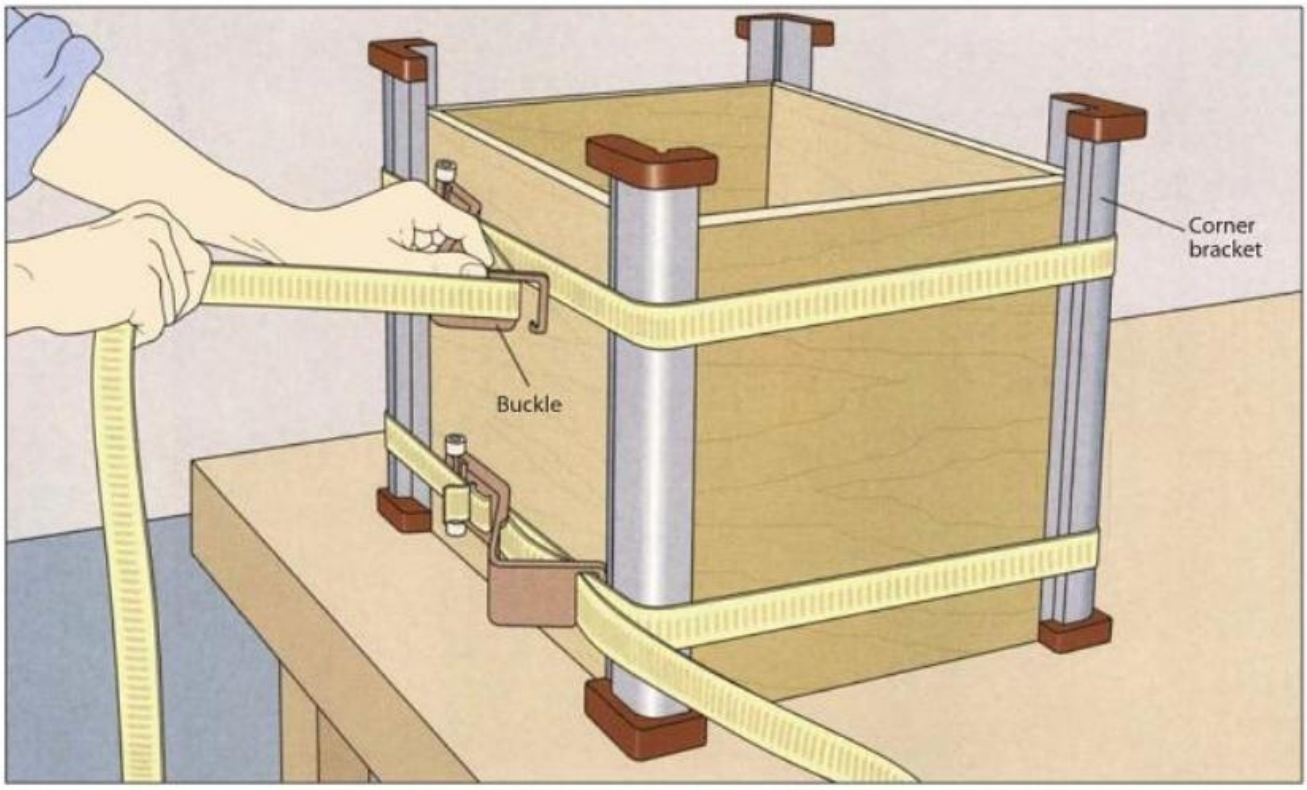
Setting up the plate joiner

Place two adjacent panels on a work surface, inside-face up, and mark slot locations on both pieces; also add reference letters for ease of assembly. Start about 2 inches in from the edges, spacing the lines at 4- to 8-inch intervals. Repeat the procedure at the other three corners of the carcase. Adjust the plate joiner's fence to the proper angle, following the manufacturer's directions. For the model shown, the panel is clamped to the work surface with one beveled end projecting off the edge. Rest the tool's faceplate against the end, loosen the fence locking lever and swivel the fence downward against the face of the panel. Lock it in place while the faceplate is flush against the bevel *(above)*.



Cutting the slots

Holding the tool firmly against the stock, align the guideline on the faceplate with a slot location mark. Switch on the tool and plunge the cutter into the workpiece *(left)*. Repeat the procedure to cut the remaining slots.



Gluing up the carcase

Once all the slots have been cut, set the panels on the work surface inside-face up. Squeeze glue into the slots and along the edges of the panels, inserting biscuits as you go. Assemble the carcase, working quickly to prevent the biscuits from swelling before you have had time to complete the glue up. To keep the beveled edges from slipping out of alignment as the adhesive is drying, secure the carcase with web clamps. The type shown here uses corner brackets to distribute pressure evenly along the length of each joint. Wrap straps around the unit and tighten them with the buckles before locking them in place *(above)*.

Lap and Groove Joints

The three dozen joints featured in this chapter are used in applications as varied as building cabinet carcases and piecing together frames and doors. This is a versatile family of joints, with the added virtue of being strong and simple.

In addition, almost all of these joints can be made in several ways, using either hand or power tools. For example, a dado can be cut with a router, a table saw, or a radial arm saw; it can be started with a hand saw and finished with a chisel. However, the typical woodworker will probably produce better-fitting joints in less time using power tools.

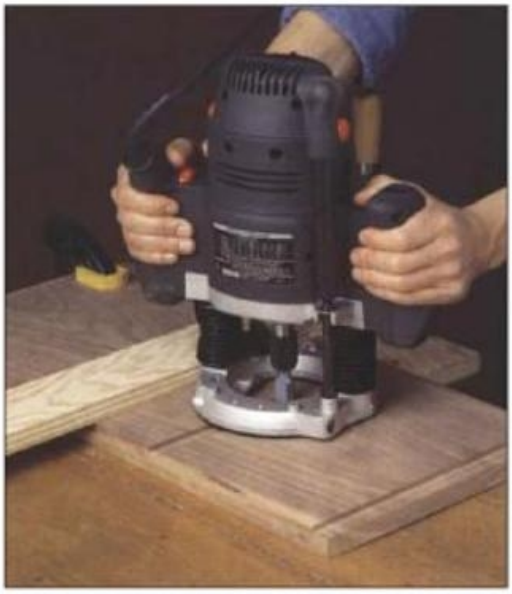
Perhaps the simplest of all joints are lap joints, the first covered in this chapter. As the name suggests, a lap joint is formed by laying one board over another and fastening the two at the required angle. The simple lap is weak and unattractive, but the joint can be rendered strong and elegant by first cutting a dado in one or both boards so that their faces lie flush with each other. The lap provides good long-grain surface contact for gluing, and additional reinforcement is seldom required unless the joint will be subjected to tensional stress.

Rabbet joints, the second group described, are most frequently used to join carcase and drawer corners, and less often for edge joining. Some variants, like the stopped rabbet *(page 86)* and the mitered rabbet *(page 87)*, are intended to conceal the end grain of the pieces. Remember, however, that any corner joinery that mates end grain requires reinforcement in the form of dowels, screws, or glue blocks.

A third group, tongue-and-groove joints, are most often used for edge-to-edge joinery. They may be glued, but sometimes are assembled dry so that the wood can move as humidity alters the moisture content.

Dado joints, illustrated above and on the opposite page, are simple and useful; they are the method of choice for installing shelves or assembling drawers. A self-locking joint can be made by adding a dovetail.

A catalog of lap, rabbet, groove, and dado joints and techniques for making them begins on page 68. Experiment with the methods shown, or alter them to suit your own skills and the tools you own. The results should be useful and enlightening.



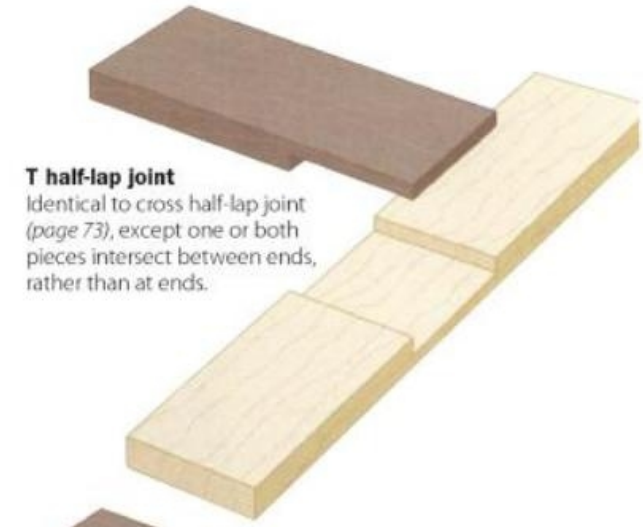
Shelves are often fixed to carcase sides with dado joints. Here, a router plows a through dado. An edge guide helps keep the cut parallel to the end of the panel.

The dado joint is a popular choice for assembling drawers. The dado-and-rabbet works well for joining the back to the sides, while the drawer front demands a stronger joint such as a double dado.

Lap Joints

The lap, rabbet, tongue-and-groove, and dado joints illustrated on the following pages appear quite different, but all are linked by a common feature: Each owes its strength to a channel of some sort in one piece that accepts a mating piece. Some joints, like the dovetailed half-lap *(page 76)*, are essentially variations on a theme, introducing a decorative effect or a slight modification that adds an extra measure of strength. Others solve a particular problem; for instance, the glazing bar half-lap *(page 77)* connects the muntins of a window sash or a glazed door.

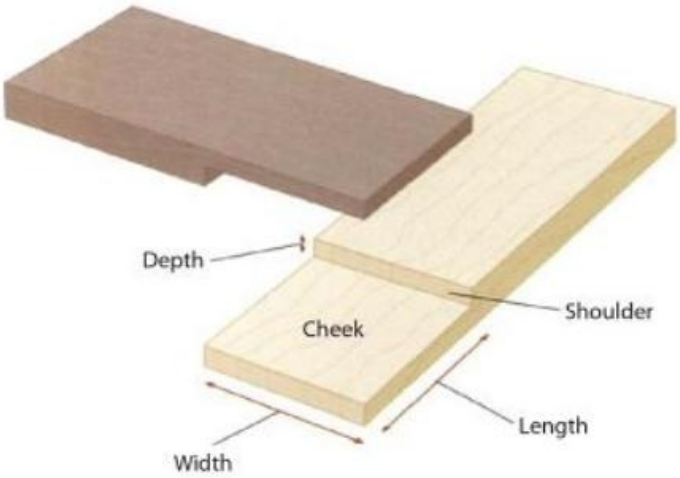
Most of the techniques shown on the following pages can be applied to make other joints shown in the chapter when a similar type of cut is needed. For example, the handsaw and chisel technique shown on page 75 can be used to make a dado, end rabbet, or lap cut; a backsaw and edge guide clamped onto the workpiece can take the place of a miter box.



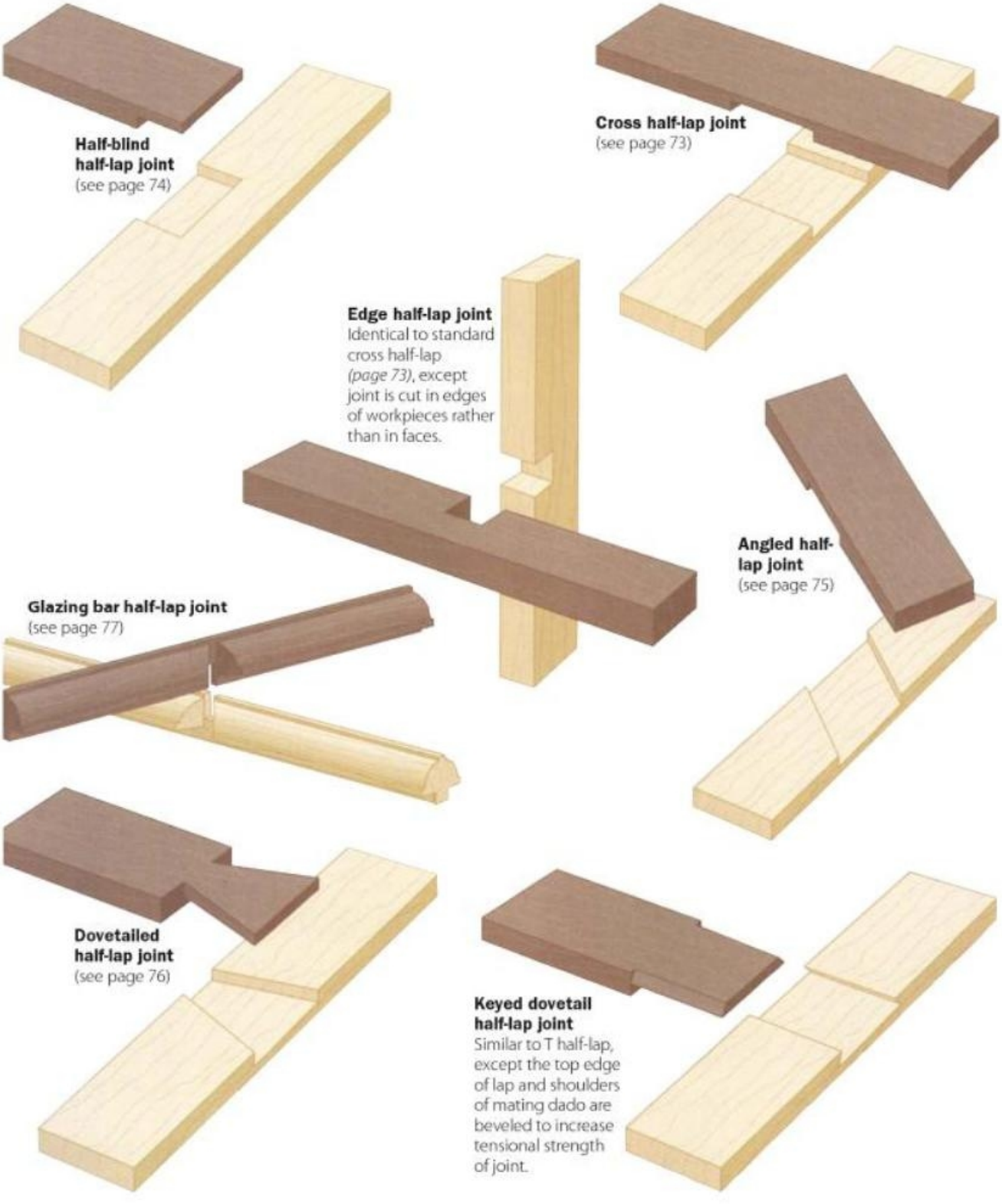
T half-lap joint
Identical to cross half-lap joint *(page 73)*, except one or both pieces intersect between ends, rather than at ends.

Mitered half-lap joint
Similar to corner half-lap *(page 70)*; cheek of one piece and shoulder of mating board are mitered at 45°.

Anatomy of a Corner Half-Lap Joint
(See Page 70)



Full lap joint
Dado in one piece is deep enough to house full thickness of mating board; dado is cut as in cross half-lap *(page 73)*.



Half-blind half-lap joint
(see page 74)

Cross half-lap joint
(see page 73)

Edge half-lap joint
Identical to standard cross half-lap *(page 73)*, except joint is cut in edges of workpieces rather than in faces.

Angled half-lap joint
(see page 75)

Glazing bar half-lap joint
(see page 77)

Dovetailed half-lap joint
(see page 76)

Keyed dovetail half-lap joint
Similar to T half-lap, except the top edge of lap and shoulders of mating dado are beveled to increase tensional strength of joint.

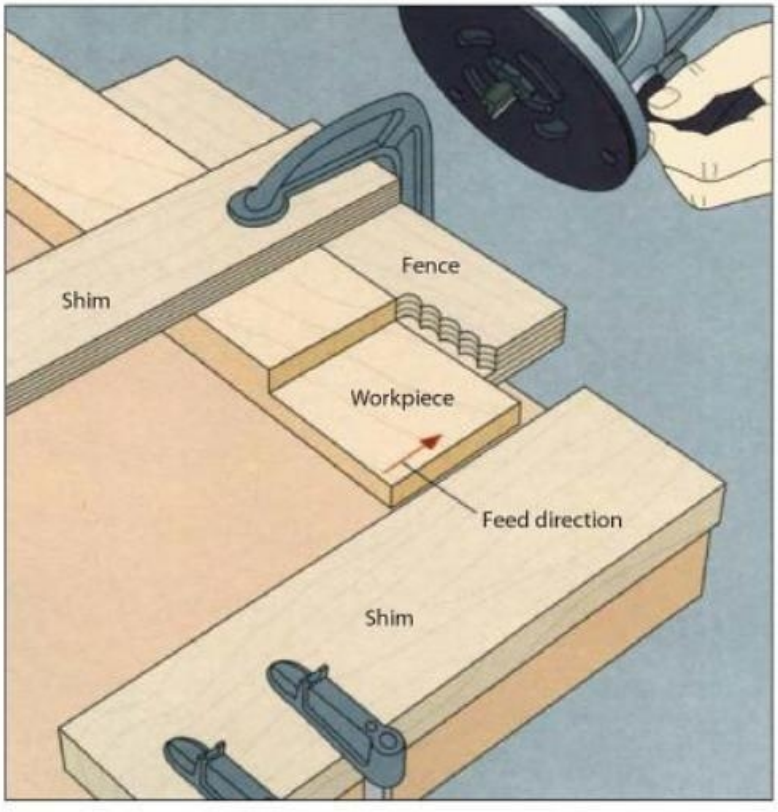
Corner Half-Lap Joint

The corner half-lap joint is often used to assemble frames and doors. Adding dowels or screws to the joint provides an extra measure of strength. The joint can be cut on a table saw with a dado blade, but a router will do the job just as well. Do not try to make the cut freehand. This joint depends upon perfectly square shoulder cuts. Use a T-square like the one shown below to guide the router. If you are making many repeat cuts on boards that are the same size, take the time to build the jig shown on page 72.

Routing a Corner Half-Lap Joint

Using a T-square jig

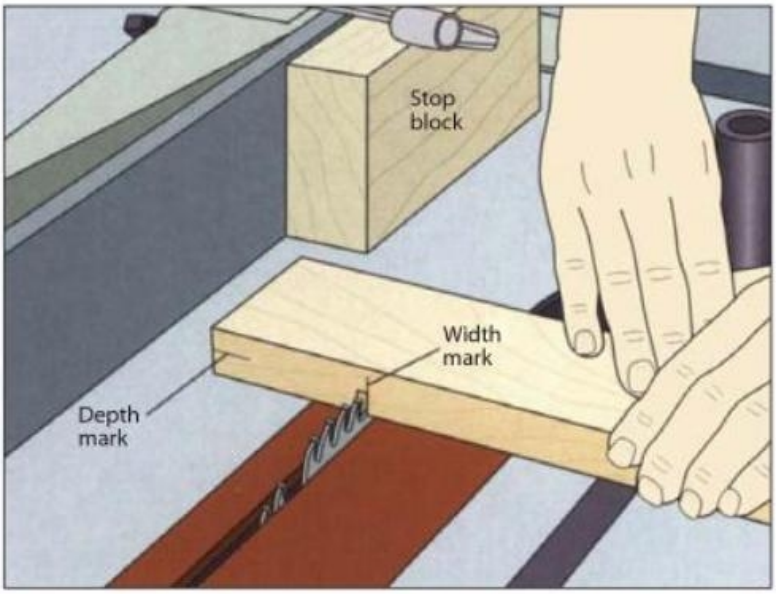
To rout half-laps with shoulders that are straight and square to the edges of the stock, use a T-square jig like the one shown at right. Make the jig from ¾-inch plywood so that each piece is about 4 inches wide; the fence should extend on either side of the edge guide by about the width of the router base plate. Assemble the jig by attaching the fence to the guide with countersunk screws, using a try square to make certain the two pieces are perpendicular to each other. Mark the shoulder of the half-lap on your workpiece and set the stock on a work surface. Install a straight bit in the router, align the cutter with the shoulder line of the half-lap, and clamp the jig atop the workpiece so the edge guide is butted against the router base plate, and the edges of the fence and workpiece are flush against each other. Rout the half-lap with a series of passes that run across the end of the stock, as shown by the arrow in the illustration. Start at the end of the workpiece and continue until you make the last pass with the router riding along the edge guide.

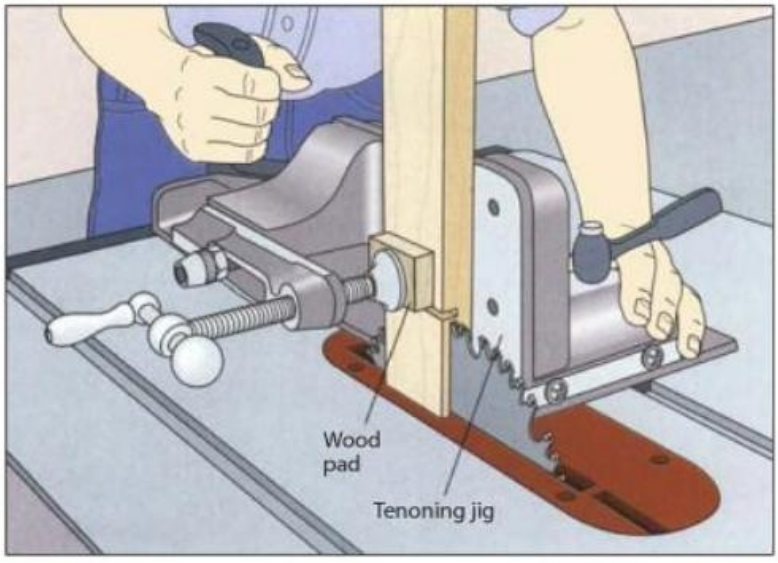


Making a Corner Half-Lap Joint

Cutting the shoulders

Make a half-lap on the table saw by cutting the shoulders first, and then the cheeks. Mark the depth and width of the half-lap on the edge of the workpiece, then install a crosscut blade and set the cutting height to one-half the stock thickness. Clamp a stop block to the rip fence; position the block so that the stock will clear it before reaching the blade. Align the width mark with the blade and position the fence for the width of cut. Then butt the end of the workpiece against the stop block and holding it in position on the miter gauge, feed it into the blade *(right)*.





Cutting the cheeks

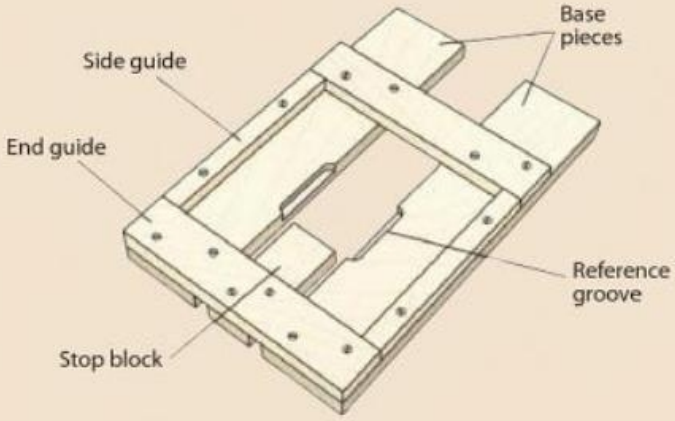
Install a commercial tenoning jig on the table following the manufacturer's instructions; the model shown slides in the miter slot. (Instructions for building a shop-made tenoning jig are on page 72.) Clamp the workpiece to the jig, using a wood pad to protect the stock. Raise the blade to the width of the half-lap, then shift the jig laterally to line up the depth mark with the blade. Push the jig forward to make the cut *(left)*.

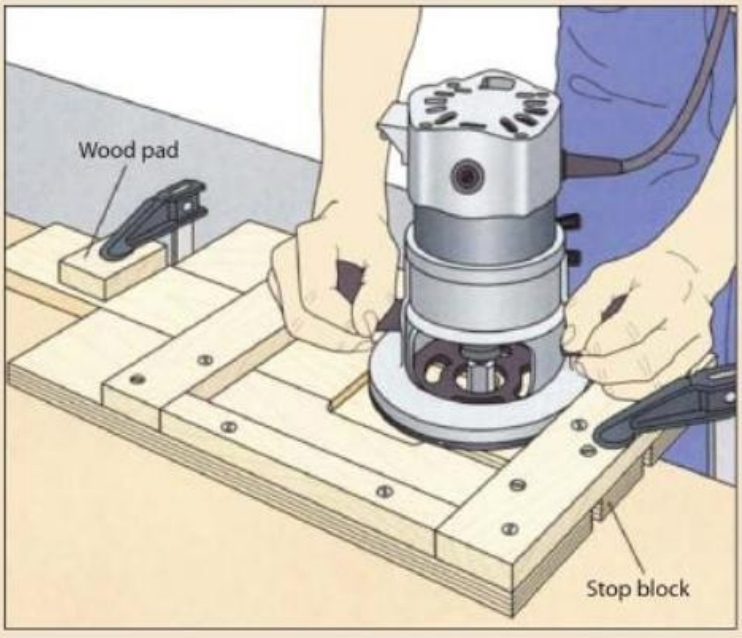
Corner Half-Lap Joint Jig

If you have to make corner half-laps in several boards of the same size, it is worth taking the time to build the jig at right. Cut the two base pieces and the stop block from plywood that is the same thickness as your stock. The base pieces should be wide enough to accommodate the edge guides and support the router base plate as you cut the half-laps. Use solid wood strips for the four edge guides.

To assemble the jig, mark the shoulder of the half-lap on one workpiece and set the board face-up on a work surface. Butt the base pieces against the edges of the board so that the shoulder mark is near the middle of the base pieces. Install a straight bit in the router and align the cutter with the shoulder mark. Position one end guide across the base pieces and against the tool's base plate. Without moving the workpiece, repeat the procedure to position the opposite guide. Now align the bit with the edges of the workpiece and attach the side guides, leaving a slight gap between the router base plate and each guide. (The first half-lap you make with the jig will rout reference grooves in the base pieces.) Slip the stop block under the end guide, butt it against the end of the workpiece, and screw it in place. Countersink all fasteners.

To use the jig, clamp it to the work surface and slide the workpiece between the base pieces until it butts against the stop block. Protecting the stock with a wood pad, clamp the workpiece in place. Adjust the router's cutting depth to one-half the stock thickness. Then, with the router positioned inside the guides, grip the tool firmly, turn it on and lower the bit into the workpiece. Guide the router in a clockwise direction to cut the outside edges of the half-lap, keeping the base plate flush against a guide at all times. Then rout out the remaining waste, feeding the tool against the direction of bit rotation.





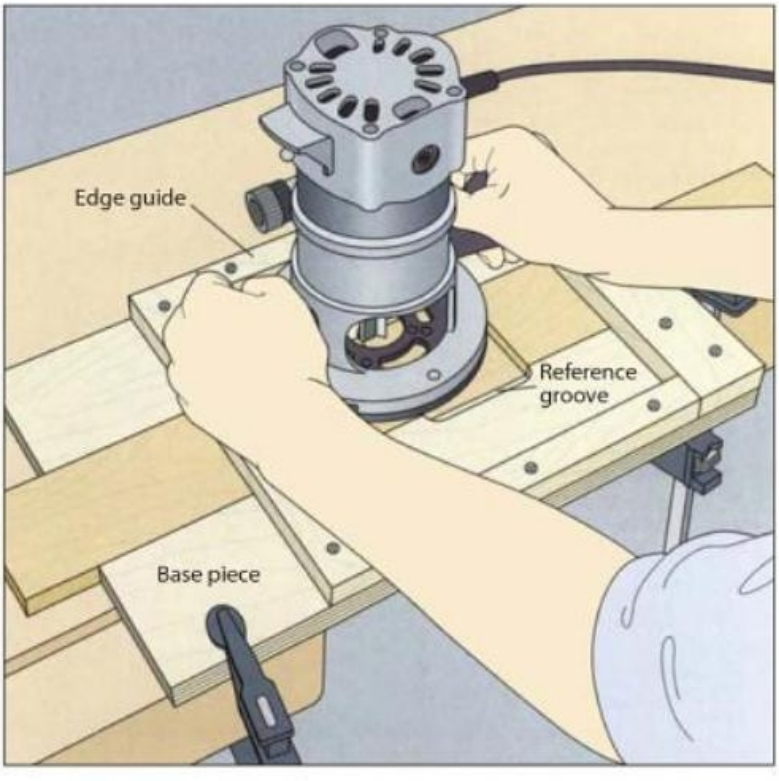
Cross Half-Lap Joints

Formed by cutting dadoes in two boards of equal thickness, the cross half-lap is an excellent method of joining the intersecting pieces of face frames. This joint requires no reinforcement.

Routing a Cross Half-Lap Joint

Using a router and a shop-made jig

Build a jig like the one shown on page 72, but eliminate the stop block; this will allow you to align any section of the workpiece with the middle of the jig. Make a test cut in a scrap board to rout reference grooves in the base pieces. These will make it easy to line up the cuts. Mark shoulder lines for the half-laps on the workpieces, then install a straight bit in the router and set the cutting depth for half the thickness of the stock. Position the stock in the jig, aligning the shoulder marks with the reference grooves in the base pieces. Clamp the jig to the work surface, then install a second clamp to secure the workpiece in place. Rout the half-lap *(right)* as you would to make a corner half-lap joint.



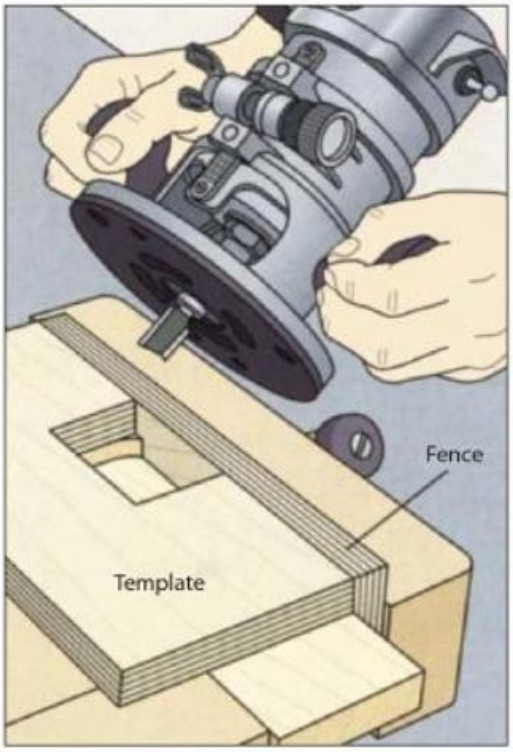
Half-Blind Half-Lap Joints

A variation of the T half-lap, the half-blind half-lap joint conceals the end grain of one member. The socket for the half-lap can be cut with a router, as shown below, or by hand using a chisel.

Making a Half-Blind Half-Lap Joint

Cutting the half-lap

Make this joint by cutting the half-lap on the table saw first, and then routing out the socket. Mark the shoulder of the half-lap on the leading edge of one piece. Install a dado head and set the cutting height to one-half the stock thickness. Butt the shoulder mark against the outside blade of the dado head, then position the rip fence flush against the workpiece. Cut away the waste in successive passes, working from the end of the board to the shoulder mark. Make the final pass with the board flush against the fence *(above)*. **(Caution: Blade guard removed for clarity.)**



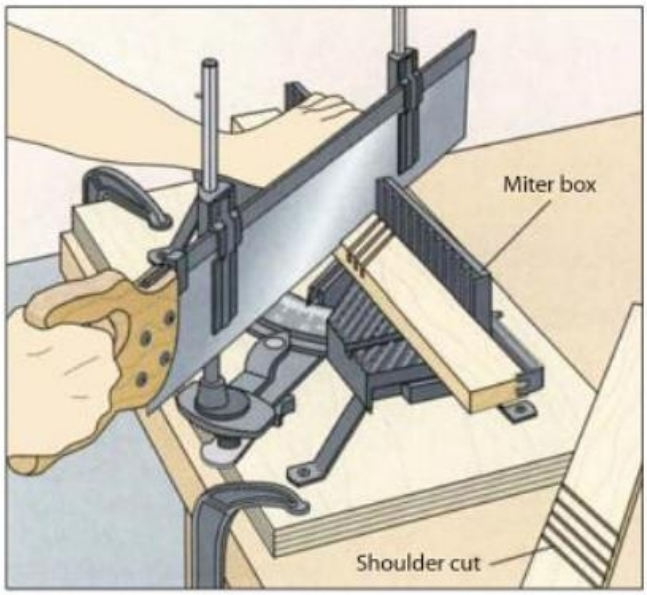
Cutting the joint socket

A plywood template is used to rout out the socket. Outline the half-lap cut in Step 1 on the template, then cut out the pattern with a band saw, saber saw or coping saw. Fasten a fence to the cut-out edge of the template with countersunk screws. Secure the template and the workpiece in a vise, aligning the cut-out with the outline on the stock. Install a top-piloted straight bit in your router and make the cutting depth equal to one-half the stock thickness plus the thickness of the template. Rout the outline of the socket by keeping the bit pilot against the template, then remove the remaining waste by moving the router in a clockwise direction, against the direction of bit rotation. Use a chisel to square the corners.

Angled Half-Lap Joints

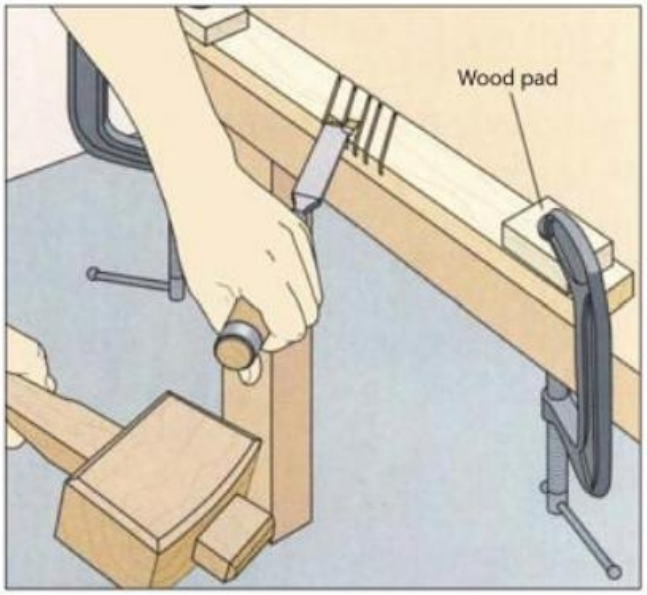
Woodworkers use the angled half-lap—or oblique lap joint—to join boards that cross at angles other than 90°, such as diagonal table leg stretchers.

Cutting an Angled Half-Lap Joint



Cutting kerfs in the half-lap outline

Mark the shoulders of the half-lap on the face of the workpiece, angling the lines to suit the job at hand. The cuts can be made with a radial arm saw, table saw, router, or, as shown here, a handsaw and miter box. Set the workpiece in the miter box with the edge against the fence and align one shoulder mark with the blade. Lock the blade at this angle and adjust the depth to one-half the stock thickness. Hold the board in position as you saw into it. Repeat to cut the other shoulder line. Then saw a number of kerfs between the two cuts *(above)*.



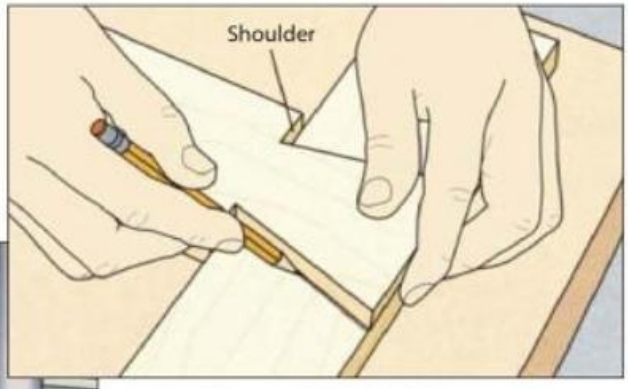
Chiseling out the waste

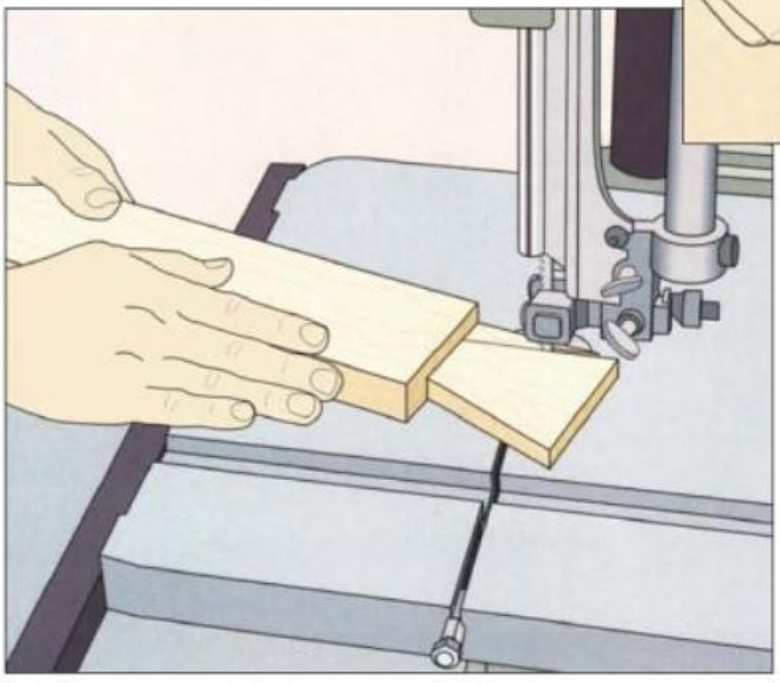
Clamp the workpiece face-up on the bench, protecting the stock with wood pads. Holding a wood chisel bevel-up horizontally, strike the handle with a mallet to split off the waste between the shoulder cuts *(above)*. After the bulk of the waste has been removed, pare the bottom of the half-lap until it is smooth and even.

Dovetailed Half-Lap Joints

Combining the strength of the dovetail joint with the simplicity of the half-lap, the dovetailed half-lap is a favorite joinery method for frames and table stretchers. The joint strongly resists tension.

Making a Dovetailed Half-Lap Joint





Cutting the dovetailed half-lap and the socket

In one workpiece, cut a corner half-lap *(page 70)*. Then, outline the dovetail on the cheek of the half-lap and cut it out on the band saw *(left)*; use an angle of 1:8 if you are working with hardwood, or a 1:6 angle for softwood. Use the dovetailed half-lap to outline the socket in the mating workpiece; make sure the shoulder of the half-lap is butted against the edge of the board as you mark the lines *(above)*. Make the socket using a router with a template *(page 73)*, a table saw, a radial arm saw, or a handsaw and miter box *(page 75)*, cutting to one-half the stock thickness.

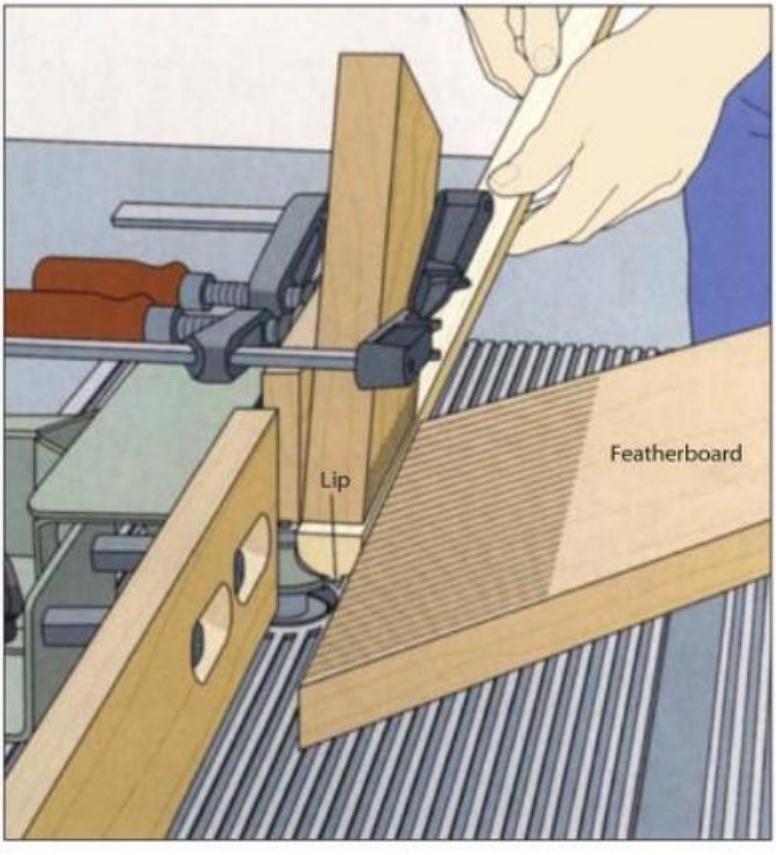
Glazing Bar Half-Lap Joints

For many of us, the glazing, or sash, bar half-lap joint is as familiar as the view from the kitchen window. Featuring a mitered half-lap cut into a molded wood strip, the joint has traditionally been used to create a grid to hold the glass panes of a cabinet door or window. The panes sit in rabbets routed along the edges of the bars and are held in place with thin strips of molding.

Making a Glazing Bar Half-Lap Joint

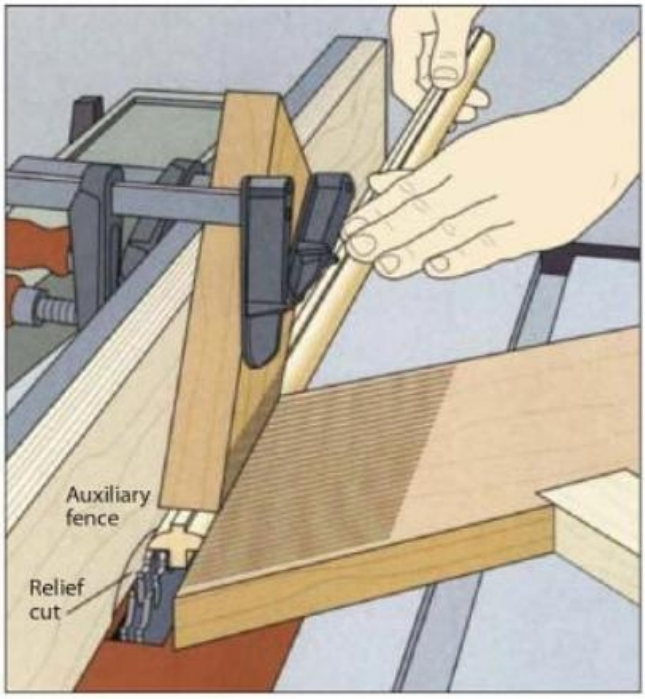
Molding the glazing bar

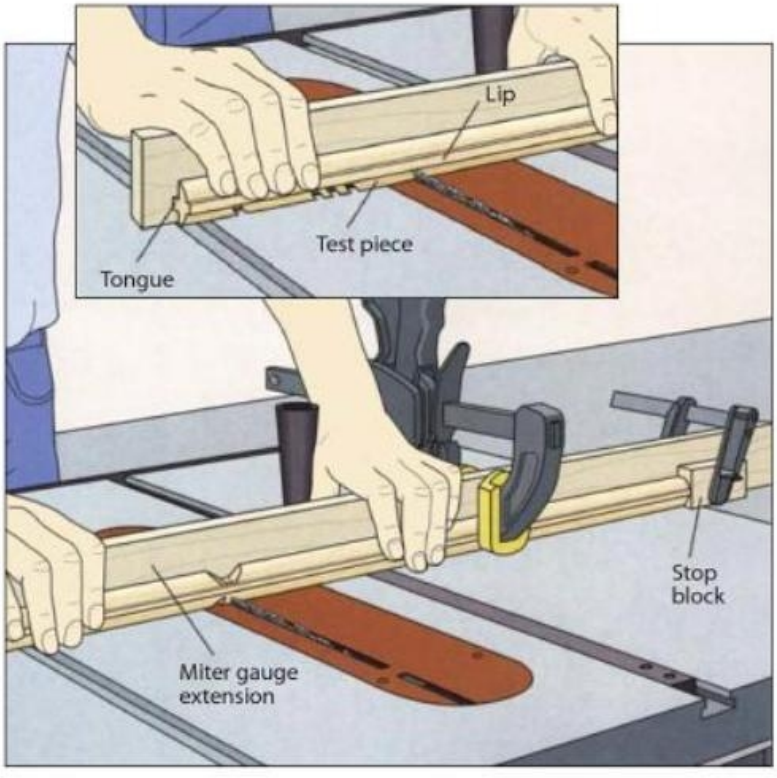
This joint is made in three stages: First, the proper profile is cut into the glazing bar, as shown at right; next, rabbets are cut into the opposite side of the bar to hold the glass and molding strips; finally, the mitered half-lap is produced. For the first stage, install a piloted round-over bit in a router, mount the tool in a table, and align the fence with the bit's pilot bearing. The stock should be wide enough so that making a pass on each side of the bar will leave a ¼-inch-wide lip between the cuts. Support the workpiece during the operation with three featherboards: Clamp one to the table opposite the bit and two to the fence on either side of the cutter. (In the illustration, the featherboard on the outfeed side of the fence has been removed for clarity.) Feed the bar into the bit until your fingers approach the bit, then use the next piece as a push stick or move to the other side of the table and pull the workpiece past the cutter. Repeat the cut on the other side of the bar *(right)*. Prepare an extra bar to help set up the cut.



Cutting rabbets for the glass panes

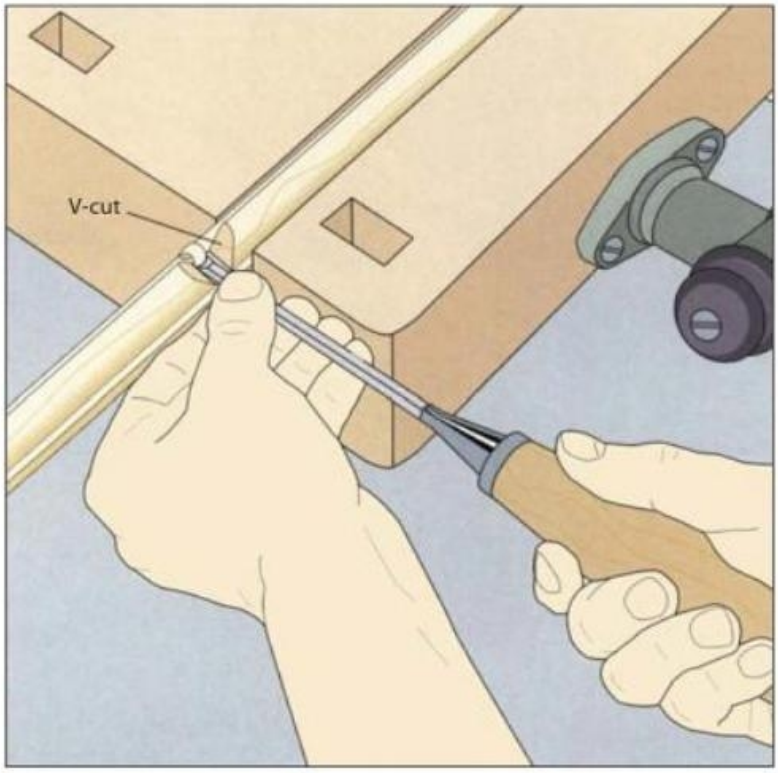
Install a dado head on your table saw slightly wider than the desired rabbets. The tongue remaining after the rabbets are cut should measure at least ¼ inch. Install a wooden auxiliary fence and mark the rabbet depth on it—the combined thickness of the glass and the molding strip. Position the auxiliary fence over the dado head, ensuring that the metal fence is clear of the cutters. Turn on the saw and slowly crank up the dado head until it forms a relief cut to the marked line. Turn off the saw and mark the width of the rabbets on the leading end of the glazing bar. Butt one of the marks against the outer blade of the dado head, then position the fence flush against the bar. Use three featherboards to support the workpiece as before adding a support board to provide extra pressure for the featherboard clamped to the table. (Again in this illustration, one of the featherboards has been removed for clarity.) Feed the bars by hand *(right)* until your fingers approach the featherboards, then use the next workpiece to push the bar through. Finish the cuts on the final workpiece by pulling it from the outfeed side of the table.





Making the miter cuts

Remove the dado head and install a crosscut blade. Adjust the blade angle to 45°, then attach a miter gauge extension. To set the blade height, hold the extra glazing bar on the saw table so the tongue you previously cut is flush against the extension. The top of the blade should be level with the lower side of the lip. Make a test cut and adjust the blade height until the cutting edge just scores the lip *(inset)*. Then mark out the miter cuts on both sides of the bars; at their widest point the Vs should be the same width as the stock. To make the cut, hold the tongue of the bar flat against the miter gauge extension and align one of the marks with the blade. Butt a stop block against the end of the stock and clamp it to the extension to line up subsequent cuts. Clamp the workpiece to the extension and feed the glazing bar into the blade while holding it firmly in place. Rotate the piece and repeat to cut the other side of the V. Repeat the process to cut the V on the opposite side of the bar *(left)*.

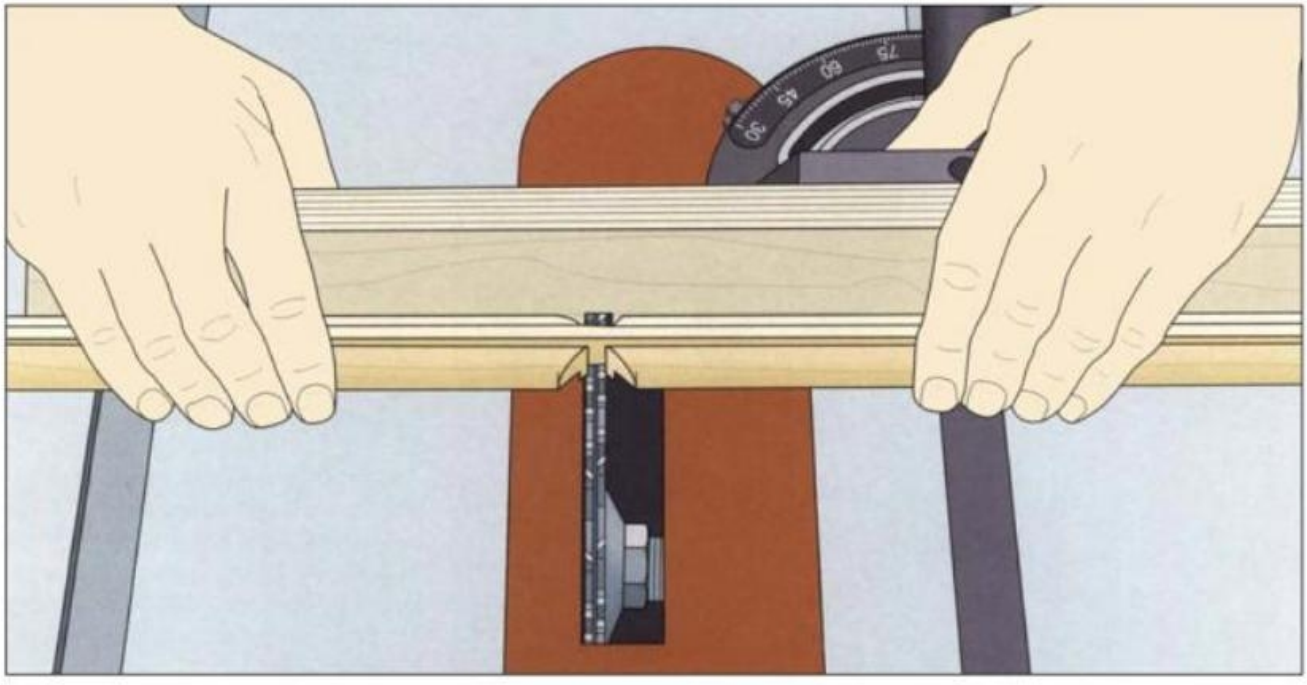


Cleaning up the V-cuts

Once all the miter cuts have been made, use a narrow chisel to pare away the waste. The width of the channel at the bottom of the V should equal the width of the lip. Holding the chisel bevel side up, pare away the waste *(left)* until the bottom of the V is smooth and flat. Work carefully to avoid tearout.

Cutting the half-laps

Adjust the table saw dado head to the width of the bar's lip and set the cutting height to one-half the stock thickness. You will be cutting a half-lap in the bottom of one glazing bar, then making an identical cut in the top of the mating piece. Set up the cut by aligning the middle of the V-cut with the dado head, while holding the bar flush against the miter gauge extension. Keep the workpiece flat on the saw table and flush against the extension as you cut the half-laps *(below)*.



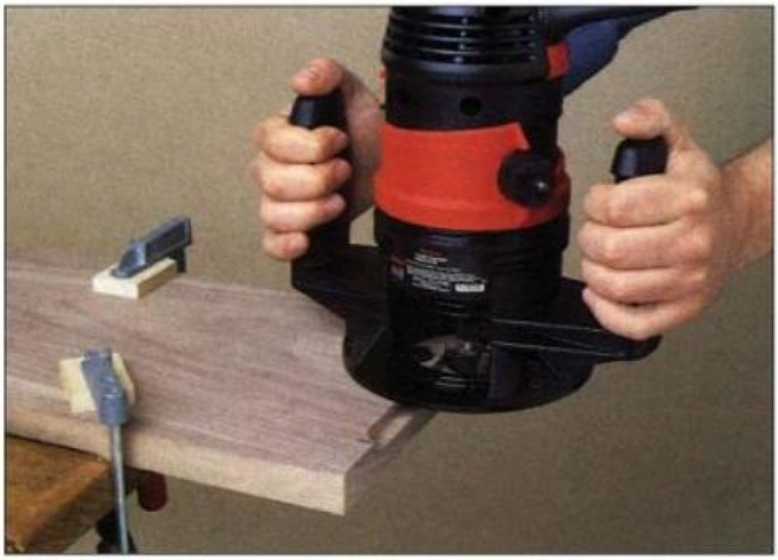
Rabbets

A rabbet is one of the most basic of cuts, commonly used in a corner joint or to accommodate the back of a cabinet. Few tools do the job better or more quickly than a router. As shown below, a rabbet can be routed with a piloted rabbeting bit, or a straight bit and edge guide will work equally well.

With a piloted bit, the pilot bearing rides along the edge of the workpiece while the cutting edges above the bearing rout the stock. The width of the rabbet is equal to one-half the difference between the diameter of the bit and the diameter of the bearing. A 1¼-inch-diameter bit with a ½-inch bearing, for example, will cut a rabbet ⅜ inch wide.

So that woodworkers do not have to own a different bit for each possible rabbet, many router bit manufacturers now sell rabbeting sets, consisting of a single cutter and a selection of different-sized bearings.

A straight bit and an edge guide *(page 81)* can be used to cut rabbets of any width. The cutter can be positioned at any distance from the edge of the stock. To rout extra-wide rabbets that exceed the capacity of your largest bit, make two or more passes, adjusting the location of the edge guide each time.

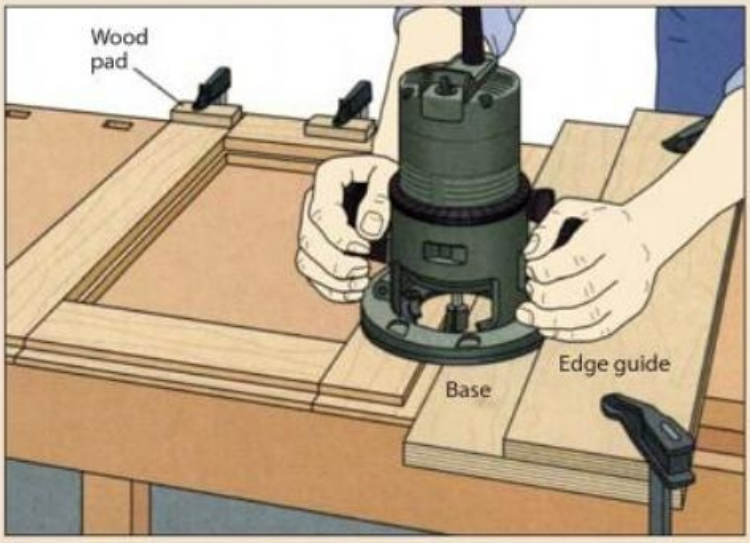


A rabbeting bit carves a stopped rabbet into the underside of a shelf. The rabbet will fit into a wooden shelf support attached to the side of a car-case. This technique conceals both the rabbet and the shelf support.

Rabbeting Jig

Make it easy to cut wide or non-standard-width rabbets with a straight bit and the simple jig shown at right. Made from two strips of wood, the jig is simple to assemble and set up.

Cut the base from plywood or solid stock the same thickness as your workpiece. Make the edge guide from ¾-inch plywood. Both pieces should be at least as long as the largest piece you plan to cut.

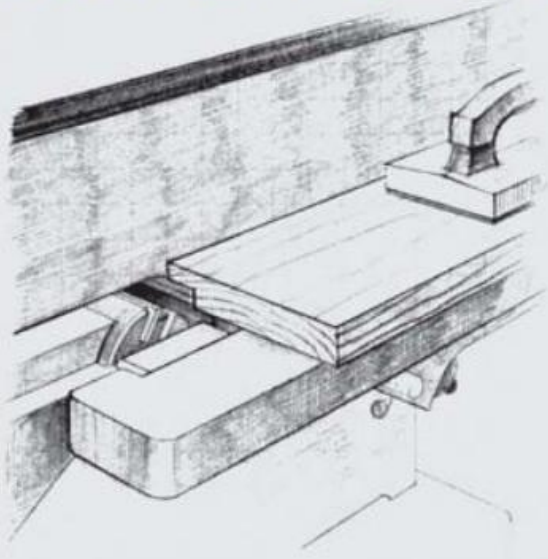


To set up the jig, secure the stock to a work surface and outline the rabbet on it. Butt the jig base against the edge of the stock. Align the bit over the cutting mark, then position the edge guide flush against the router base plate. Fasten the edge guide to the base of the jig with countersunk screws, ensuring that both boards are parallel to the edge of the workpiece. Clamp the jig in position. In making the cut, feed the bit against the direction of bit rotation and keep the tool's base plate pressed firmly against the edge guide throughout the operation.

Shop Tip

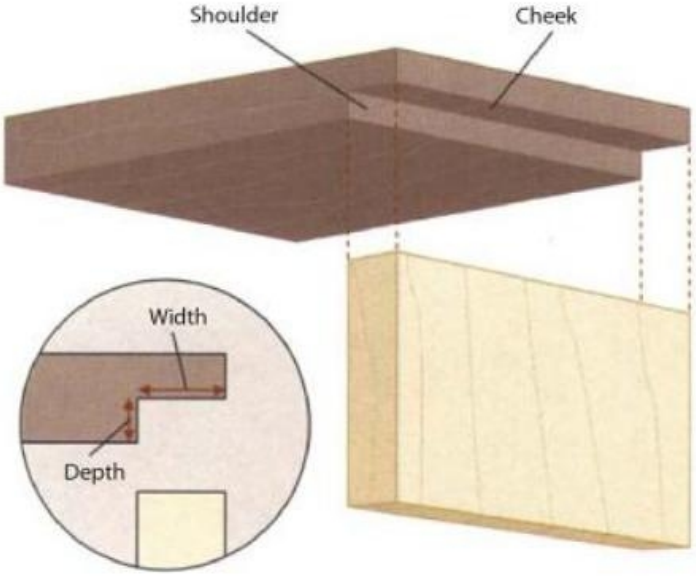
Rabbeting on the jointer

If your jointer has a rabbeting ledge, it can cut rabbets along either the face or edge of a board. In fact, many woodworkers consider the jointer the best tool for rabbeting with the grain of a workpiece. Adjust the cutting depth to no more than ⅛ inch, then align your cutting mark for the rabbet with the end of the jointer knives and butt the fence against the stock. Keep the workpiece flat on the table and butted against the fence as you make the pass. For a rabbet along a board face, use a push block. Make as many passes as necessary, increasing the cutting depth ⅛ inch at a time.

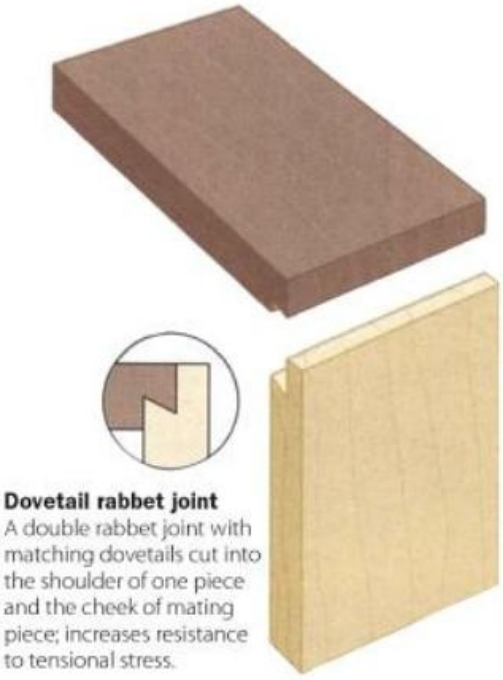


Rabbet Joints

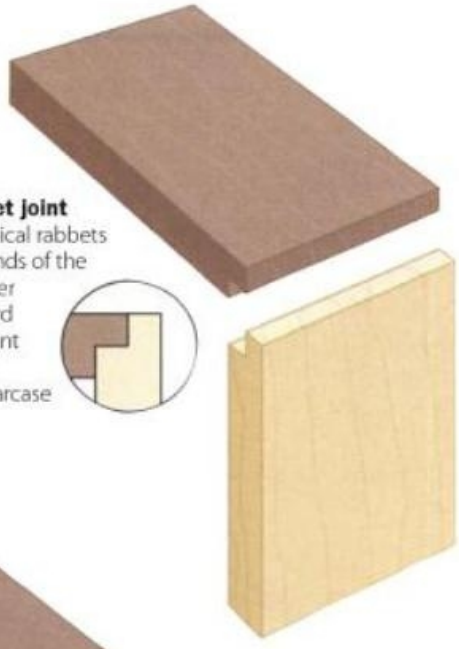
Anatomy of a Rabbet Joint
(See page 84)



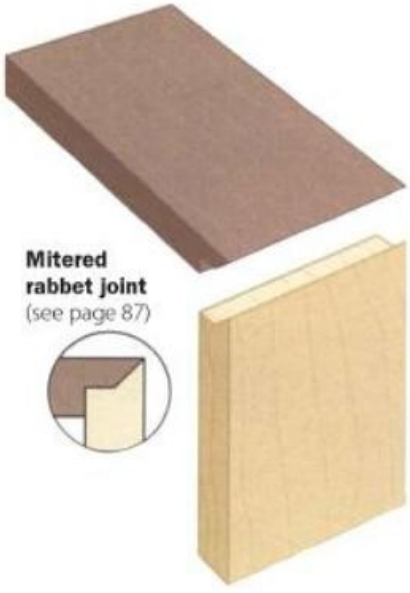
Widely used in carcase and drawer construction, the rabbet joint is essentially a modified butt joint in which the end or edge of one board fits in a rabbet cut in the mating piece. The rabbet's width should equal the thickness of the stock; its depth should be half that amount.



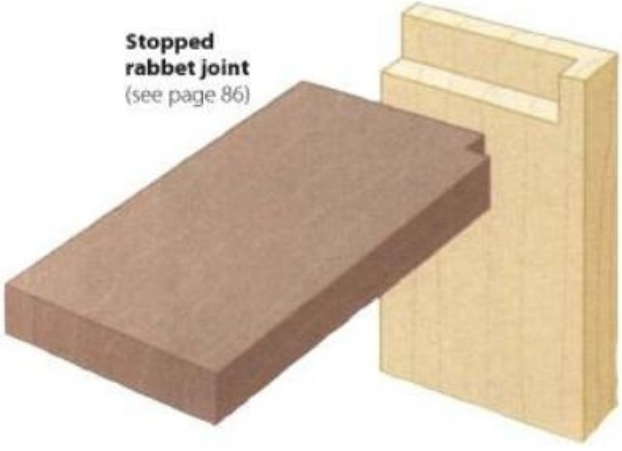
Dovetail rabbet joint
A double rabbet joint with matching dovetails cut into the shoulder of one piece and the cheek of mating piece; increases resistance to tensional stress.



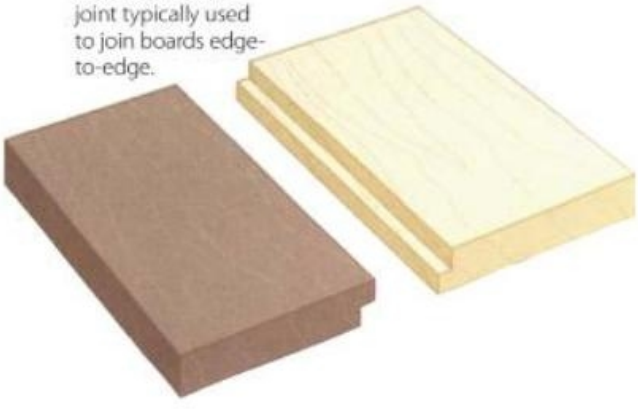
Double rabbet joint
Features identical rabbets cut into the ends of the pieces; stronger than a standard rabbet, this joint is commonly used to join carcase corners.



Mitered rabbet joint
(see page 87)

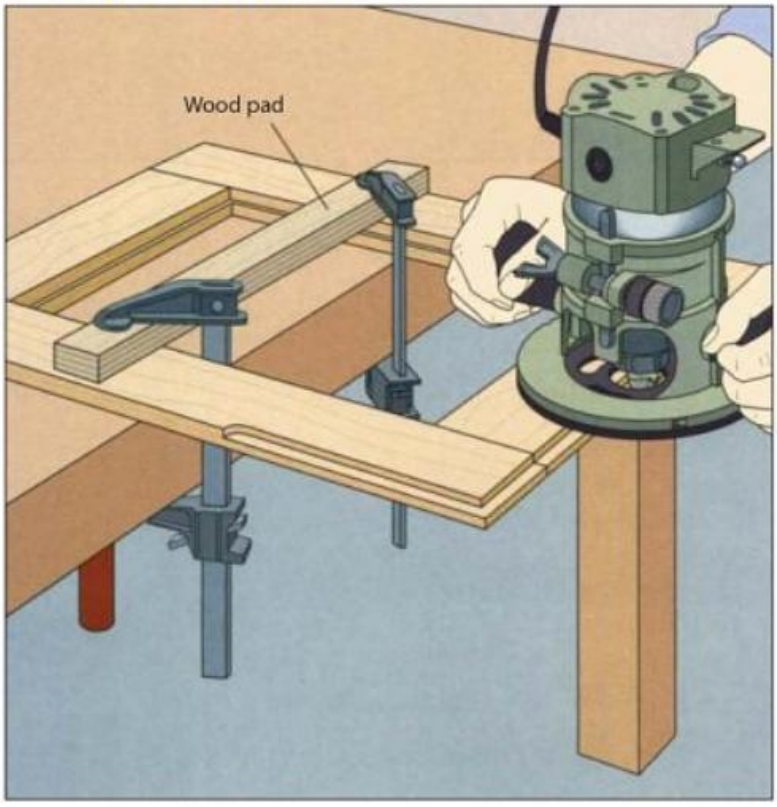


Stopped rabbet joint
(see page 86)



Shiplap joint
A double rabbet joint typically used to join boards edge-to-edge.

Making a Rabbet Joint



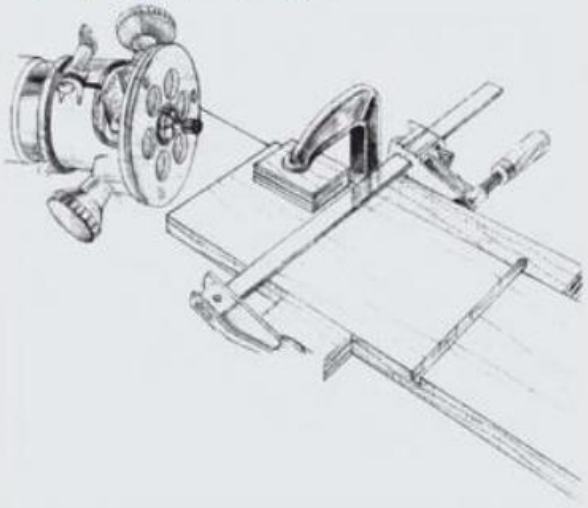
Using a router

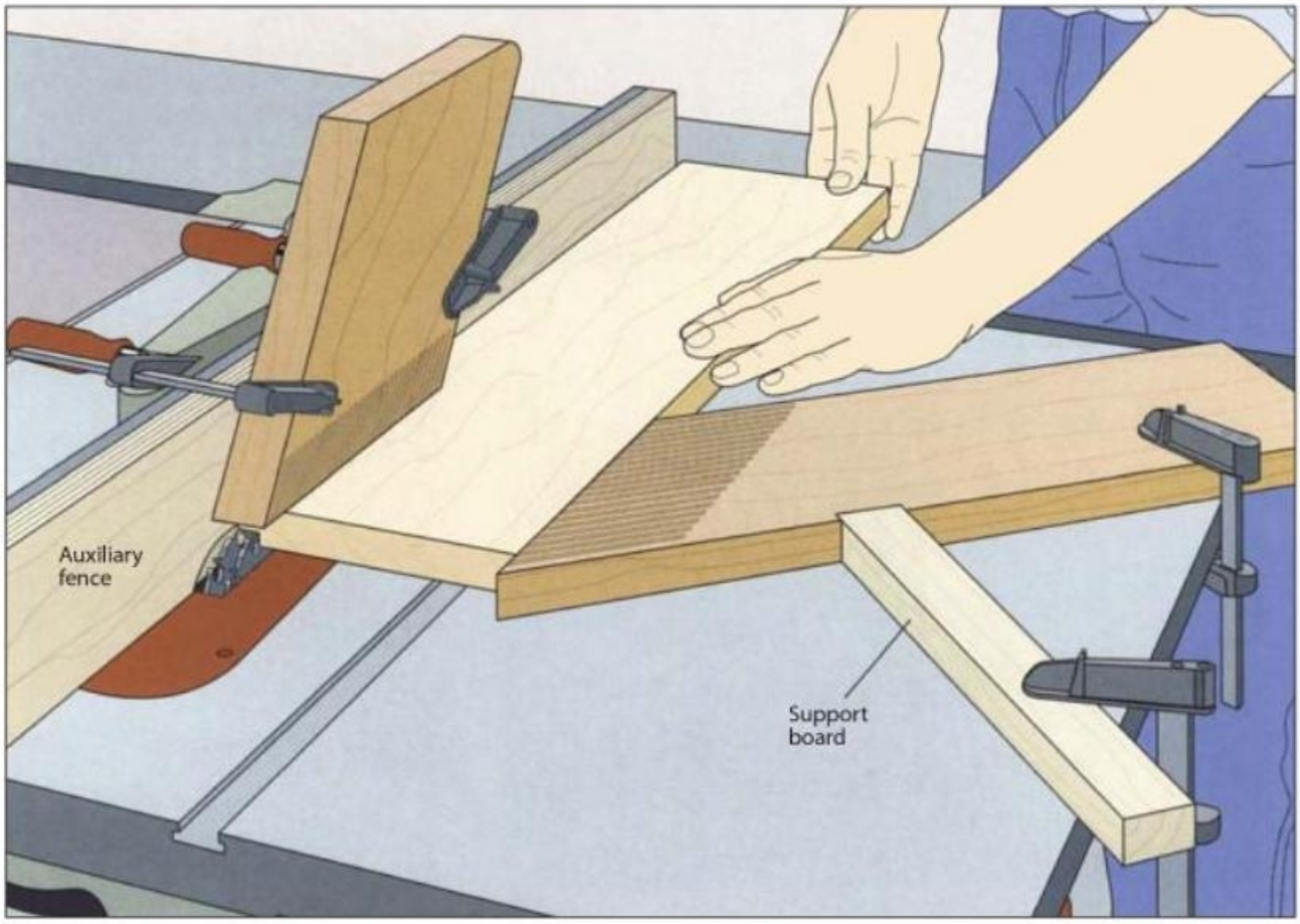
You can use either a piloted bit or a non-piloted bit with an edge guide. In either case, clamp the stock to a work surface. For a non-piloted bit, mark the rabbet width on the top face of the stock. Align the cutting edge of the bit with the mark, then clamp an edge guide to the workpiece flush against the router base plate and parallel to the workpiece edge. Cut the rabbet with the plate butted against the guide *(left)*. If you are working with a piloted bit, choose a cutter that will produce the desired width of rabbet. Then, gripping the router firmly with both hands, guide the bit into the workpiece at one end. Ride the pilot bearing along the edge as you make the cut.

Shop Tip

Minimizing tearout

Router bits can tear wood fibers as they exit a workpiece at the end of a crossgrain rabbet or dado cut. To prevent splintering, clamp a wood block the same thickness as your workpiece along the edge from which the bit will exit. The pressure of the block against the stock will compress the fibers and reduce the problem of tearout.



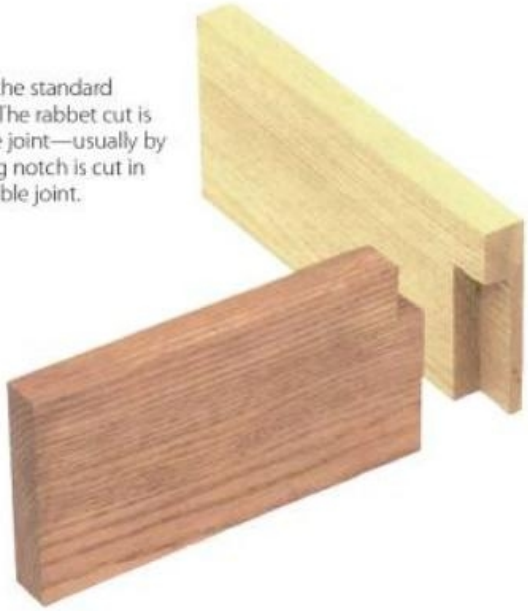


Cutting a rabbet on the table saw

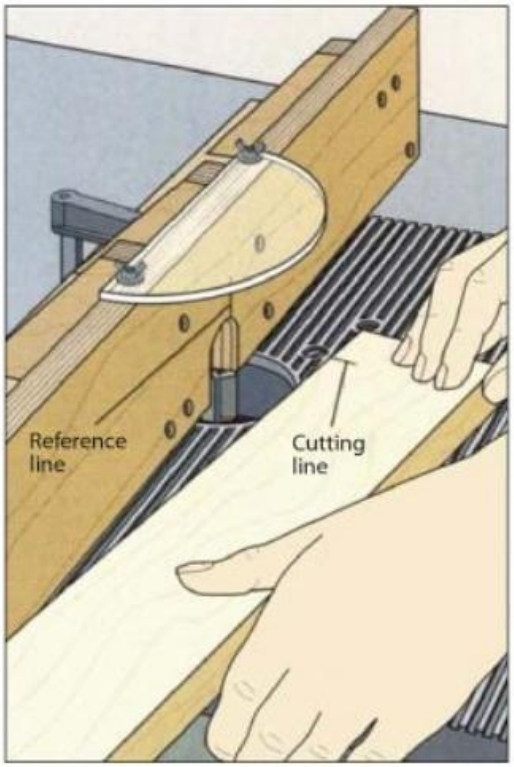
Install a dado head slightly wider than the rabbet you wish to make, then install an auxiliary fence and make a relief cut in it as you would when cutting a glazing bar half-lap *(page 77)*. Mark a cutting line for the inside edge of the rabbet on the workpiece. Butt the mark against the outer blade of the dado head, then position the rip fence flush against the workpiece. Clamp two featherboards to hold the workpiece securely against the fence and saw table; a support board provides extra stability. Feed the workpiece with both hands *(above)* until the rabbet is completed. Use a push stick to finish the pass on narrow stock.

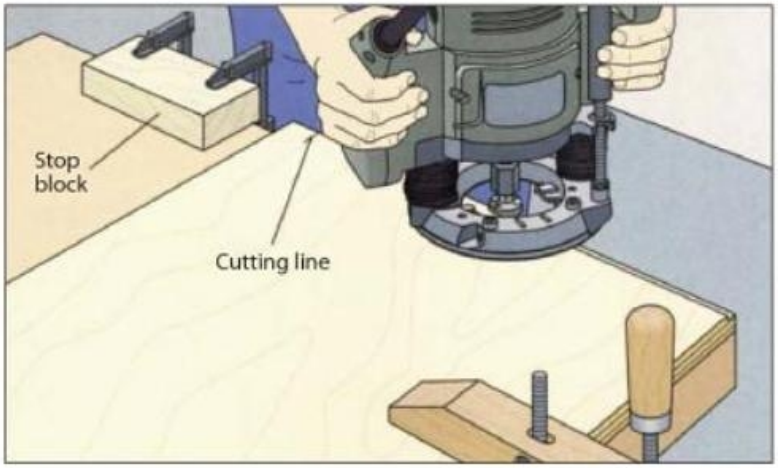
Stopped Rabbet Joints

The stopped rabbet joint is similar to the standard rabbet, with an important difference: The rabbet cut is stopped short of the front edge of the joint—usually by no more than 1 inch—and a matching notch is cut in the mating piece, resulting in an invisible joint.



Two Ways to Rout a Stopped Rabbet



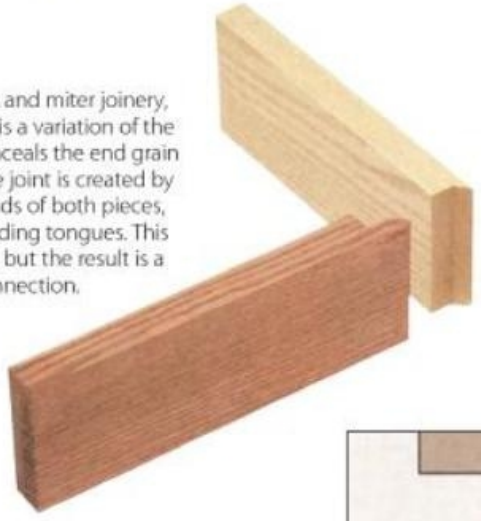


Routing a stopped rabbet

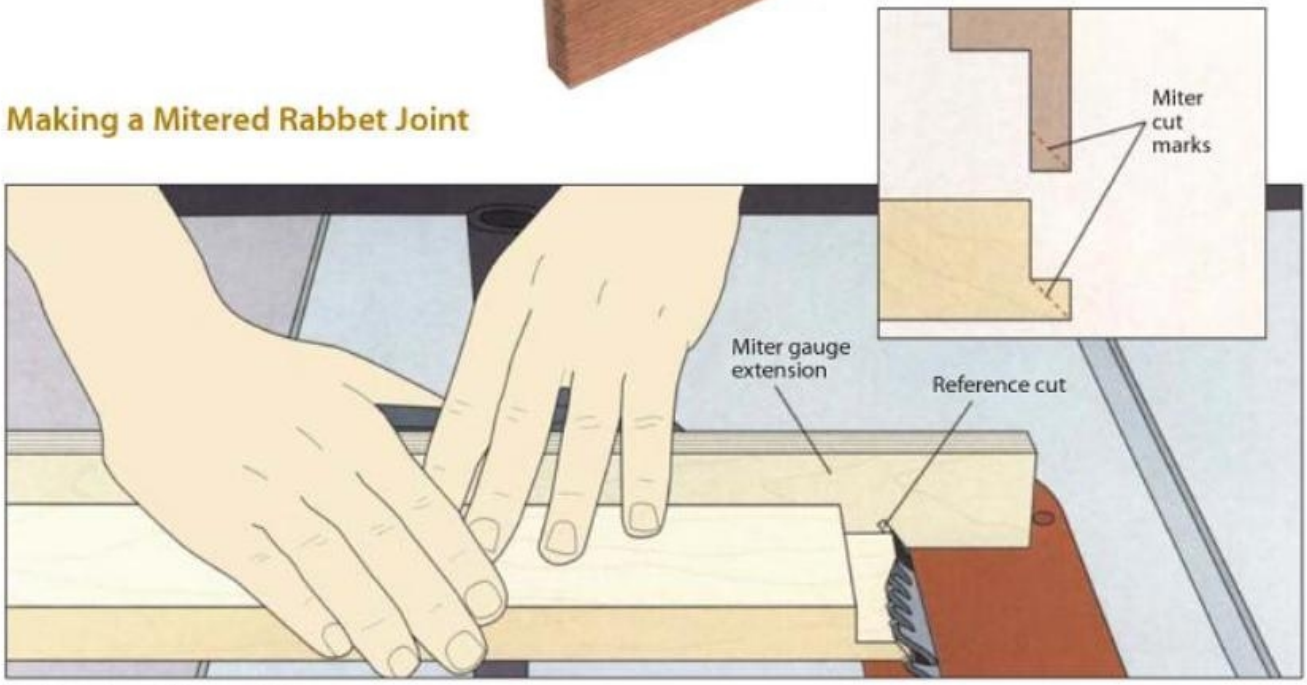
Make the cut on a router table or with the router hand-held. In either case, mark a cutting line on the face of the workpiece for the end of the rabbet. For the router-table method, install a straight bit, set the depth of cut, and adjust the fence for the desired width of cut. Draw a reference line on the fence to mark the position of the cutter where it exits the fence. With the stock clear of the bit, turn on the router and press the workpiece flush against the fence while feeding it forward. When the cutting line on the board lines up with the reference line, pivot the stock off the fence *(above, left)*. To make the cut with a hand-held router, install a piloted rabbeting bit and clamp the stock to a work surface. Align the bit with the cutting line on the workpiece and clamp a stop block against the router base plate. Feed the bit into the stock at the starting end of the rabbet, butting the bit's pilot bearing against the edge. Continue the cut along the edge *(above, right)* until the base plate touches the stop block. For both methods, square the end of the rabbet with a chisel.

Mitered Rabbet Joints

A combination of rabbet and miter joinery, the mitered rabbet joint is a variation of the standard rabbet that conceals the end grain of the mating pieces. The joint is created by cutting rabbets in the ends of both pieces, then mitering the protruding tongues. This joint demands precision, but the result is a strong and attractive connection.



Making a Mitered Rabbet Joint

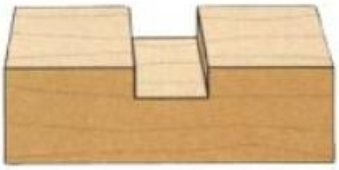


Cutting the rabbets and miters

Cut rabbets in both pieces. Make the cuts to the same depth—about two-thirds the thickness of the stock. The width of one rabbet should equal the stock's thickness, the width of the other should equal the thickness of the tongue left by the first rabbet cut. Mark 45° angle lines across both tongues for the miter cuts, starting each mark at the outside corner of the tongue *(inset)*. Adjust the blade angle on your table saw to 45°, and set the cutting height so the blade will cut through the tongue. Next, screw an extension board to the miter gauge and make a reference cut in the board. Holding the workpiece flush against the extension, align the cutting line with the reference cut, then cut the miter *(above)*. When mitering the workpiece with the shorter tongue, adjust the cutting height to just sever the waste; otherwise, the blade will bite into the rabbet shoulder and weaken the joint.

A Gallery of Grooves and Accessories

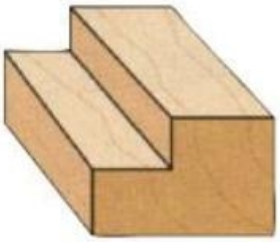
Dadoes and Grooves



Dado
A rectangular channel cut across the workpiece grain; typically forms part of a joint, but can also be used for decoration.

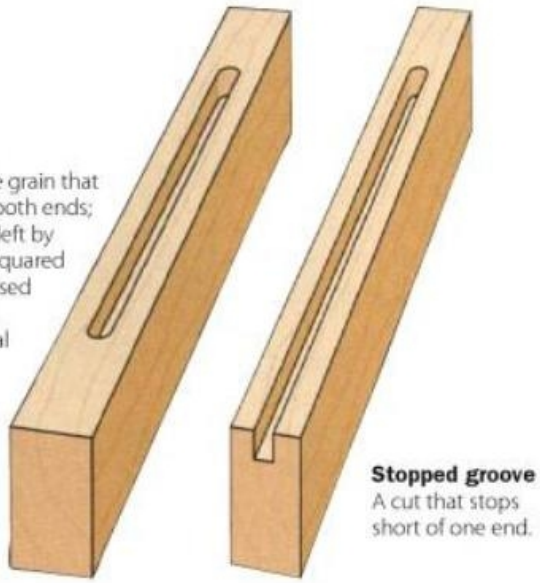
Dovetail groove
A wedge-shaped channel, typically interlocks with a mating board, forming part of a sliding dovetail joint.

Groove
A cut along the grain of a workpiece, forming a rectangular channel; may be decorative but usually functional.



Rabbet
A cut in the edge or end of a workpiece, with or across the grain. Usually functional.

Lock miter joint
Also known as mitered lock rabbet joint. Type shown made up of dado *(page 95)* and miter cut; variation can be cut with specially designed shaper cutter or router bit.

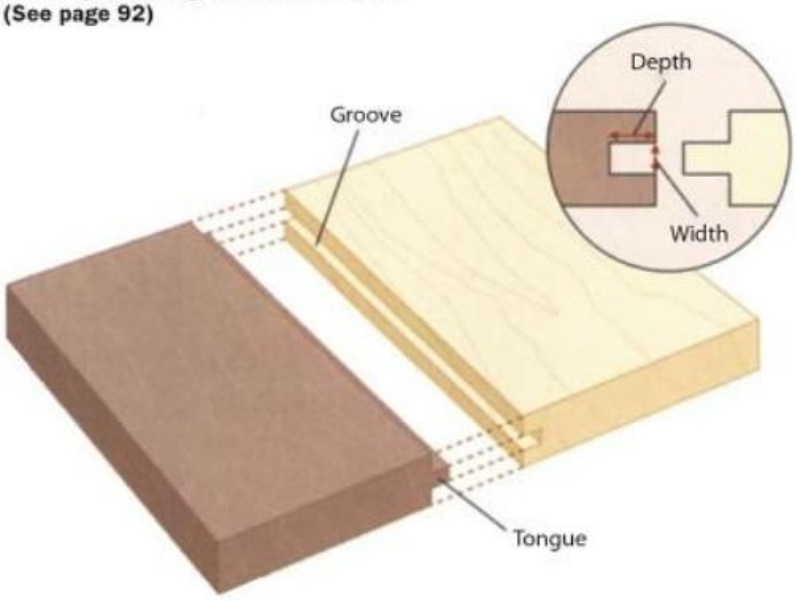


Blind groove
A cut along the grain that stops short of both ends; rounded ends left by router can be squared with a chisel. Used in both joinery and ornamental applications.

Stopped groove
A cut that stops short of one end.

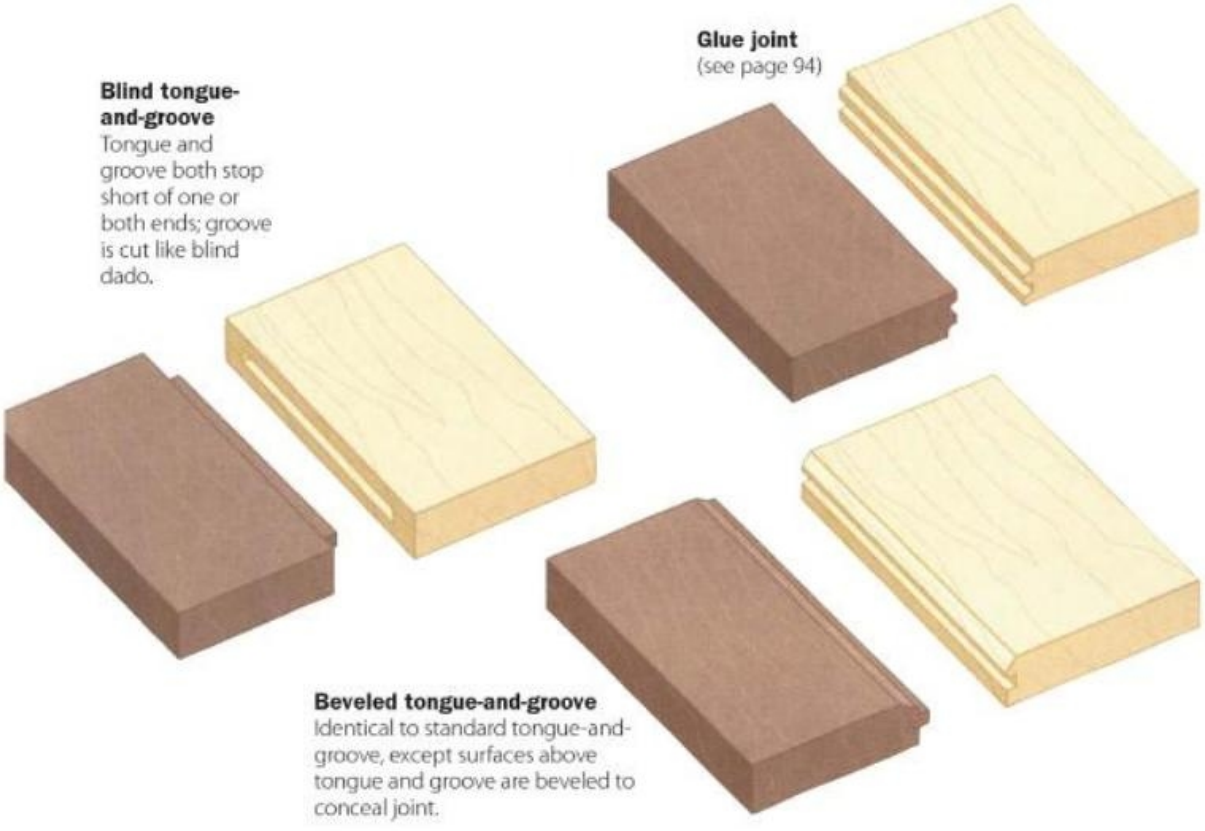
Tongue-and-Groove Joints

Anatomy of a Tongue-and-Groove Joint
(See page 92)



Blind tongue-and-groove
Tongue and groove both stop short of one or both ends; groove is cut like blind dado.

Glue joint
(see page 94)



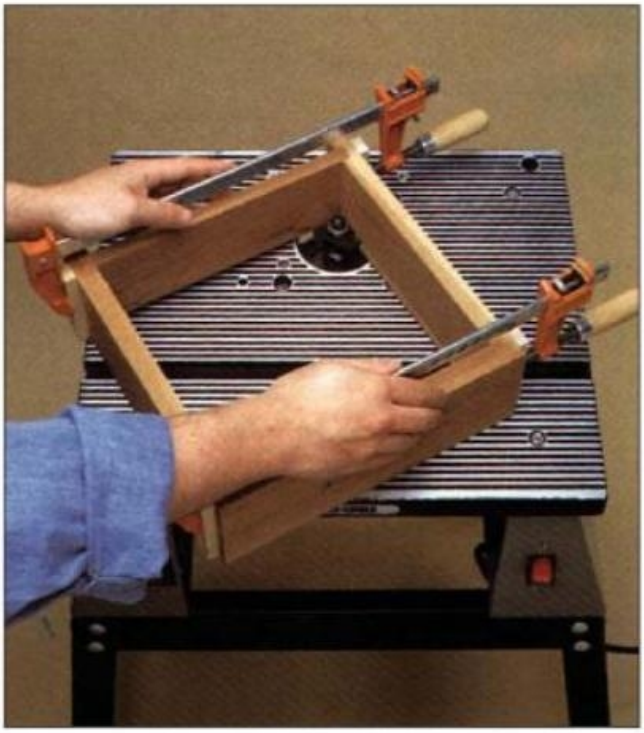
Beveled tongue-and-groove
Identical to standard tongue-and-groove, except surfaces above tongue and groove are beveled to conceal joint.

Grooving on a Router Table

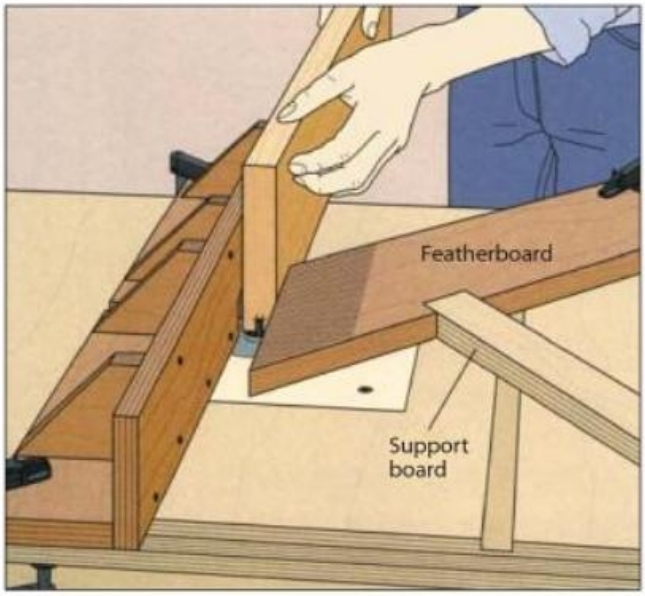
Mounted upside down in a table, the router works very much like a shaper. In addition to carving decorative contours on board edges and making precise joinery cuts, a table-mounted router offers a safe and quick method to cut dadoes and grooves. The setup allows you to exert greater control over routing operations.

Virtually any dadoing operation can be performed with a table-mounted router, but the arrangement is particularly convenient for cutting grooves in narrow stock *(below)*. Stopped grooves can be cut with either a straight bit or a three-wing slotting cutter. As shown on page 91, your best choice is the slotting cutter since it allows the workpiece to be pivoted into the cutter with the face of the board flat on the table. With a straight bit, the stock is lowered onto the bit edge down, with the board face resting against the fence—a trickier operation.

Remember that several light cuts are safer and more accurate than one heavy pass. If you need to cut a groove wider than your largest straight bit, make two or more passes, advancing the fence after each pass. For deep grooves, also make a series of cuts, increasing the cutting depth for each pass.



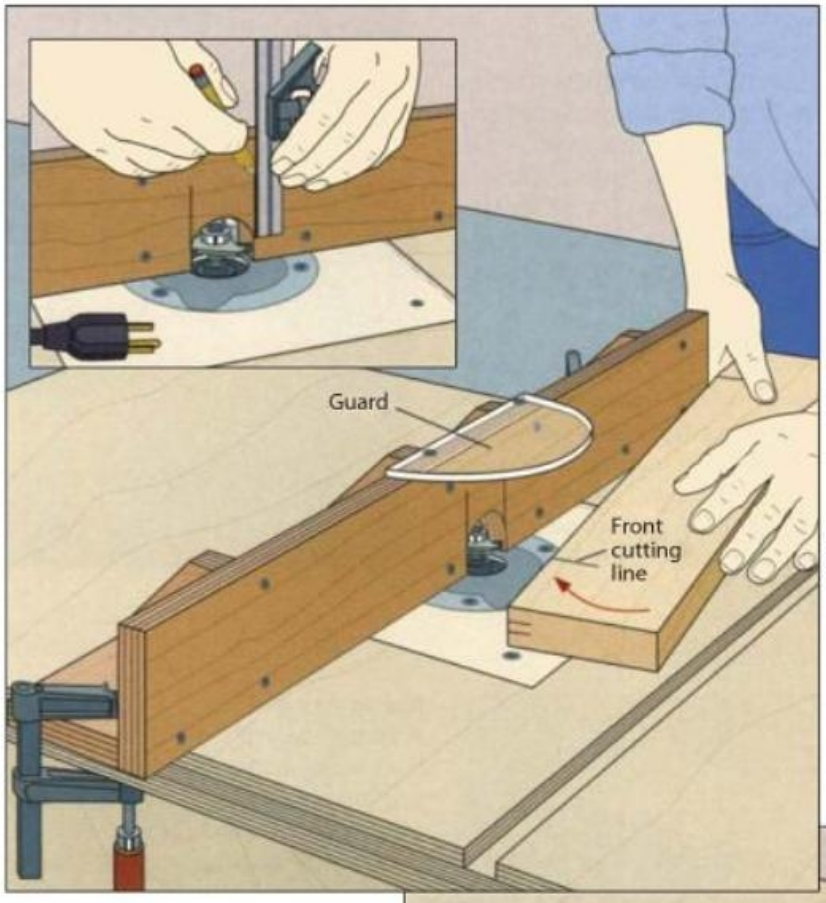
A table-mounted router fitted with a piloted three-wing slotting cutter routs a groove along the inside of a drawer for a bottom panel. Keeping the pilot against the stock keeps the groove depth uniform and controls kickback.



Cutting a Groove in a Board Edge

Making the cut

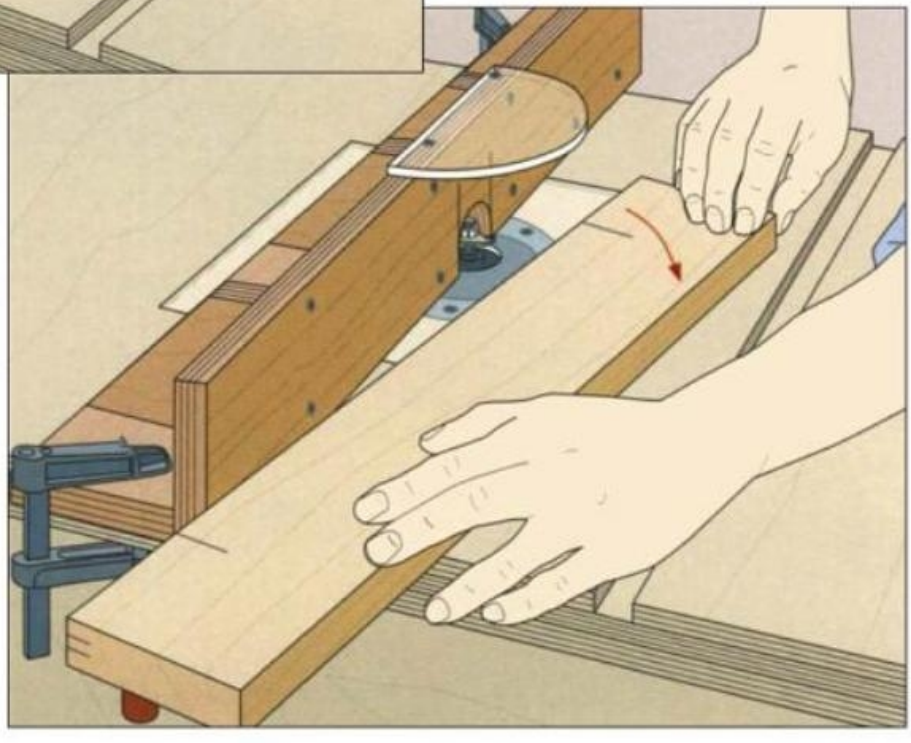
With a straight bit in the router, set the cutting depth and align the cutting marks with the bit. For the shop-built router table and clamp-on fence shown in the illustration, position the fence flush against the board face and secure it to the tabletop; make certain the fence is parallel to the edge of the table. To secure the workpiece, clamp a featherboard to the table opposite the bit; clamp a support board at a 90° angle to the featherboard for extra pressure. Feed the workpiece into the bit, pressing the stock firmly against the fence *(left)*. If you are working with narrow stock, protect your fingers from the bit using a push stick.



Cutting a Stopped Groove

Setting up and starting the cut

Mount your router in a table with a three-wing slotting cutter in the tool. Mark two sets of cutting lines on the workpiece: one on its leading end for the width and position of the groove and the other on its face for the length of the groove. Butt the marks on the end of the board against the cutter and adjust the cutter height. Install the fence on the table, lining it up with the pilot on the cutter. To keep track of the location of the cutter, mark the points on the fence where the bit starts and stops cutting *(inset)*. Attach the guard to the fence. To start the cut, turn on the router with the workpiece clear of the bit. Hold the board face down on the table and align the front cutting line on the workpiece with the bit cutting mark on the fence farthest from you. Bracing the board against your thigh, slowly pivot it into the cutter *(left)*.

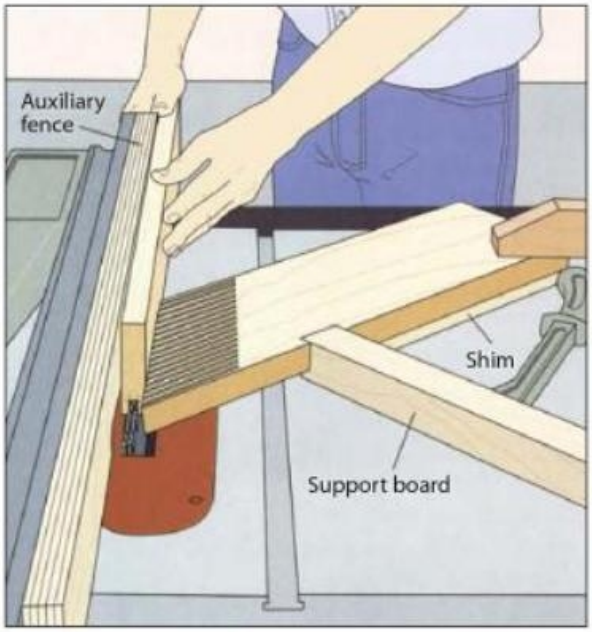


Finishing the cut

When the workpiece is flush against the fence, feed it forward while pressing it down and against the fence. Continue the cut until the back cutting line on the workpiece aligns with the bit cutting mark closest to you. Pivot the trailing end of the workpiece away from the cutter with your right hand *(right)*, steadying the board against the table and fence by hooking your left hand around the edge of the table. Avoid lifting the board until the stock is clear of the cutter. Use a chisel to square the ends of the groove, if necessary.

Tongue-and-Groove Joints

The tongue-and-groove joint has many uses for the woodworker—from joining boards edge-to-edge to fixing shelving to carcases. When used to form carcase panels, the joint can be assembled without glue to allow for wood movement caused by fluctuations in humidity.



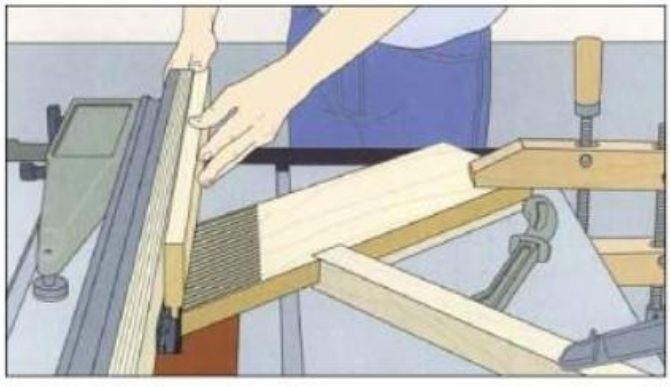
A Tongue-and-Groove Joint on the Table Saw

Cutting the groove

Mark the outline of the groove on the end of the workpiece. It should be ⅓ the stock thickness; the depth is often ½ inch. Install a dado head and adjust it to the desired width and height. Install an auxiliary wood fence and make a relief cut in it. (Although the auxiliary fence is only necessary for cutting the tongue, it is better to mount it now.) Align the cutting marks with the dado head, butt the rip fence against the stock, and clamp a featherboard to the table for support. Rest the featherboard on a wood shim to keep the workpiece from tipping and clamp a support board against the featherboard for extra pressure. Press the workpiece against the fence as you feed the stock into the dado head *(left)*. Complete the pass with a push stick.

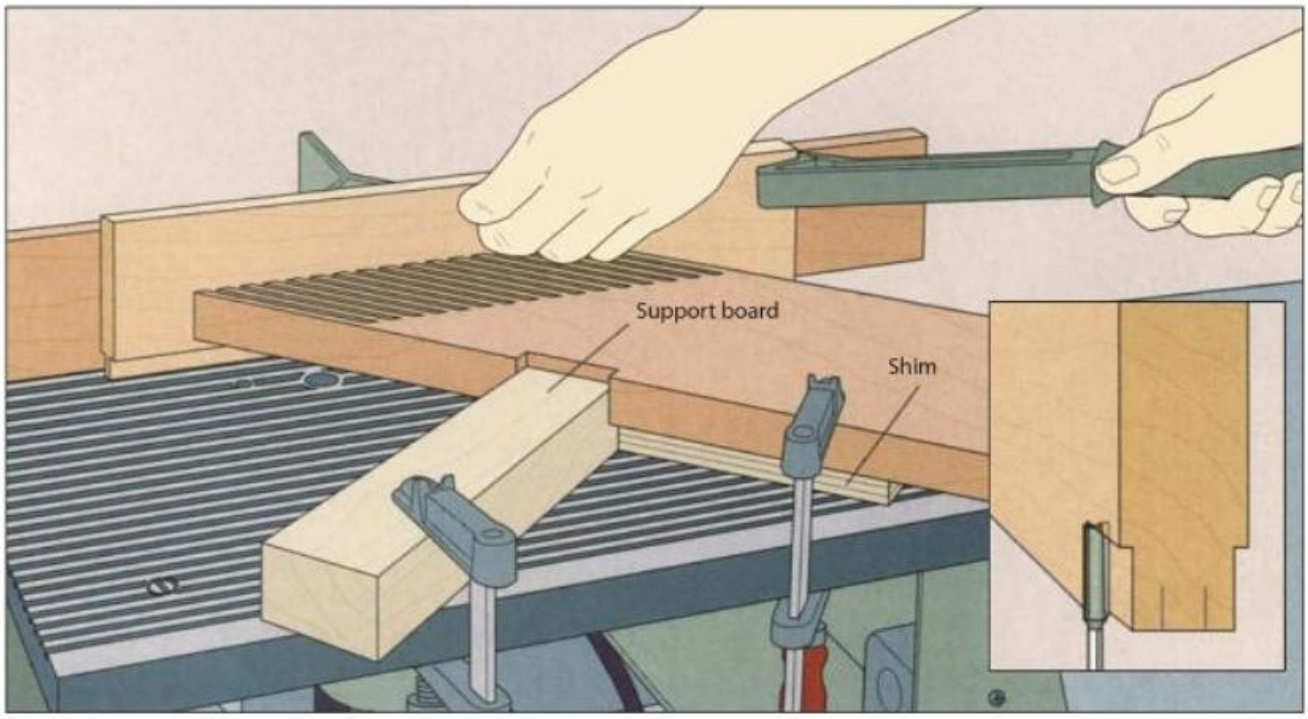
Cutting the tongue

Mark the tongue on the leading end of the workpiece, using the groove as a guide. Adjust the dado head for a slightly wider cut and lower the cutting height a little so the tongue will not reach the bottom of the groove. Align the dado head with one of the cutting marks and move the fence against the stock; also position the featherboard and support board. Feed the board as you did cutting the groove, using a push stick to complete the pass. Turn the workpiece end-for-end and repeat on the other side of the tongue *(right)*. Test-fit the tongue in the groove and adjust the rip fence, if necessary.



With its long gluing surface, the tongue-and-groove joint is commonly used to strengthen carcase joinery and to assemble glued-up panels and solid cabinet doors.

Cutting a Tongue-and-Groove Joint on a Routing Table



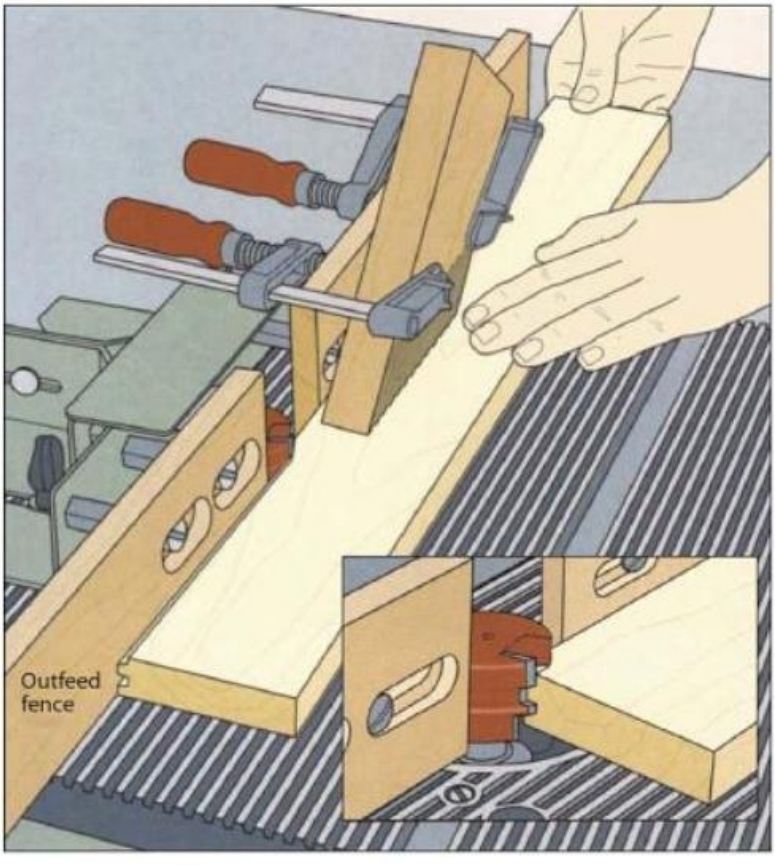
Routing the groove and tongue

Fit your router with a straight bit. Start by cutting the groove *(page 92)*, then cut the tongue in several passes, removing the waste a little at a time *(inset)*. The tongue's depth should be slightly less than the groove. To support the workpiece during the cut, clamp a featherboard to the table and rest it on a shim so that it presses against the workpiece above the bit; clamp a support board at a 90° angle to the featherboard for extra pressure. Slowly feed the stock into the cutter. Turn the workpiece end-for-end and repeat the procedure. Finish each pass with a push stick *(above)*. Move the fence back from the bit to remove more waste and make two more passes, test-fitting the joint and continuing until the tongue fits snugly in the groove.

Glue Joints

The glue joint is a variation of the standard tongue-and-groove and is easily produced with the router or the shaper.

Used to reinforce glued-up panels, the glue joint consists of two boards with identical cuts in their edges. Both cuts are produced on a router table with the same bit; one of the boards is flipped to mate with the other.



Making a Glue Joint on the Router Table

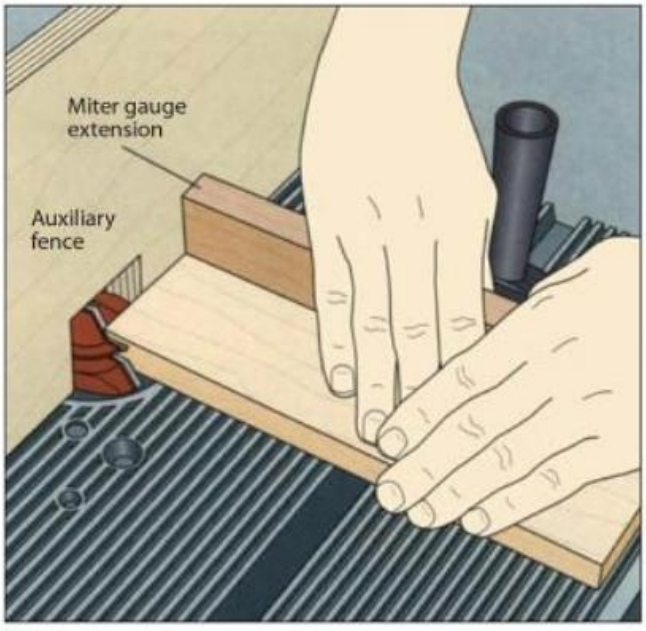
Making the cuts

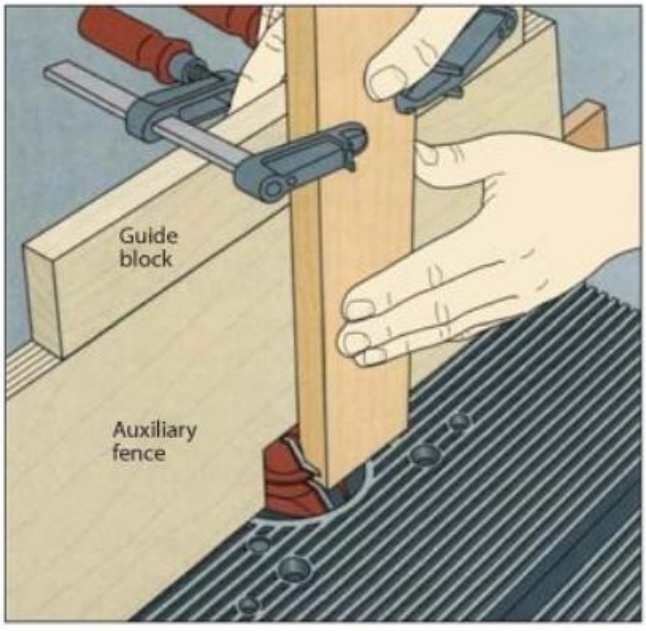
Install a glue joint bit in a router and mount the tool in a table. Adjust the cutting depth so that the thickness of the waste removed by the upper part of the cutter will equal the thickness of the stock left below the bottom part of the cutter *(inset)*. Position the fence so that the bit makes a full cut in the board, removing the entire edge. Secure the workpiece with two featherboards clamped to the fence on both sides of the bit; in the illustration, the featherboard on the outfeed side has been removed for clarity. To make a pass, feed the stock into the bit with your right hand while pressing it firmly against the fence with your left hand. To keep the entire edge flush against the fence throughout the operation, adjust the outfeed part of the fence when the board reaches it. Stop the cut and turn off the machine, but do not remove the workpiece. Holding the workpiece in place, advance the outfeed fence until it butts against the cut edge. Then complete the pass *(left)*.

Lock Miter Joint

Also known as a drawer lock joint, the lock miter is often used to assemble drawers. The joint features identical cuts in the mating boards, one in a board end and the other along the joining face. Both cuts are produced on a router table with the same bit. Because the lock miter is suitable with plywood, it is a good alternative to dovetails in such situations.

Routing a Lock Miter

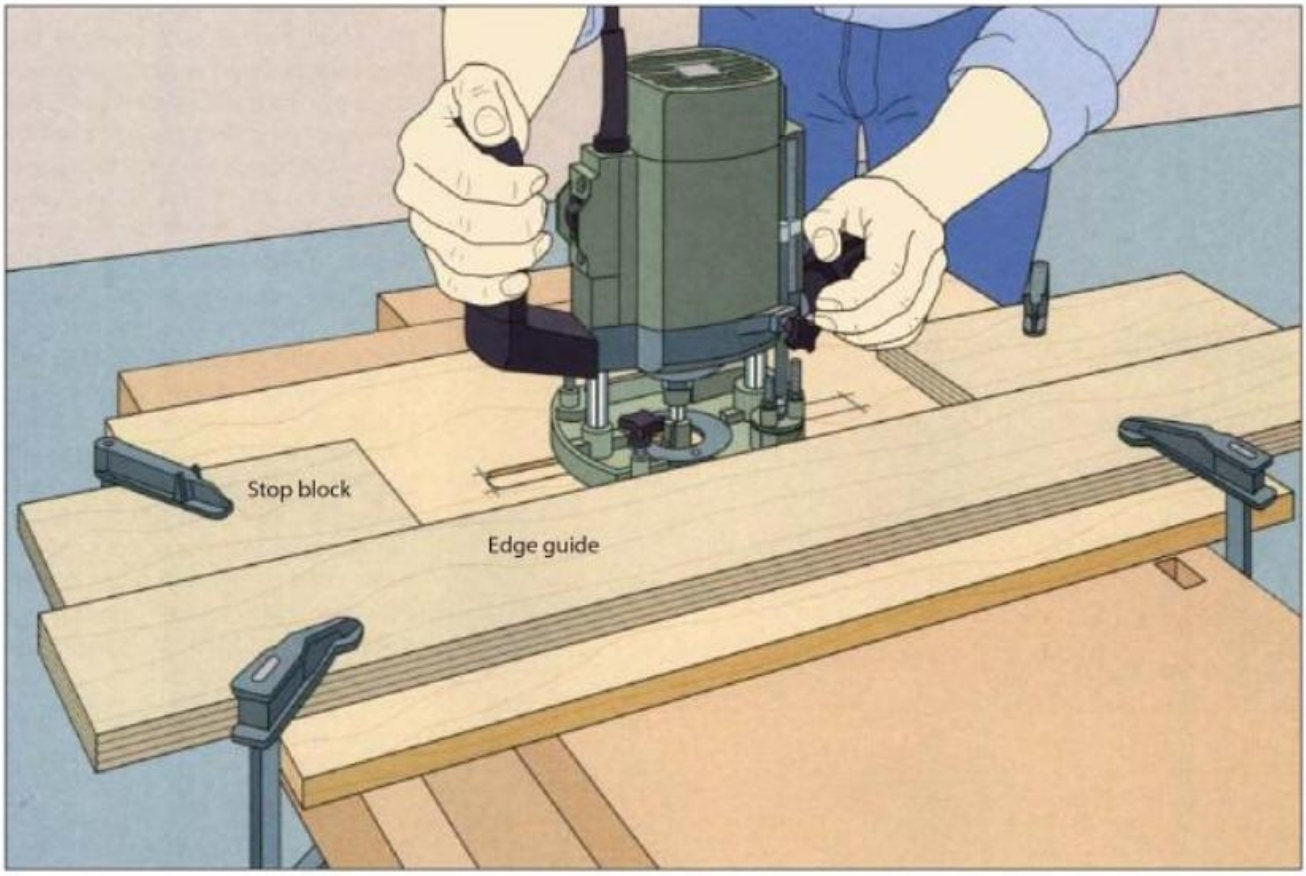




Making the cuts

Install a lock miter bit in your router and mount the tool in a table. Attach a notched auxiliary fence and screw an extension board to the miter gauge. Set the bit height so the uppermost cutter is centered on the board end with the workpiece flat on the table. Position the fence so the bit will dado the stock without shortening it. Holding the workpiece against the fence and the miter gauge extension, feed the stock into the bit *(above, left)*. To cut the mating piece, clamp a guide block to it to ride along the top of the fence. Then feed the board on end into the cutter, keeping it flush against the fence with one hand while pushing it and the guide block forward with the other hand *(above, right)*.

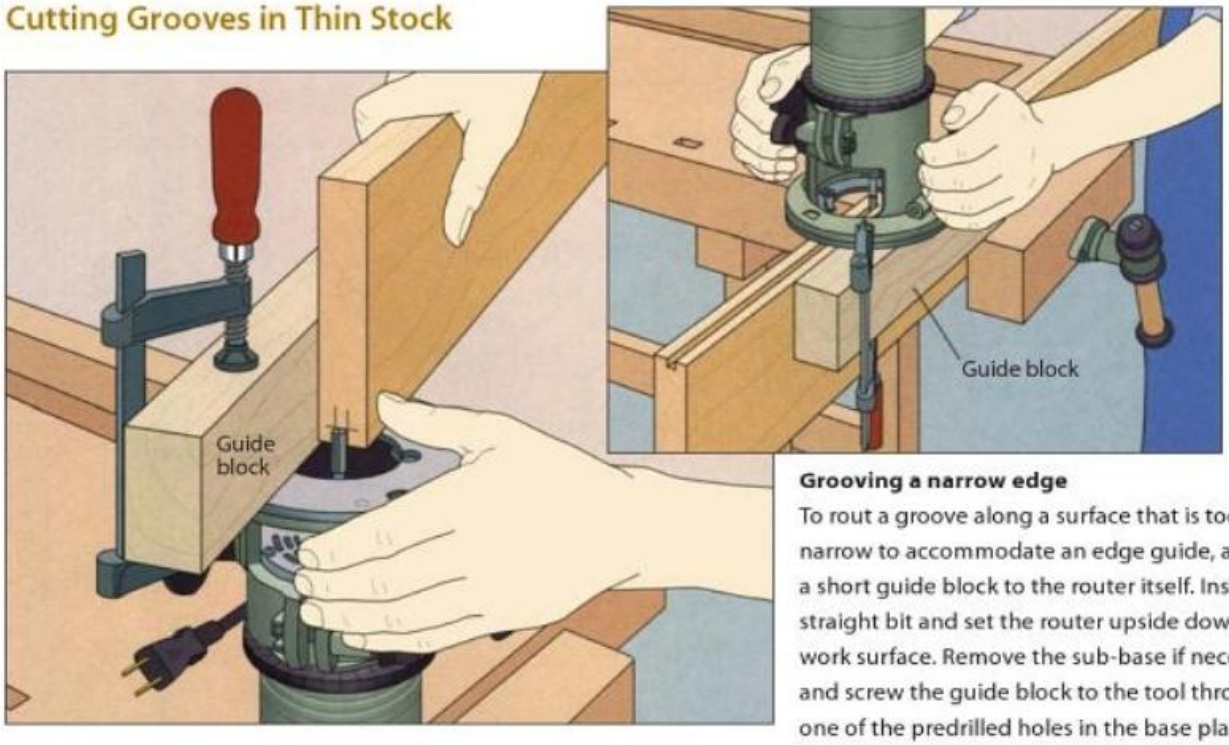
Routing a Stopped Groove



Using an edge guide and stop blocks

Set the stock on a work surface, then center the bit over the cutting lines. Clamp an edge guide to the workpiece flush against the router base plate; check that the guide is parallel to the edge of the workpiece. Next align the bit with one end of the marked lines and clamp a stop block to the workpiece flush with the router base plate. Repeat the process at the other end of the groove. To start the cut, rest the base plate on the workpiece with the bit clear of the stock and the plate butted against the edge guide and one of the stop blocks. Then plunge the bit into the stock. Guide the router toward the other stop block, keeping the base plate flush against the edge guide *(above)*.

Cutting Grooves in Thin Stock



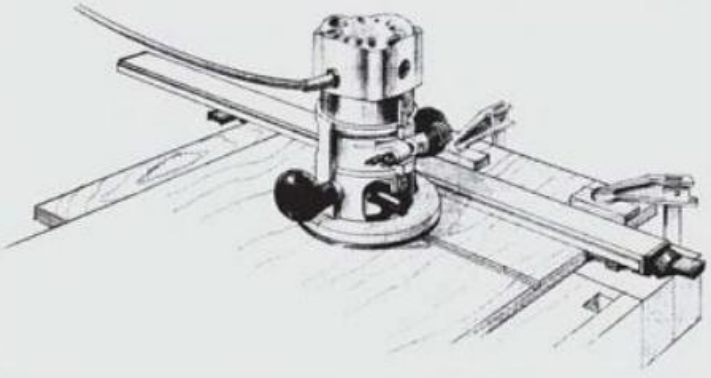
Grooving a narrow edge

To rout a groove along a surface that is too narrow to accommodate an edge guide, attach a short guide block to the router itself. Install a straight bit and set the router upside down on a work surface. Remove the sub-base if necessary and screw the guide block to the tool through one of the predrilled holes in the base plate. Mark the width of the groove on one end of the workpiece and align the marks with the bit. Then pivot the guide block until it is flush against the face of the stock. Clamp the guide to the base plate. Hold the marked end of the workpiece against the bit again to check that the guide is positioned properly *(above, left)*. To cut the groove, secure the workpiece edge up in a vise. Set the router flat on the edge of the board with the bit clear of the stock at one end and the guide block flush against the face of the workpiece. As you feed the bit through the cut, keep the base plate flat on the board's edge and the guide block pressed against the workpiece *(above, right)*. Reposition the board, if necessary, to avoid hitting the vise with the clamp.

Shop Tip

Eliminating tearout

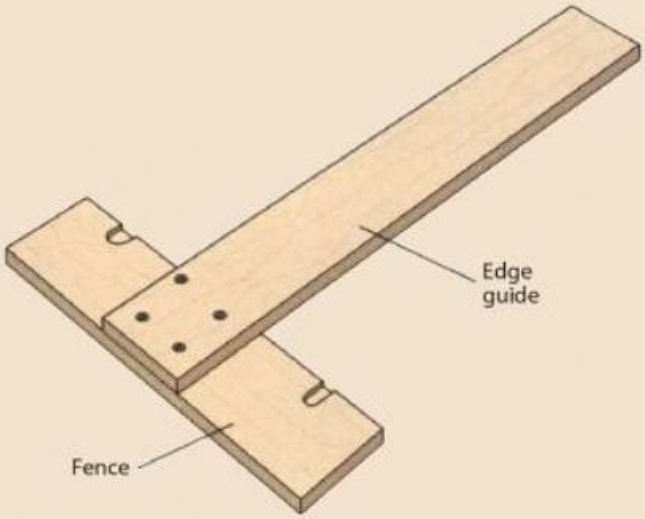
Routers have a tendency to cause tearout, particularly as they exit a workpiece at the end of a dado cut. To minimize splintering, always use an edge guide for straight cuts and secure a wood block the same thickness as your workpiece along the edge from which the bit will emerge. The pressure of the block against the workpiece will help to eliminate tearout.

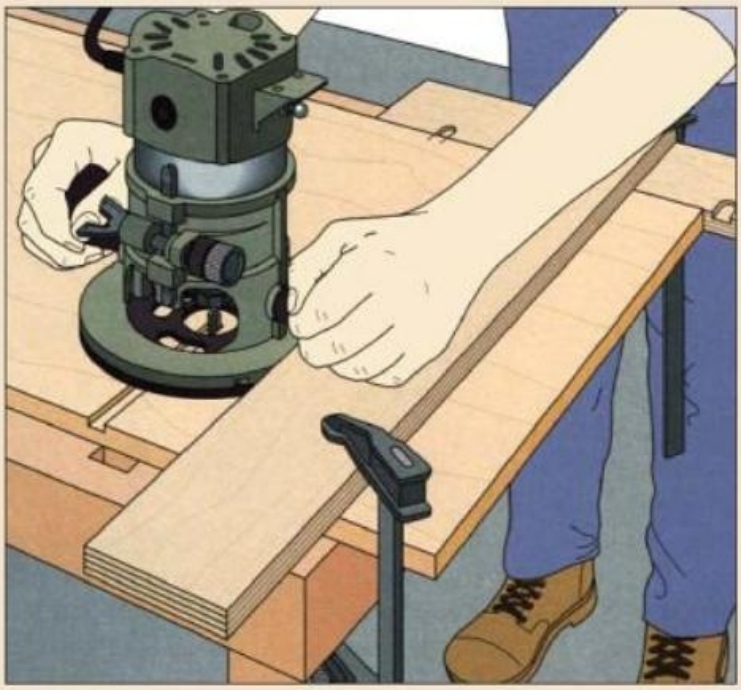


T-Square Jig for Grooving

To rout dadoes and grooves that are straight and perfectly square to the edge of your stock, construct a T-square jig like the one shown at right, made from ¾-inch plywood.

Size the jig to accommodate the stock you will be using and the diameter of your router base plate. Make the edge guide about 4 inches wide and at least as long as the width of the workpiece; the fence, also about 4 inches wide, should extend on either side of the guide by about the width of the router base plate.



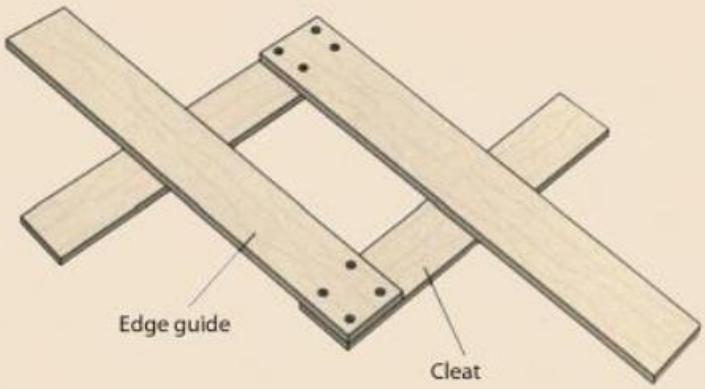


To assemble the jig, screw the fence to the edge guide with countersunk screws. Use a try square to make certain the two pieces are perpendicular to each other. Then clamp the jig to a work surface and rout a short dado on each side of the fence, using your two most commonly used bits—often ¾-and ½-inch. These dadoes in the fence will minimize tearout when the jig is used, as well as serving to align the jig.

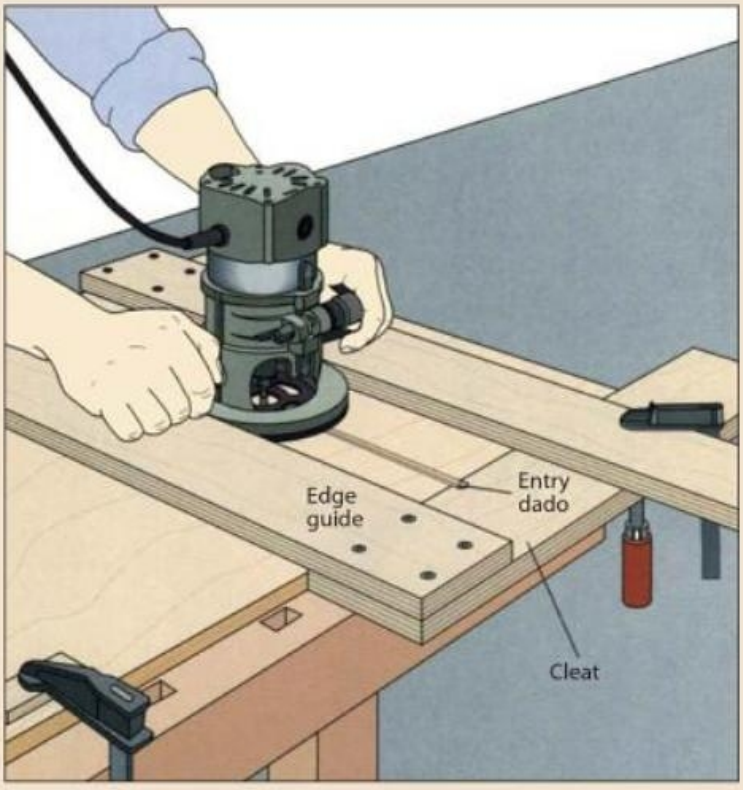
To use the jig, clamp it to the workpiece, aligning the appropriate dado in the fence with the outline on the stock. When making the cut, keep the router base plate firmly against the edge guide *(left)*. Continue the cut a short distance into the fence before stopping the router.

Quick-Setup Grooving Jig

Consisting of four strips of ¾-inch plywood assembled to form two Ls, the jig shown at right makes it easy to rout dadoes and grooves with minimal tearout. Make all the pieces of the jig about 4 inches wide. Cut the edge guides a few inches longer than the cut you intend to make. The cleats should be long enough to overlap the adjacent edge guide by several inches when the jig is set up. Attach the cleats to the edge guides, making sure that the pieces are perpendicular to each other; use four countersunk screws for each connection.

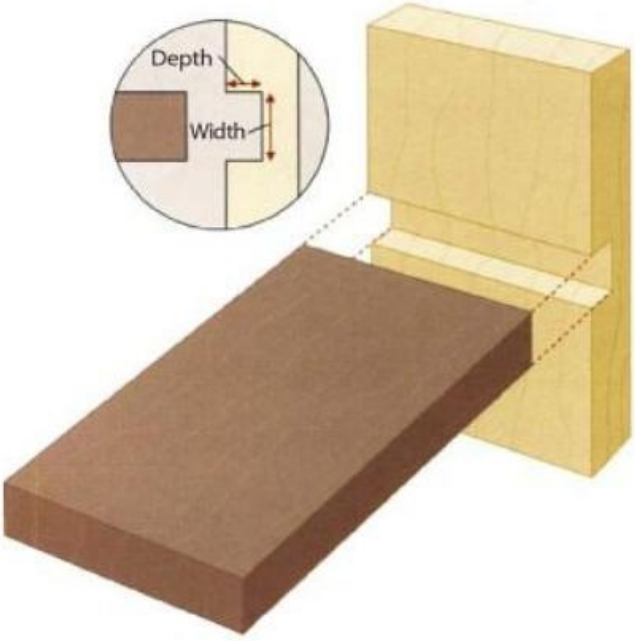


Set up the jig by clamping the stock to a work surface and butting the cleats against the workpiece at the beginning and end of the cut. Then set your router between the edge guides, aligning the bit over the dado outline. Slide the guides together until they butt against each side of the router base plate. Secure the jig by clamping it at opposing corners and to the workpiece. Then turn on the router and, with the tool between the edge guides, start the cut in the cleat, creating an entry dado. Guide the router across the workpiece *(right, bottom)*, extending the cut completely through the stock and into the second cleat. This will minimize tearout as the bit exits the workpiece. If you need to rout several dadoes of the same size, leave the jig clamped together and align the entry dado with the cutting lines marked on the stock.

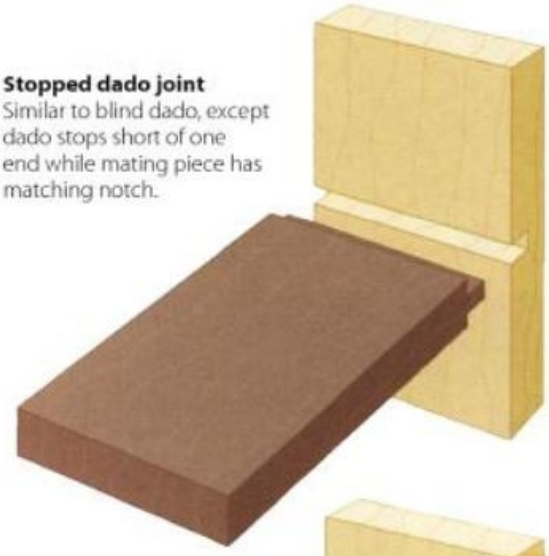


Dado Joints

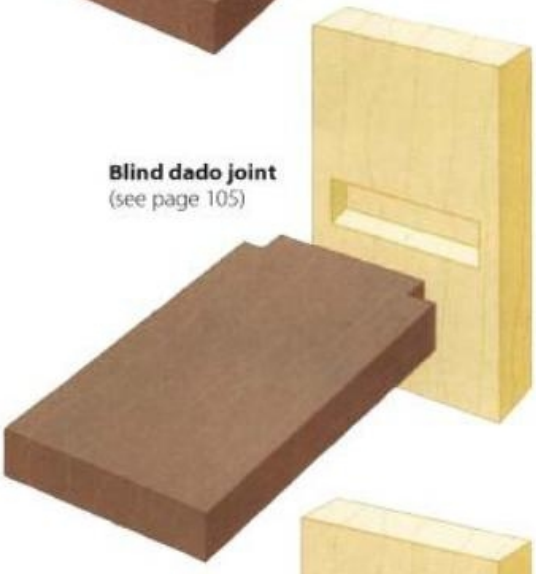
Anatomy of a Through Dado Joint (See page 102)



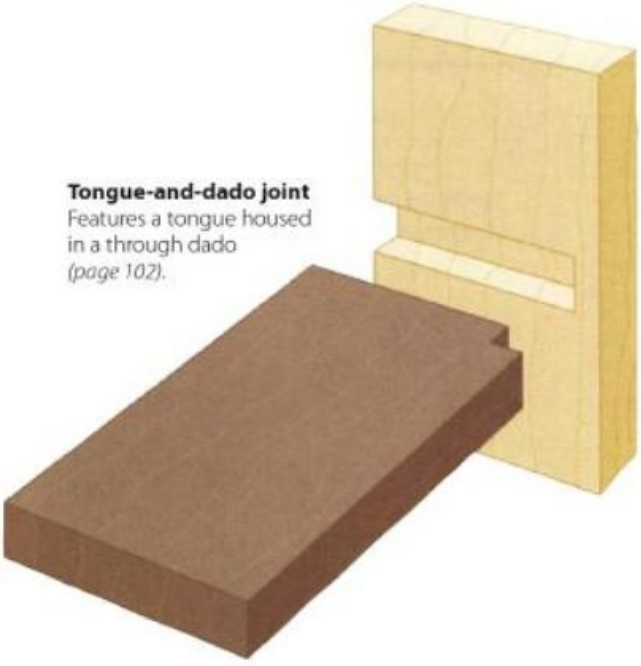
Stopped dado joint
Similar to blind dado, except dado stops short of one end while mating piece has matching notch.



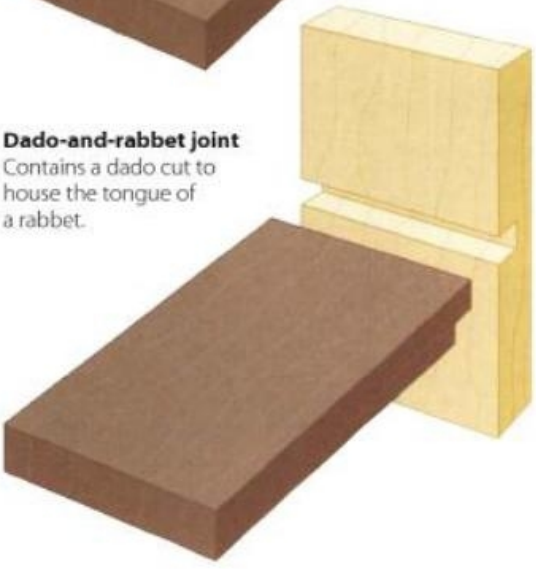
Blind dado joint
(see page 105)



Tongue-and-dado joint
Features a tongue housed in a through dado *(page 102)*.



Dado-and-rabbet joint
Contains a dado cut to house the tongue of a rabbet.



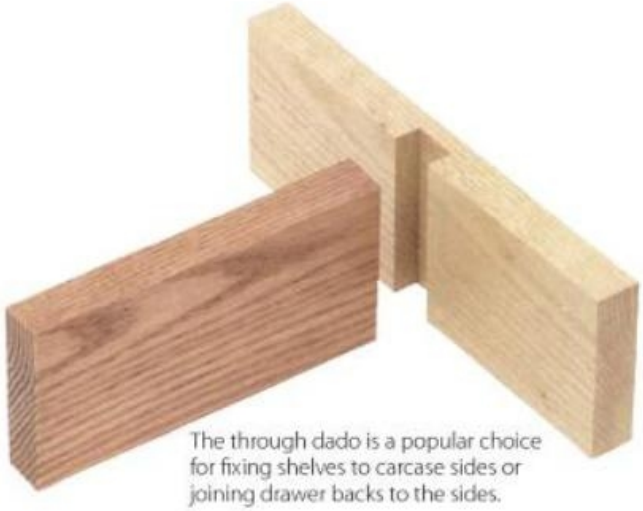
Dado Cuts

At one time, cutting dadoes cleanly and accurately was a painstaking task involving a specially designed hand plane or a saw and a wood chisel. Today, a router fitted with a straight bit can make quick work of any dado cut.

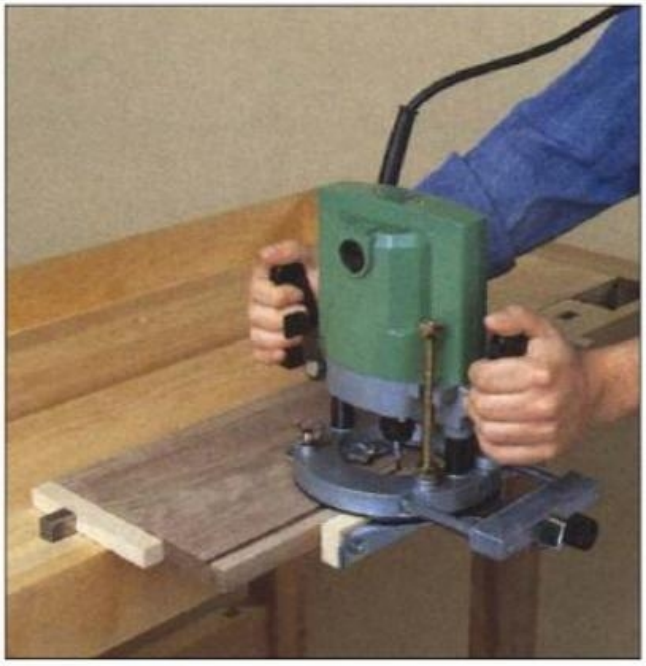
Whether you are routing a dado or a groove, the maximum depth of a single pass will depend on the hardness of the stock and the size of your router. In general, deep channels in hardwood require several passes. For cuts whose width exceeds the diameter of the bits you have on hand, make a series of passes. Three adjacent passes with a ½-inch bit, for example, will carve a dado or groove up to 1½ inches wide. (Usually, however, it would be better to make four slightly narrower cuts.)

The following pages display several useful dadoing jigs. For cuts close to the edge of a workpiece, the edge guide supplied with the router is a helpful tool, as shown in the photograph at right. For cuts farther in from the edge, use a commercial or shop-built straightedge guide. As shown on page 96, stopped grooves are easy to cut using a straightedge and two stop blocks.

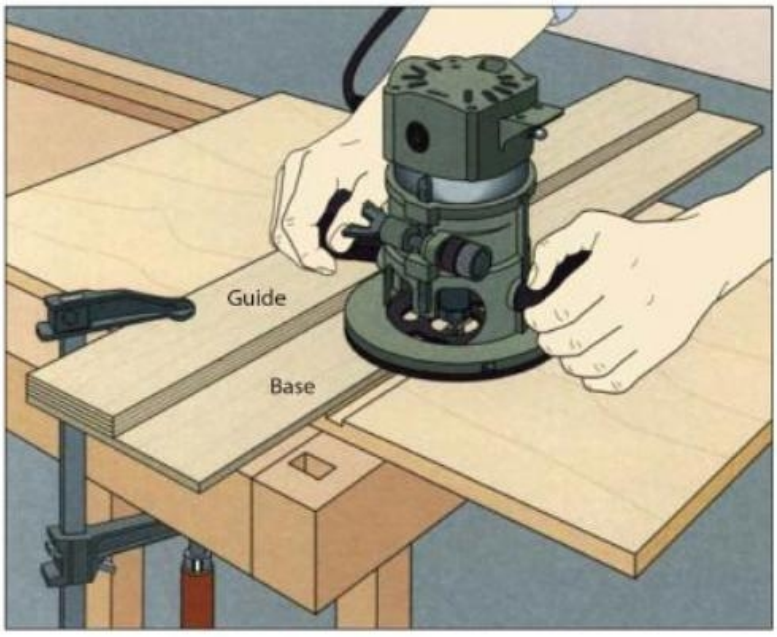
While any router will get the job done, a plunge router is best for making stopped dadoes and grooves. A standard router requires that you begin a stopped cut by tilting the base plate and pivoting the bit into the work; with a plunge router, you can hold the tool flat on the surface while plunging the bit straight into the wood.



The through dado is a popular choice for fixing shelves to carcase sides or joining drawer backs to the sides.



A straight bit carves a groove in a board. Riding an edge guide along the board produces a cut parallel to the edge.



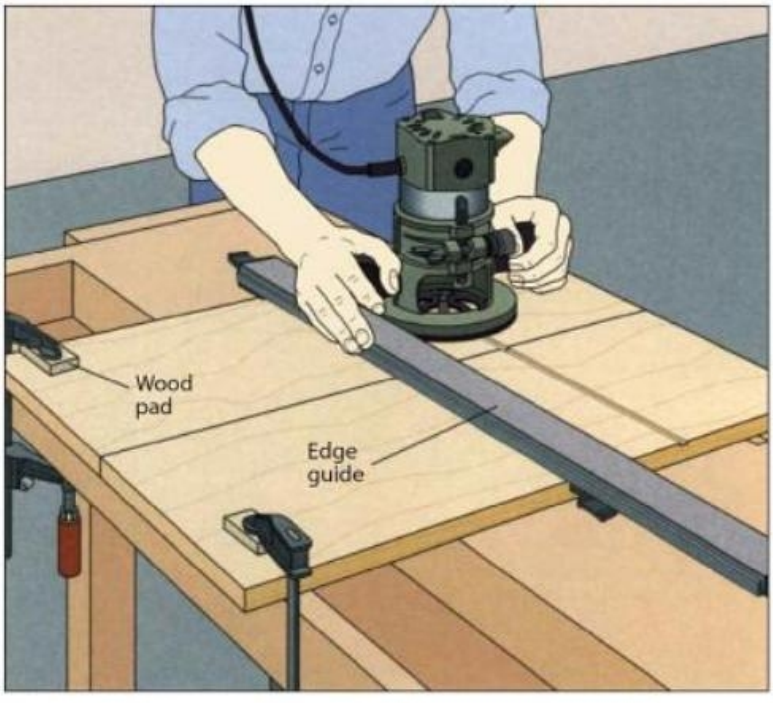
Routing Dadoes in Carcase Sides

Making and using an edge guide

Made from two pieces of plywood, the shop-built jig shown at left enables you to make quick work of a dado cut. Since the distance between the guide and the edge of the base is the same as the gap between the edge of the router base plate and the bit, the jig can be quickly lined up with the dado outline. Cut the base from ¼-inch plywood and the guide from ¾-inch plywood; rip the pieces to widths to suit your router set up. Screw the two pieces together, making sure to countersink the fasteners. Clamp the edge guide atop the workpiece, aligning the edge of the jig base with the cutting marks and rout the channel *(left)*, keeping the base flush against the guide and flat on the base.

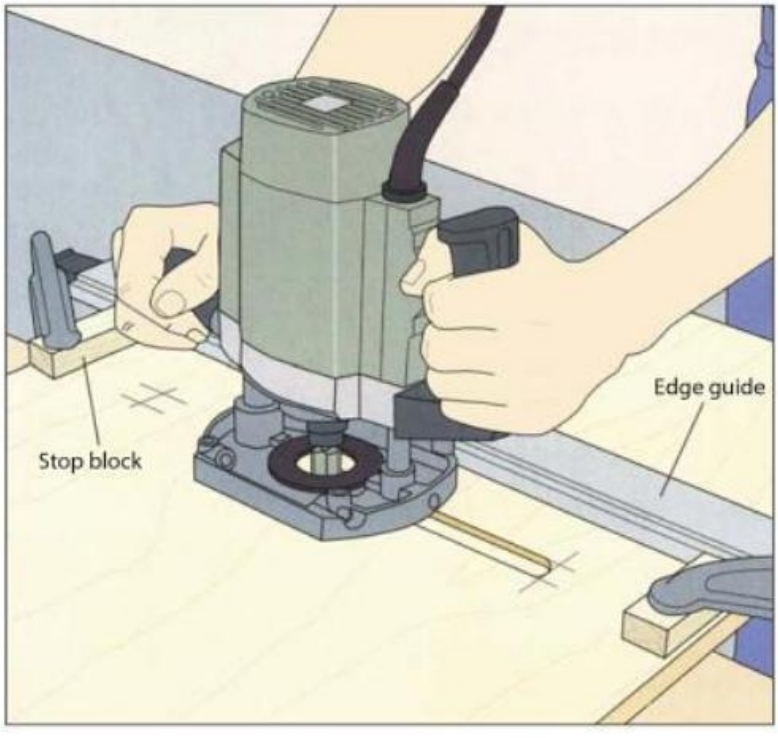
Cutting two dadoes in one pass

For a fixed shelf to sit level in a bookcase or cabinet, it must rest in dadoes at the same height in both side panels. One way to make certain the cuts line up is to rout both dadoes at the same time. Clamp the stock to a work surface, ensuring that the ends of the panels are aligned; protect the workpieces with wood pads. Then clamp an edge guide to the stock, positioning the jig so the router bit will line up directly over the dado outline. Make certain that the edge guide is square to the panel edges. Rout the dado.



Blind Dado Joints

The blind dado joint, in which the dado stops short of both edges of the board, is just as strong as the through dado, but invisible once it is assembled. The joint is commonly used for attaching shelving to cabinets.



Routing a Blind Dado

Using a plunge router

Set the stock on a work surface and mark out the dado; it should be as wide as the thickness of the mating board. Install a straight bit the same width as the dado. Align the bit over the width marks for the cut and clamp an edge guide to the workpiece flush against the router base plate. Then line up the bit with each of the dado end marks and clamp stop blocks to the workpiece. Gripping the router firmly with both hands, butt its base plate against the edge guide and one stop block and plunge the bit into the stock. Cut along the guide *(left)* until the base plate touches the other stop block. You will need to square the ends of the dado with a chisel and cut notches at both edges of the mating board to fit it into the dado.

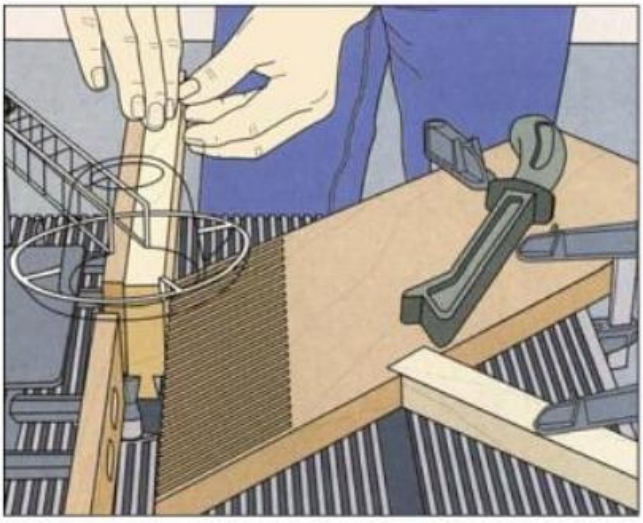
Sliding Dovetail Joints

The sliding dovetail is commonly used to assemble drawers, attach crown molding to cabinets, and install shelves in carcases. Because glue is not required to lock the mating pieces together, the joint is a good choice for furniture that must be disassembled.

A Sliding Dovetail Joint on the Router Table

Routing the dovetail groove

Cut the groove in two passes, first with a straight bit to remove most of the waste, and then with a dovetail bit to complete the groove. For the first pass, install a ¼ inch straight bit in the router and mount the tool in a table. Set the cutting depth, then center an edge of the workpiece over the bit and butt the fence against its face. To keep the workpiece flush against the fence, clamp a featherboard to the table. Complete the pass with a push stick. Install a dovetail bit in the router and make the second pass the same way *(above)*.



Making the dovetail slide

With the dovetail bit still in the router, reduce the cutting depth slightly. This will make the slide shorter than the depth of the groove, improving the fit of the joint. Move the fence toward the bit until about half the diameter of the cutter projects beyond the fence; reposition the featherboard accordingly. Cut the slide in two passes: Make the first pass the same way you routed the groove, pressing the face of the stock flush against the fence. To complete the slide, turn the workpiece end-for-end and make the second pass with the opposite face of the stock running along the fence *(above)*. Test-fit the slide in the groove, then move the fence away from the bit for subsequent cuts, until the slide fits.

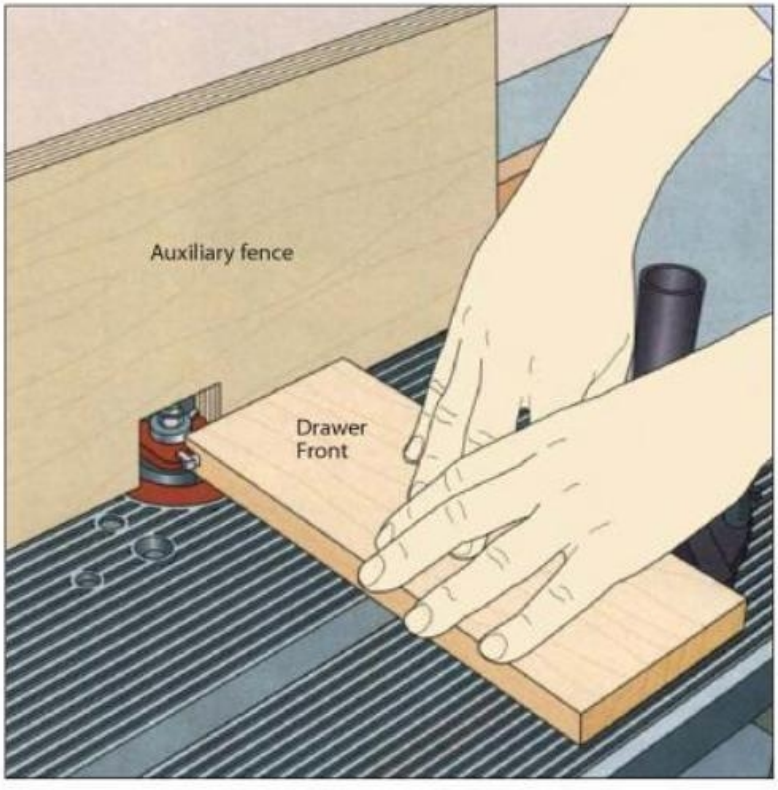
Double Dado Joint

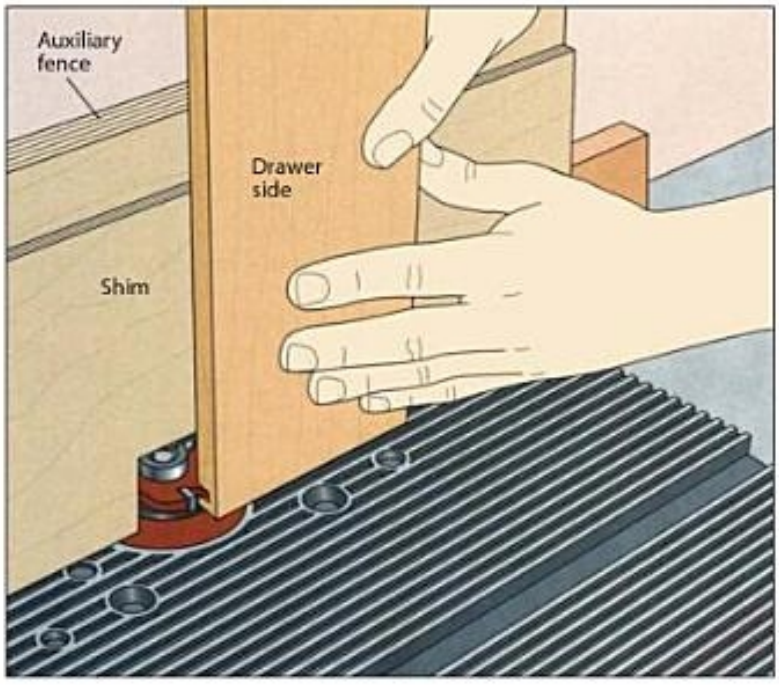
The double dado joint connects two dadoes, one dado on the inside face of one board and the other dado—with one tongue shortened—on the end of the mating piece. The joint is stronger than a standard through dado because it provides more gluing surface. It is an ideal choice for joining boards of different thicknesses, such as attaching a drawer front to the sides, and provides good resistance to tension and racking. The setup shown in the steps below and on the following page will join a ¾-inch-thick drawer front to a ½-inch-thick drawer side. The three cuts can all be made with the same bit—a three-wing slotting cutter. In this case, a ¼-inch bit is used; the shim attached to the auxiliary fence is also ¼ inch thick. By varying the sizes of the cutter and shim, you can cut the same joint in boards of different thicknesses.

Routing a Double Dado Joint

Dadoing the ends of the drawer front

If you are using double dadoes to assemble a drawer, cut the dadoes with the shortened tongue on the ends of the drawer front. Start by installing a three-wing slotting cutter in a router and mounting the tool in a table. Cut a notch for the bit through an 8-inch-high auxiliary fence and attach the fence in place; the high fence is essential for feeding stock across the table on end. Position the fence in line with the outer edge of the bit pilot bearing and parallel to the miter slot, then set the cutting height by butting the workpiece against the bit and centering the cutter on the end of the board. Keeping the face of the board flat on the table and the end pressed against the fence, feed it into the cutter using the miter gauge *(right)*.



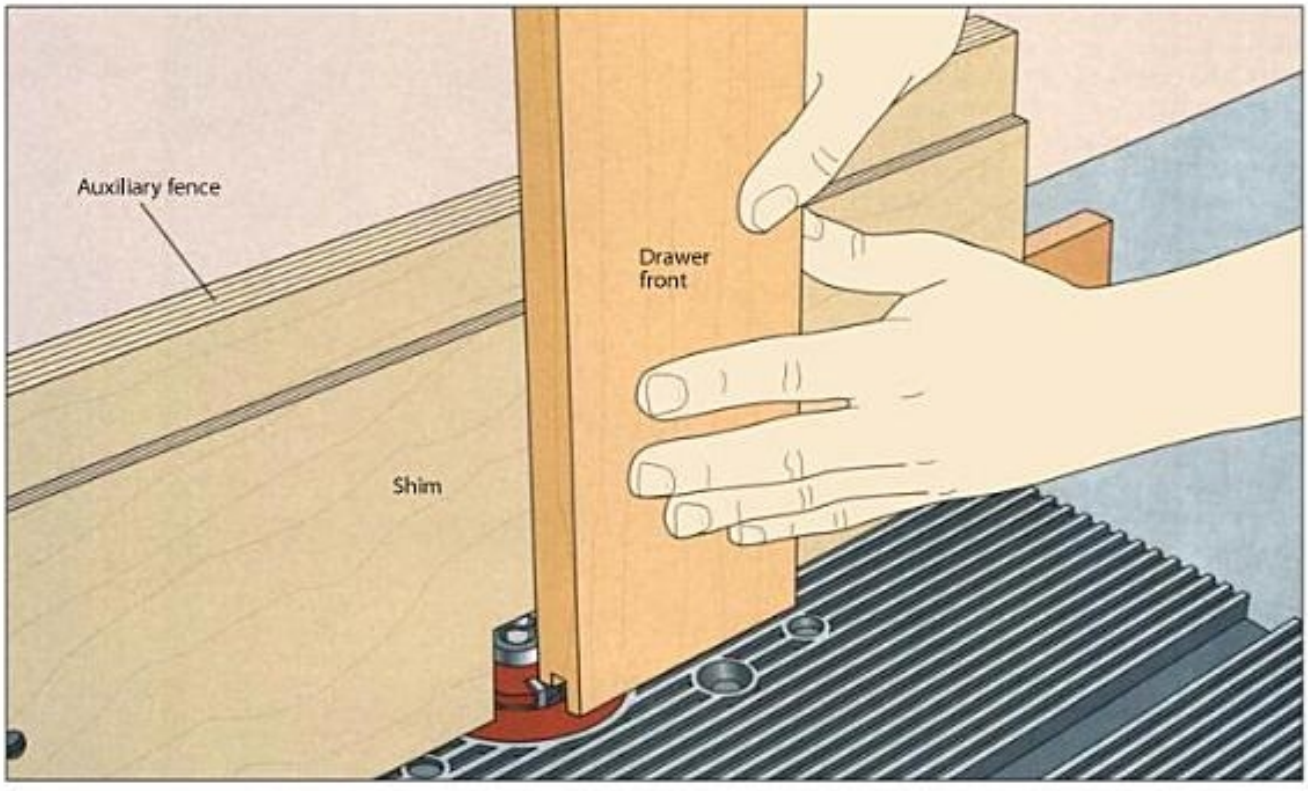


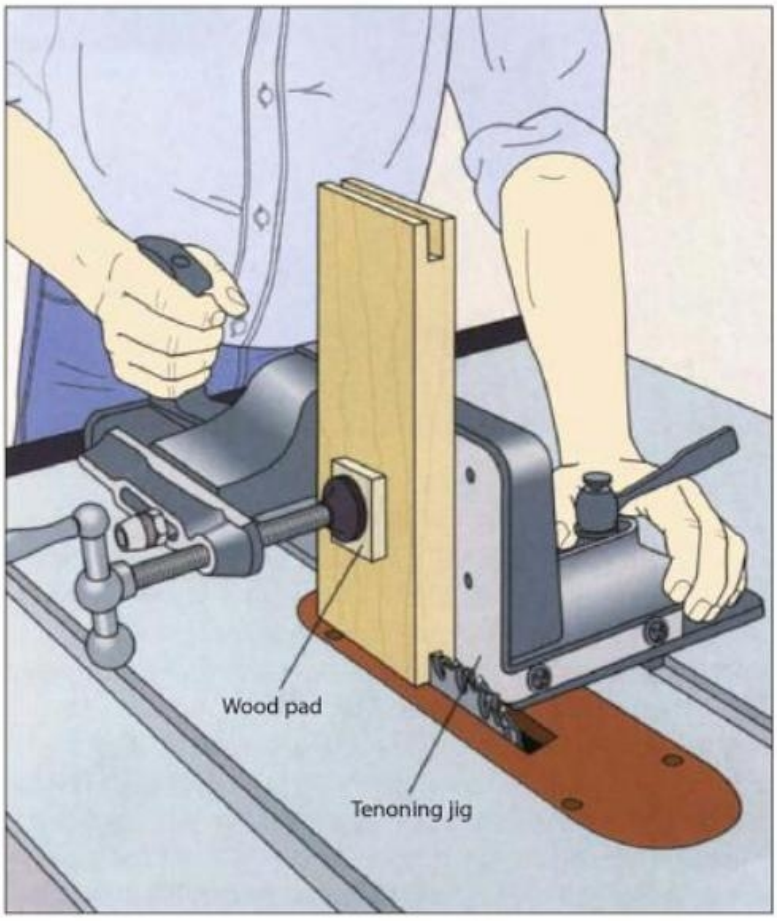
Dadoing the drawer side

Cut a notch in a wood shim for the cutter and screw it to the auxiliary fence. The shim should be as long as the fence and equal in thickness to the difference in thickness between the drawer front and sides. To rout the dado in the drawer side hold its end flat on the table and its inside face flush against the shim as you feed it across the table *(left)*. Be sure to keep your hands clear of the cutter.

Trimming the inside tongues on the drawer front

To complete the joint, you need to shorten the inside tongue of each dado you routed before. Lower the cutting height of the bit so the bottom edge of the cutter is just above the tabletop. Then feed the drawer front across the table, holding the inside face against the shim *(below)*.





A Double Dado Joint on the Table Saw

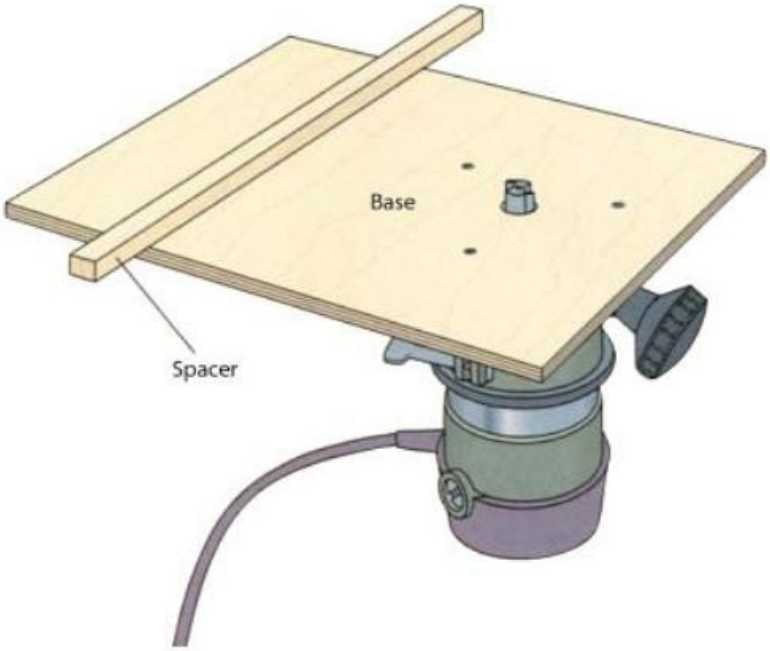
Making the cuts

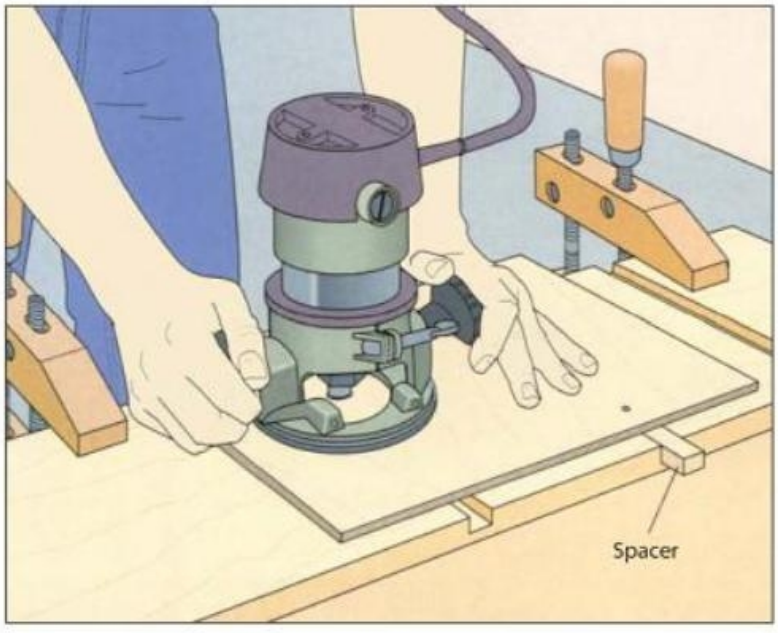
Install a dado head on your saw, adjusting its width to one-third the stock thickness. Also install a tenoning jig; the commercial model shown slides in the miter slot. Clamp the workpiece to the jig, protecting the stock with a wood pad. Adjust the jig to center the edge of the workpiece on the blades so that the dado will be cut in the middle third of the board. Slide the jig forward to feed the stock, then turn the workpiece end-for-end and repeat to cut the dado in the other end *(left)*. Next, install an auxiliary fence and notch it. Mark a cutting line on one of the tongues on the inside face of the board to divide it in half. Holding the workpiece flush against the miter gauge, inside-face down, align the mark with the dado head. Butt the fence against the stock and adjust the cutting height to cut the tongue in half. Feed the workpiece with the miter gauge to make the cut; repeat on the other end *(above)*. Complete the joint by cutting matching dadoes in the face of the mating pieces to accept the half-tongues.

A Jig for Evenly Spaced Dadoes

Assembling the jig

The jig shown at right is ideal for cutting equally spaced dadoes with a router. Dimensions depend on the size of the workpiece and the spacing between the dadoes. Begin by cutting a piece of ¼-inch plywood for the base, making it a few inches wider than the diameter of your router's base plate and a few inches longer than the spacing between the dadoes. Set the base on a work surface and place your router near one end. Mark the screw holes in the router base plate on the base; also mark a spot directly below the tool's collet. Bore holes for the screws and cut a hole at the collet mark large enough for the router bit. Remove the sub-base from the tool, screw the jig base to the router base plate, and install a straight bit the same width as the dadoes you wish to rout. Next, cut a spacer to fit snugly in the dadoes, making it slightly longer than the width of the workpiece. Screw the spacer to the bottom of the jig, making the distance between it and the bit equal to the space you want between your dadoes.



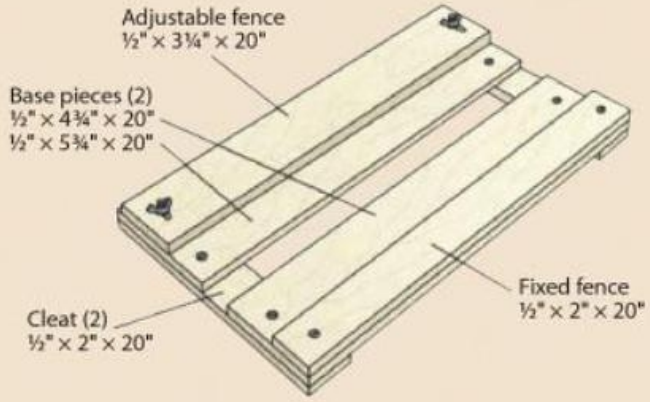


Cutting the dadoes

Clamp your stock to a work surface and set the jig on the workpiece with the spacer flush against one end and the router bit at one edge. Hold the router firmly and feed it across the surface to rout the first dado, keeping the spacer flush against the workpiece. Turn off the router and insert the spacer in the dado, repositioning the clamps as necessary. Rout the next dado, sliding the spacer in the first dado. Continue *(left)* until all the dadoes have been cut. (To vary the location of your first dado, rout it with a T-square guide like the one shown on page 98, rather than with the spacer jig.)

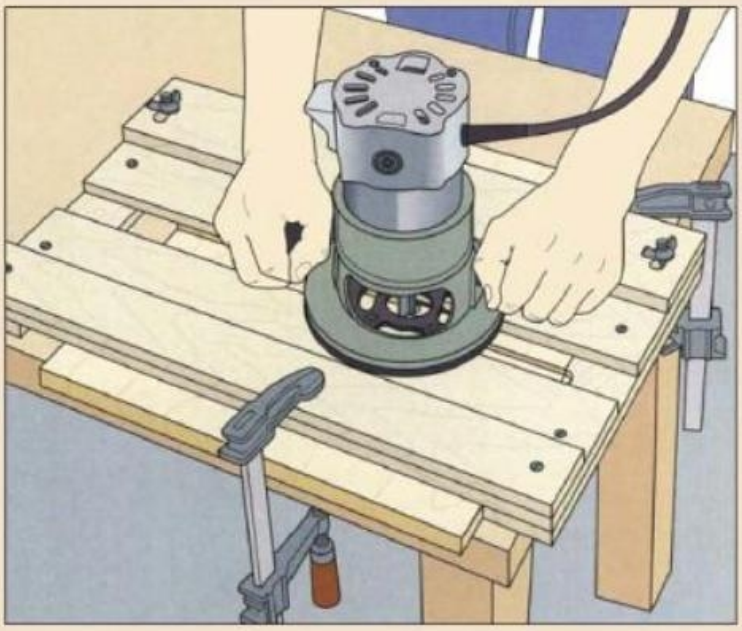
Adjustable Dado Jig

The jig at right will enable you to rout dadoes quickly and accurately. With its adjustable fence, it can also help solve the problem of making dadoes that are wider than the diameter of your largest straight bit. Cut the parts of the jig from either plywood or solid wood; the dimensions shown in the illustration will suit most routers.



Attach the base pieces to the cleats so their outer edges are flush. Fasten the fixed fence in place flush with the outside edge of the narrower base piece, countersinking all the screws. To attach the adjustable fence, bore holes through the cleats at each end of the wider base piece for a hanger bolt. Screw the bolts to the jig, leaving about 1 inch of each one protruding above the base piece. To prepare the adjustable fence, cut a 1-inch-long slot at each end. Make the slots slightly wider than the bolts, ensuring that they will line up with the bolts when the fence is installed. (You can make the slots by boring a row of connected holes on the drill press and cleaning up the cuts with a chisel.) Use washers and wing nuts to attach the adjustable fence to the wider base piece.

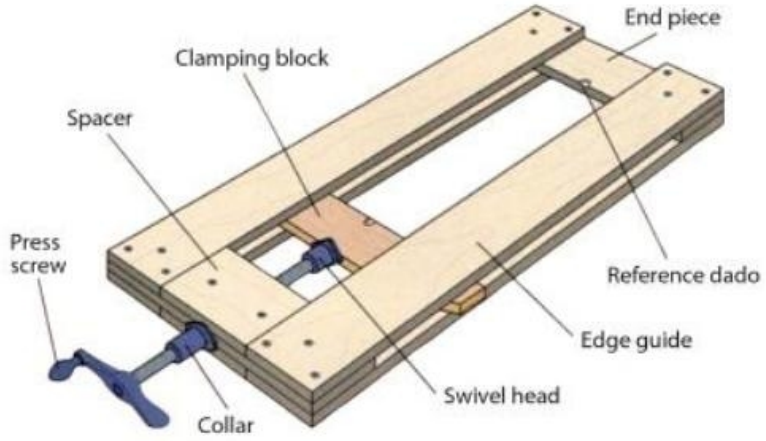
To use the jig, set your stock on a work surface and outline the dado on it. Align the edge of the narrower base piece with one edge of the outline and clamp the jig to the work surface. Place the router on the base pieces, butting its base plate against the fixed fence. Loosen the wing nuts and slide the adjustable fence against the base plate. Tighten the nuts, check that the fences are parallel, and rout the dado, riding the base plate along the fences throughout the cut *(below)*. For a dado that is wider than your bit's diameter, slide the adjustable fence away from the base plate by the appropriate amount, measuring to make sure the distance between fences is uniform along their length. Ride the base plate against the fences to rout the edges of the dado, then remove the waste between the cuts.

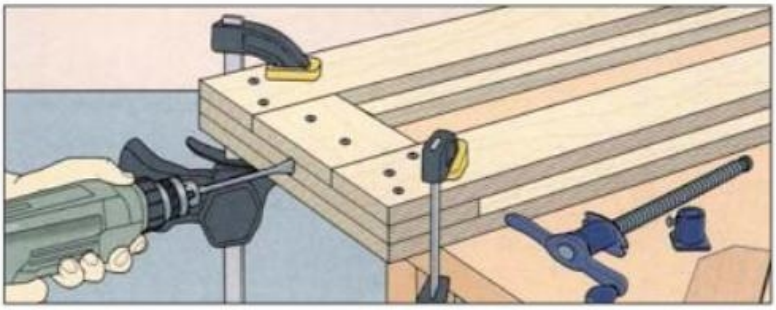


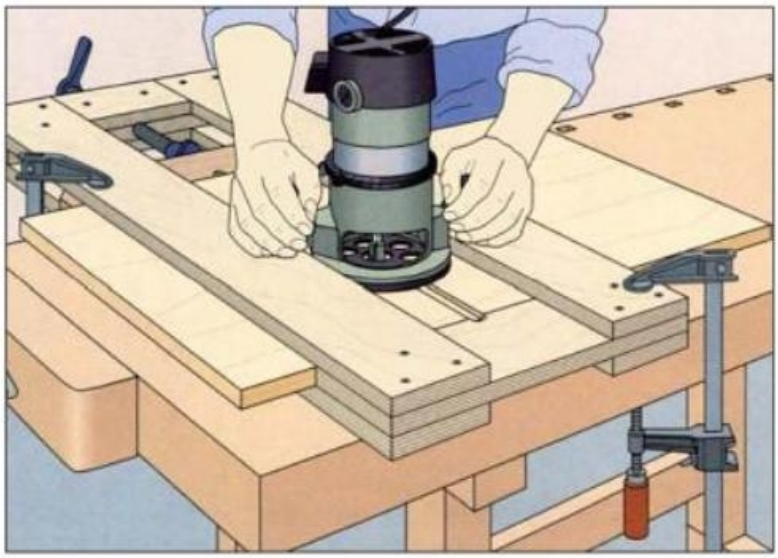
An Adjustable Dado Jig

Building the jig

The jig shown at right is ideal for routing dadoes in wide panels. Size the pieces so the distance between the edge guides equals the diameter of your router's base plate. The guides should be long enough to accommodate the widest panel you plan to rout. Cut the four edge guides, the two ends, and spacers from ¾-inch plywood; make all the pieces 4 inches wide. Sandwich the end pieces between the guides and screw them together. At one end of the frame, attach spacers to the top and bottom of the end piece. Countersink all fasteners. Cut the clamping block from ¾-inch-thick stock; make it about 3 inches wide and longer than the end pieces. To install the press screw, bore a hole for the threads through the end piece with the spacers *(right, below)*. Remove the swivel head from the press screw and fasten it to the middle of the clamping block. Attach the threaded section to the swivel head and screw the collar to the end piece. Use the router to cut short reference dadoes in the other end piece and the clamping block.

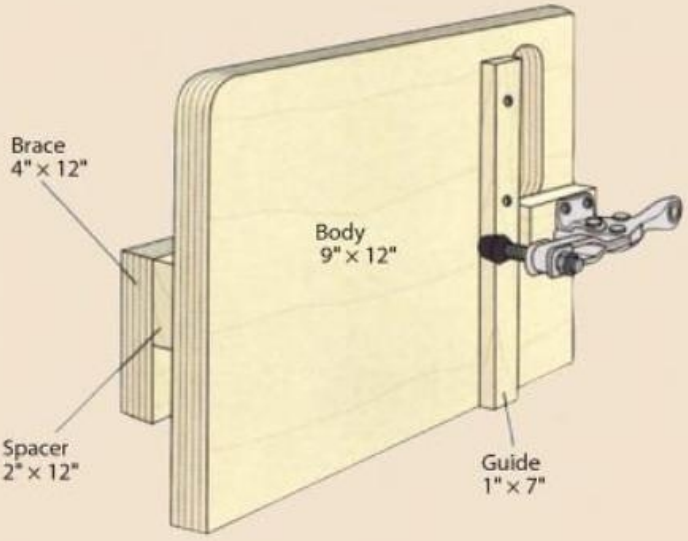






Cutting a dado

Slide the workpiece between the edge guides, aligning the marked outline with the reference dadoes. Secure the panel in position with the clamping block. Clamp the jig to a work surface. With the bit clear of the stock, turn on the router and start the cut at the reference dado in the end piece, making certain the router is between the edge guides. Feed the bit into the workpiece, keeping the base plate flat on the stock *(left)*. To minimize tearout, wait until the bit enters the reference dado in the clamping block before raising the router clear of the stock.



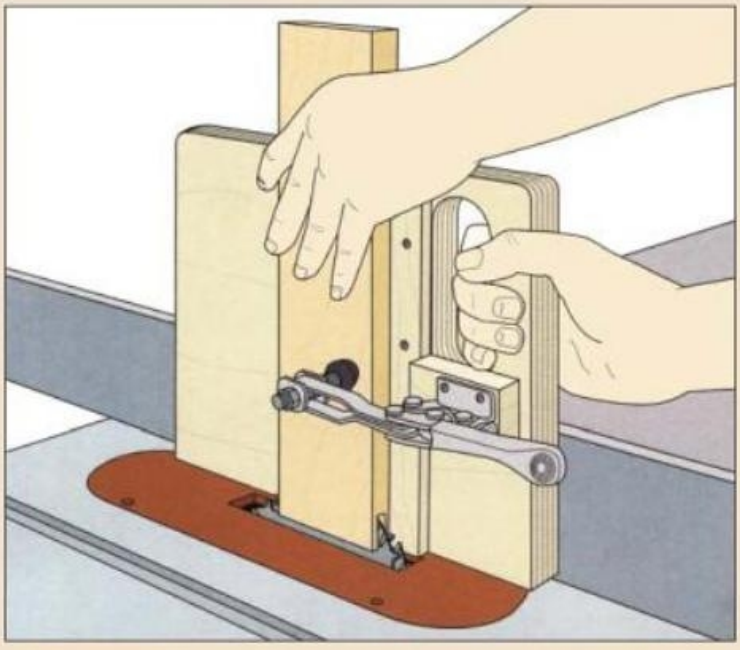


Table-Saw End-Dadoing Jig

Easy to assemble, the fence-straddling jig shown at left works well for cutting dadoes in the ends of boards. (The jig can also be used to cut half-lap joints or two-shouldered open mortise-and-tenon joints.) Refer to the dimensions suggested in the illustration, making sure the thickness of the spacer and width of the brace allow the jig to slide smoothly along your rip fence without wobbling.

Cut the body and brace from ¾-inch plywood and the guide and spacer from solid wood. Saw an oval hole for a handle in one corner of the jig body. Attach the guide to the body directly in front of the handle hole, making sure that it is perfectly vertical. (The screws should be in the top half of the guide, because the blade will cut into it for some cuts.) Screw a small wood block to the body below the hole and attach a toggle clamp to the block. Finally, fasten the spacer and brace in place.

To use the jig, place it astride the fence. Butt the workpiece against the jig guide and clamp it in place. Position the fence to align the cutting marks on the board with the blade and slide the jig along the fence to make the cut *(left, bottom)*.

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 furniture making—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 118 and 119. 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 122)* is often ¾ inch or longer, depending on the use of the mating workpiece; a through tenon will be as long as the width or thickness of the mortise workpiece.

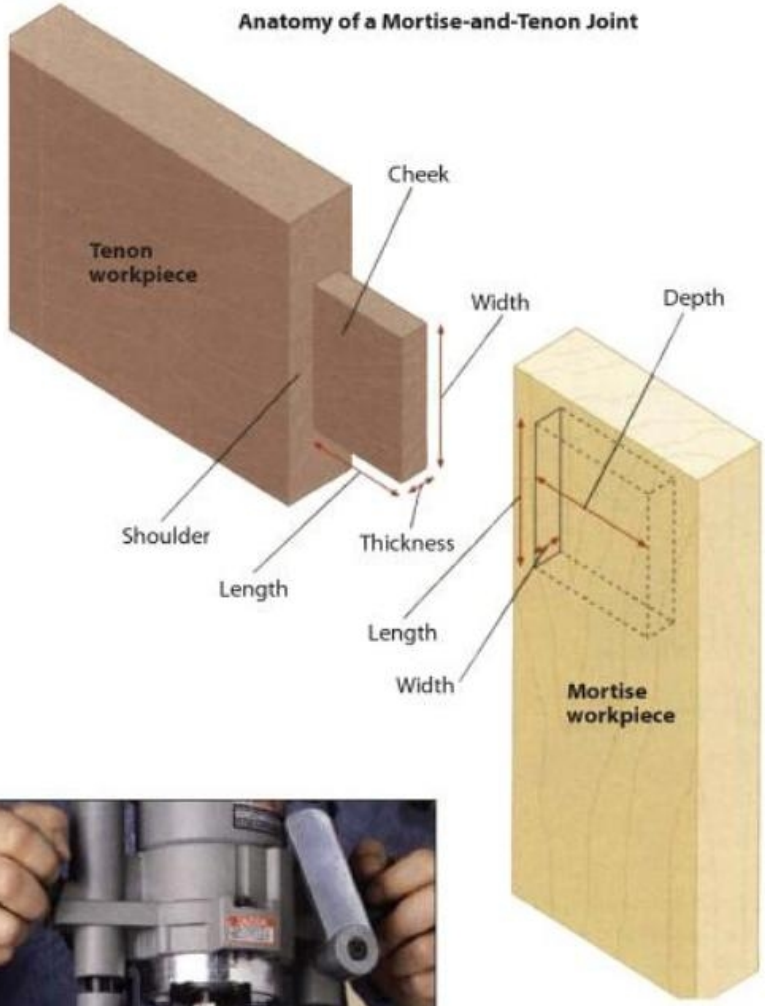
The pages that follow show several hand- and power-tool methods for cutting mortise-and-tenon joints. Tenons can be cut on the table saw *(page 120)*, with a backsaw *(page 124)*, or on the drill press *(page 125)*. Mortises can be produced on the table saw or drill press, chiseled out by hand *(page 123)*, or routed *(page 126)*. 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.

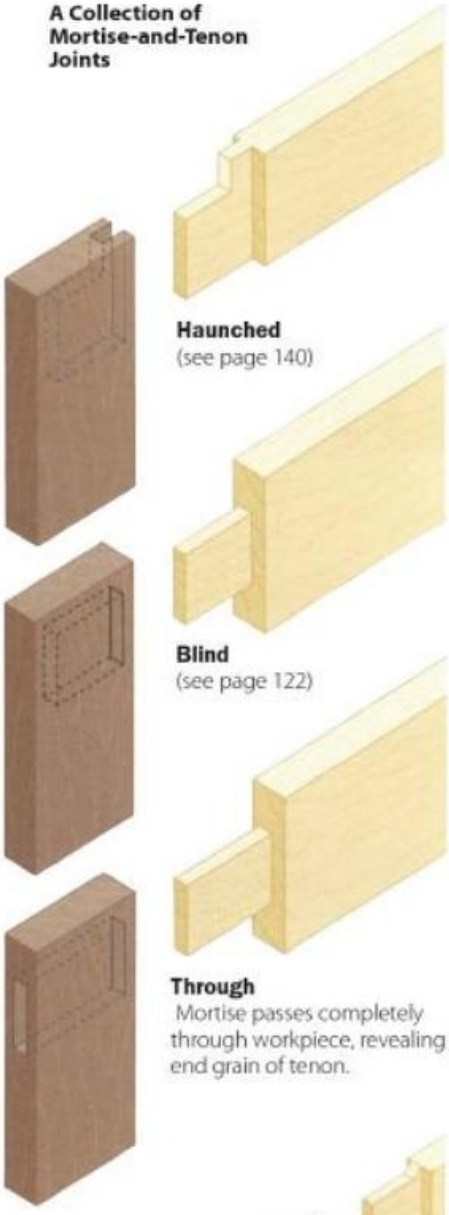
A tenon at the end of a rail fits snugly in a mortise cut out of a table leg. This blind mortise-and-tenon joint is both sturdy and long-lasting.

Mortise-and-Tenon Joints and Jigs

Anatomy of a Mortise-and-Tenon Joint



A Collection of Mortise-and-Tenon Joints



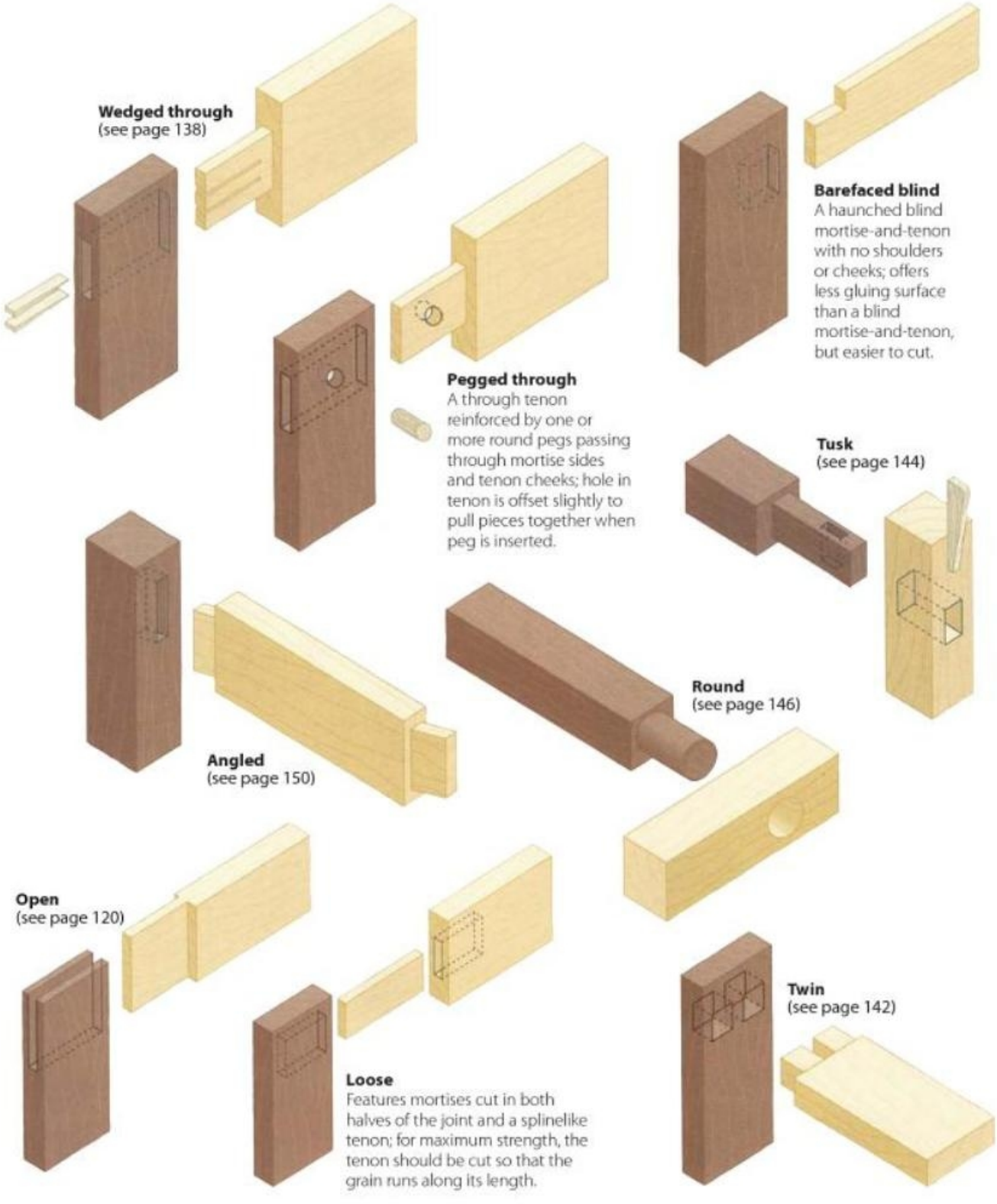
Haunched
(see page 140)

Blind
(see page 122)

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.

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.



Wedged through
(see page 138)

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 144)

Round
(see page 146)

Angled
(see page 150)

Open
(see page 120)

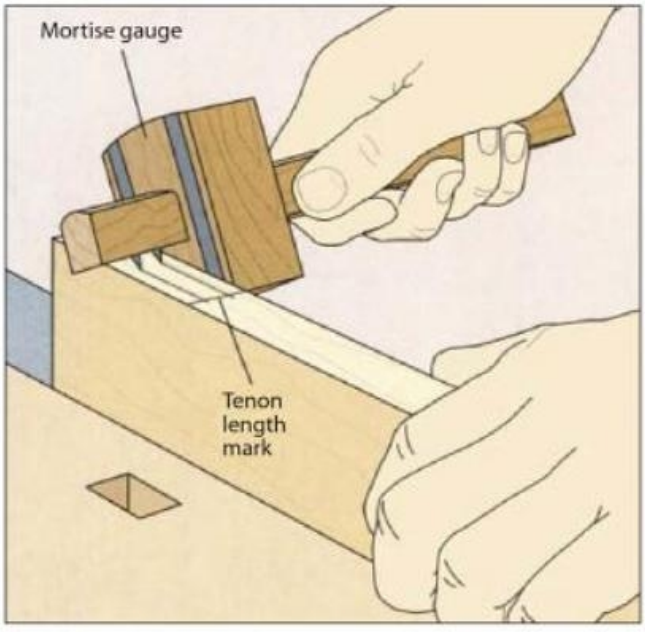
Loose
Features mortises cut in both halves of the joint and a splinelike tenon; for maximum strength, the tenon should be cut so that the grain runs along its length.

Twin
(see page 142)

Open Mortise-and-Tenon Joints

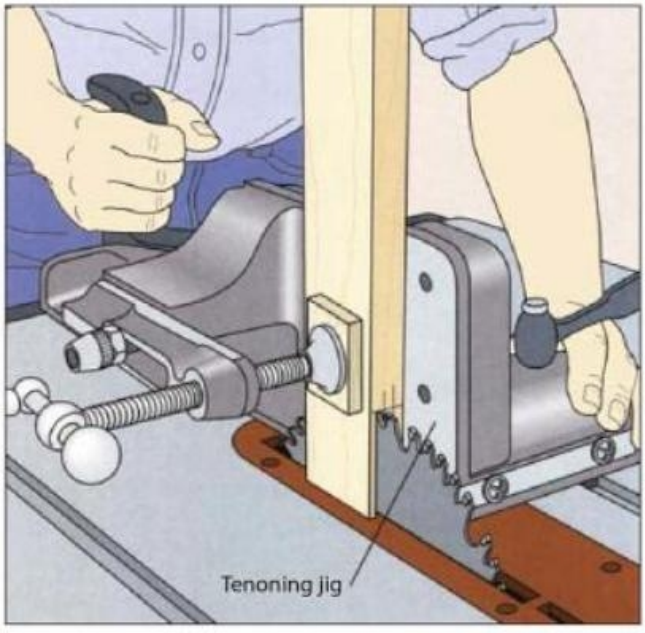
Also known as a bridle joint or slip joint, the open mortise-and-tenon is commonly used in frame construction. Both the open mortise and two-shouldered tenon can be cut on a table saw or radial arm saw.

An Open Mortise-and-Tenon on the Table Saw



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)*.

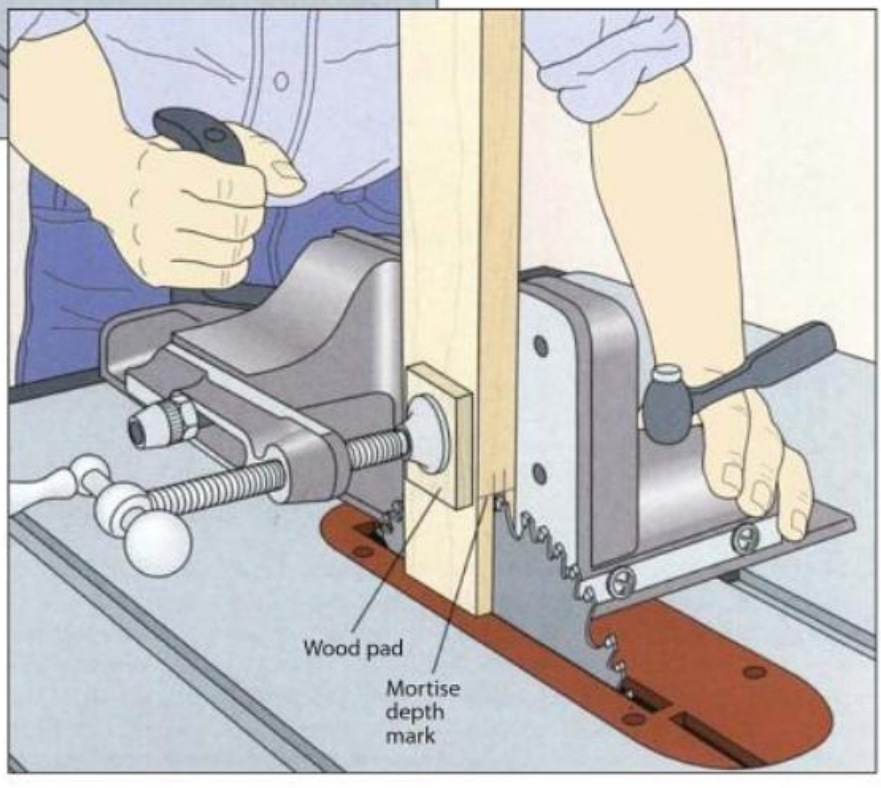


Cutting the tenon cheeks

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.

Sawing the tenon shoulders

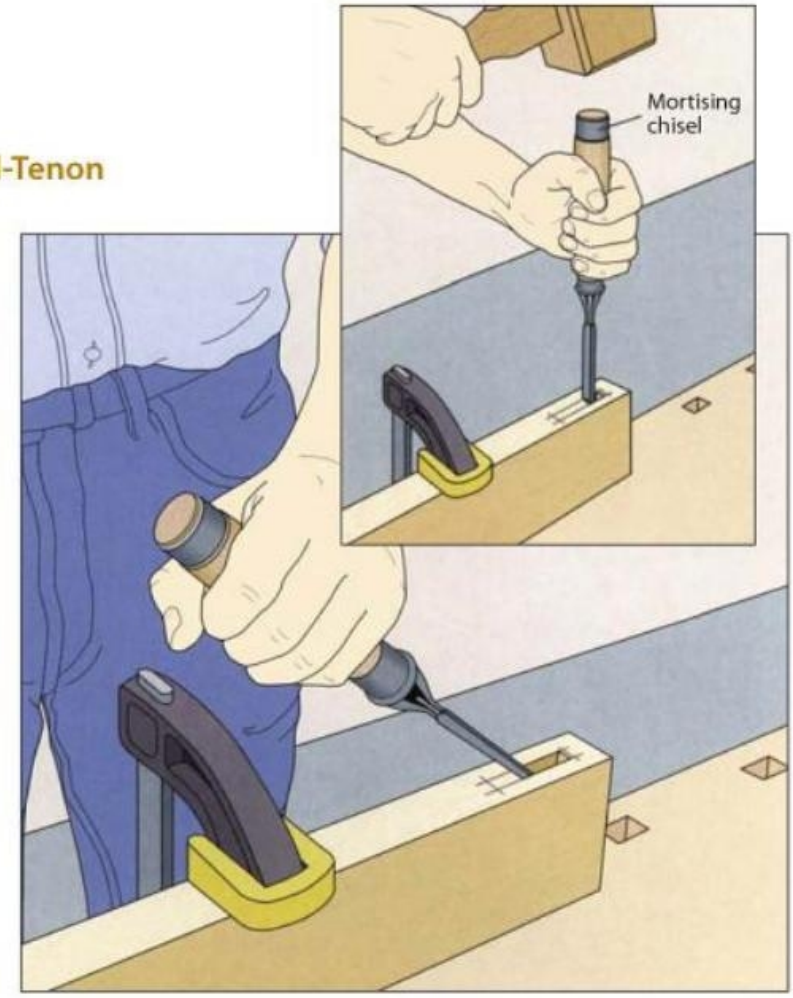
Attach an extension to your miter gauge. Holding the edge of the workpiece against the extension, adjust the blade to the height of one of the cutting lines for the tenon cheeks. Align the tenon length mark with the blade, butt a stop block against the stock, and clamp it to the extension; cut a small 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.)**



Cutting the mortise

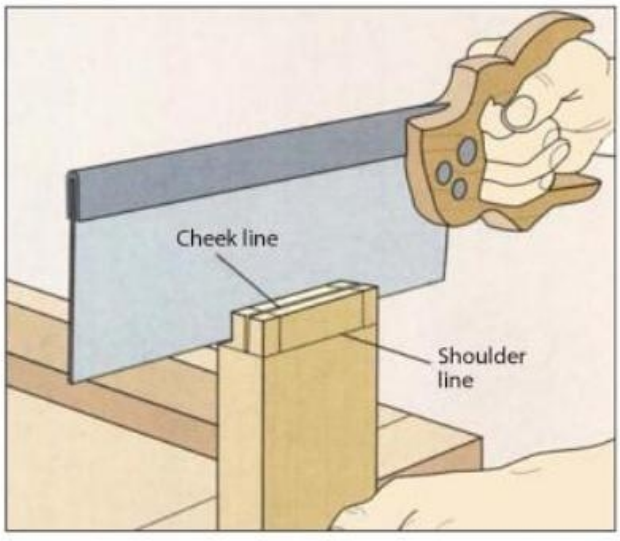
Reinstall the tenoning jig on the table. Outline the mortise the same way you marked the tenon and clamp the workpiece to the jig. Raise the blade to the mortise depth mark and cut the sides of the mortise, using the same technique you used for the tenon cheeks *(right)*. Once the sides have been cut,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

Hand-Cutting a Blind Mortise-and-Tenon



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 ¼ 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 ¼ inch. Make the second cut about ¼ inch back from the first *(inset)*, then tilt the chisel handle down and back to pry out the waste *(right)*. Continue making cuts ¼ 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.



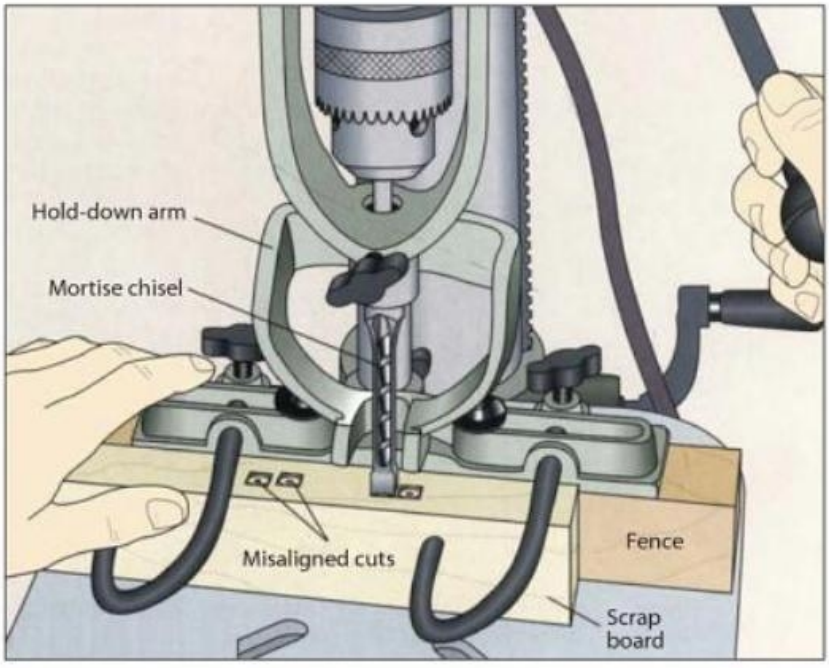
Cutting the tenon cheeks

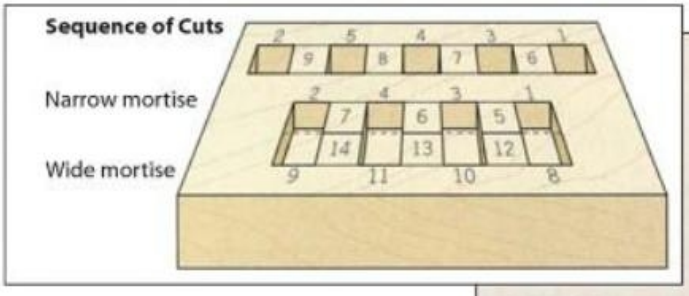
Make a four-shouldered tenon by cutting the cheeks first, and then the shoulders. Mark a shoulder line all around the end of the workpiece and outline the cheeks with four lines that intersect on the board end. Secure the workpiece upright in a vise and cut down the cheek lines with a backsaw until you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

Cutting a Mortise on the Drill Press

Setting up the mortising attachment

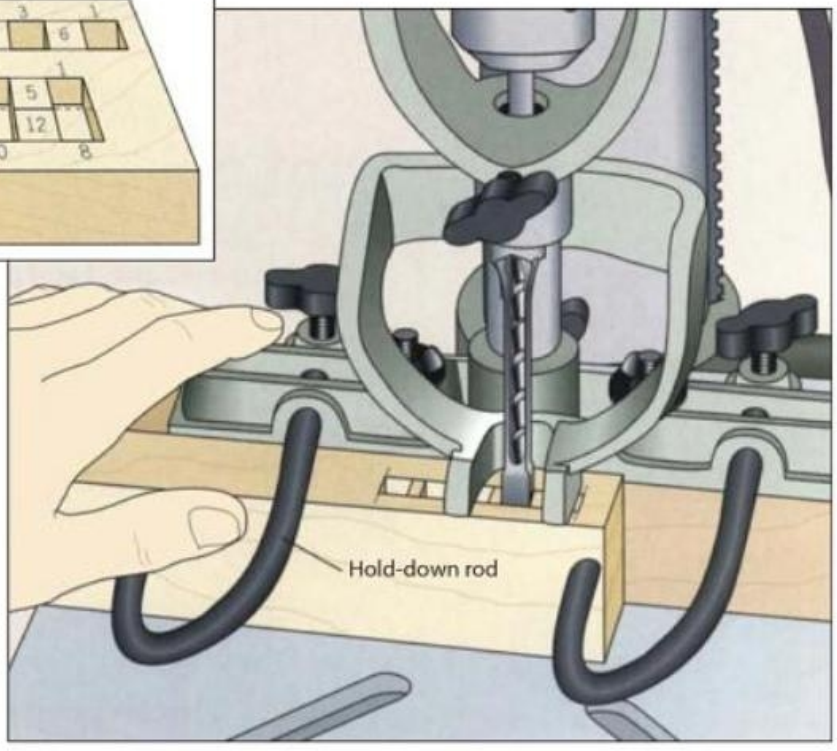
A mortising attachment consists of a drill bit surrounded by a four-sided hollow chisel that squares the hole cut by the bit. After installing the attachment on your drill press, check whether the mortise chisel will be centered on the workpiece by securing a scrap board the same width and thickness 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.)



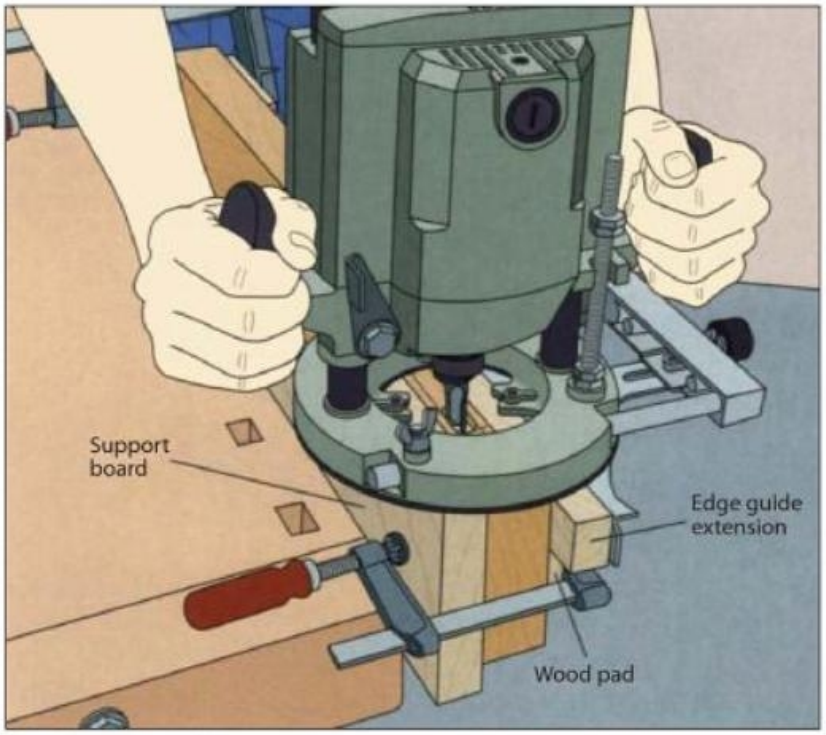


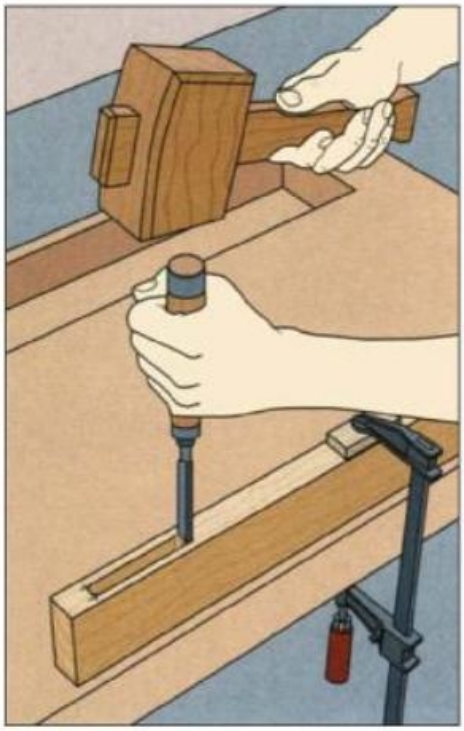
Drilling the mortise

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.



Routing Out Mortises



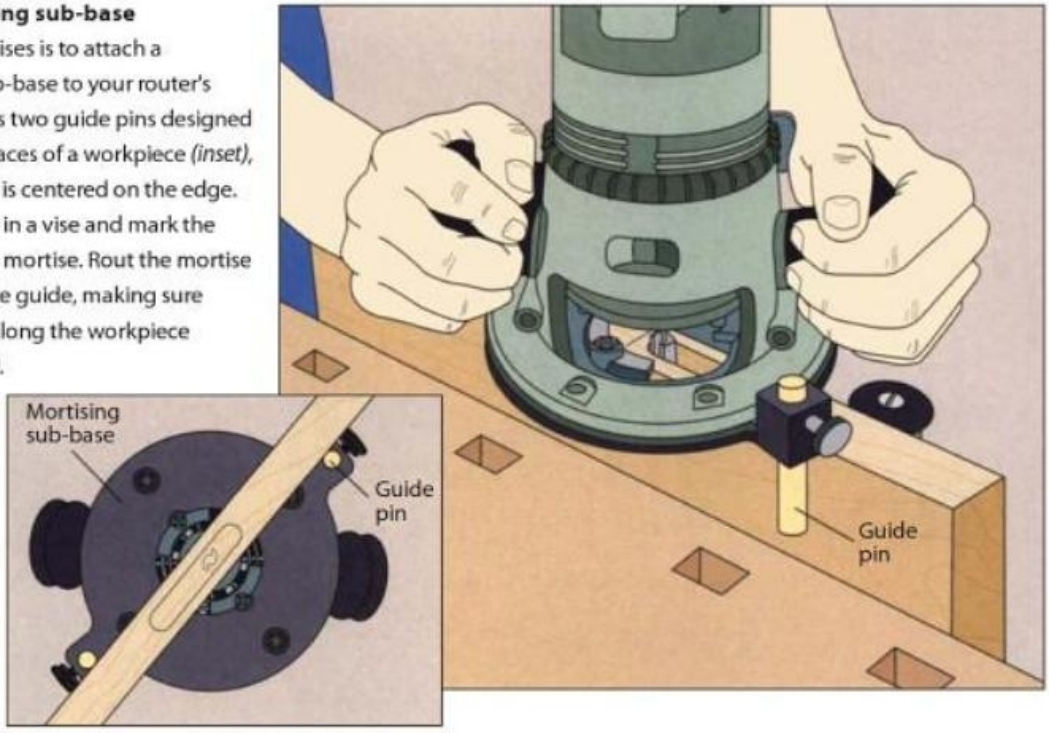


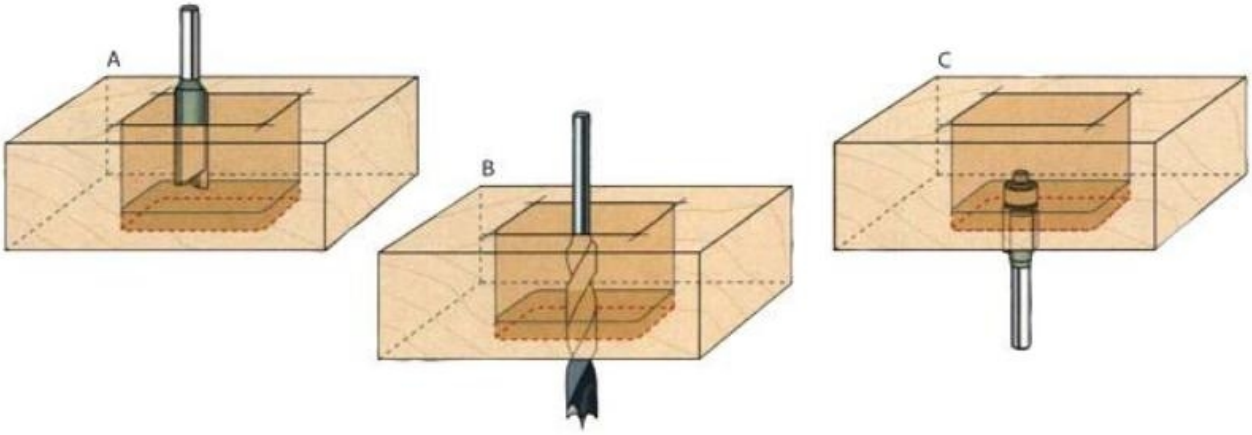
Using an edge guide

Use the tenon, which you can cut with a saw, to outline the mortise on the edge of the workpiece. Then secure the stock edge-up in a vise along with a support board to keep the router steady during the cut; make certain the top surfaces of the two boards are level, and use a wood pad to protect your stock. Install a mortising bit of the same diameter as the width of the mortise, then set the depth of cut. For a deep mortise, make one or more intermediate passes. Attach a wooden extension to the fence of a commercial edge guide, then fasten the guide to the router base plate. Center the bit over the 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 *(above, left)*, then feed the cutter to the other end. Once the cut is completed, clamp the stock to a work surface and quare the corners of the mortise with a chisel *(above, right)*, keeping the blade square to the workpiece and the bevel facing the waste.

Working with a mortising sub-base

Another way to rout mortises is to attach a commercial mortising sub-base to your router's base plate. The jig features two guide pins designed to butt against opposite faces of a workpiece *(inset)*, ensuring that the mortise is centered on the edge. Secure the stock edge-up in a vise and mark the beginning and end of the mortise. Rout the mortise as you would with an edge guide, making sure the guide pins both ride along the workpiece throughout the cut *(right)*.

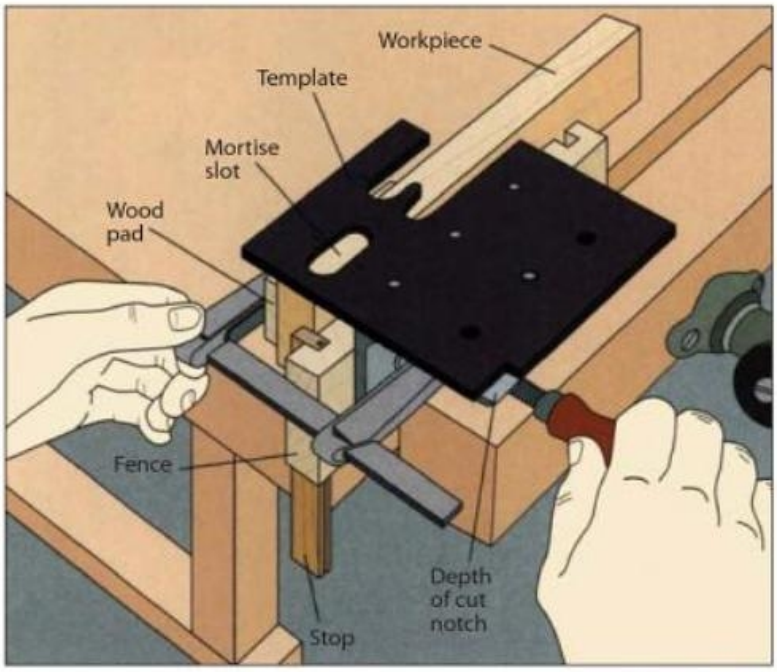




Routing deep through mortises

With the aid of an electric drill, your router can make mortises that exceed its maximum depth of cut. The illustration above shows the three steps necessary to cut a mortise through a thick workpiece. Start by installing a mortising bit in the router and making as many passes as you can until you can go no deeper. Then use the drill with a bit bigger than your router bit to bore a hole through the remaining waste. 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; keep the pilot bearing pressed against the walls of the cavity to complete the mortise.

Routing a Mortise-and-Tenon

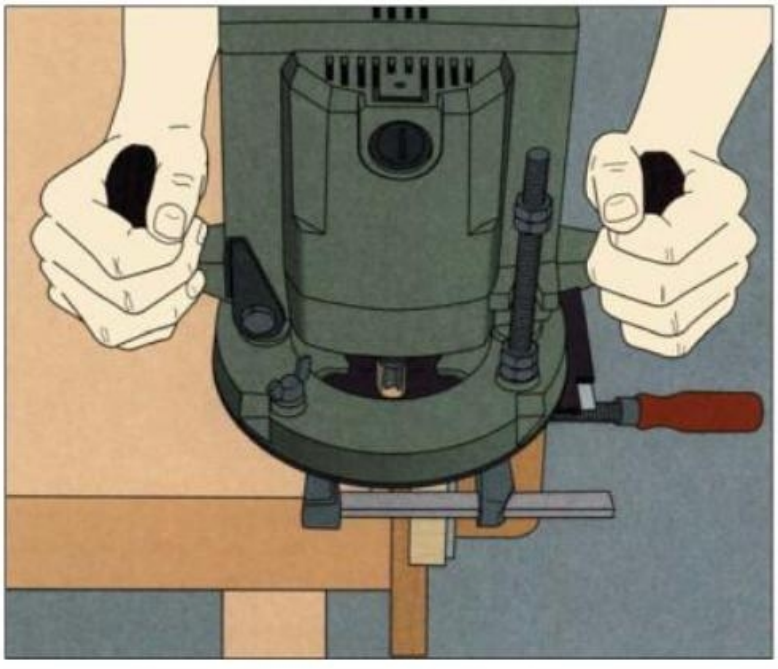


Setting up the jig

Assemble a commercial mortise-and-tenon jig following the manufacturer's instructions. The model shown allows you to rout both the mortise and tenon. Secure the jig in a vise, then clamp the workpiece to it, butting the end of the board against the stop and the edge to be mortised against the template. Use wood pads to protect the stock *(left)*. Install the piloted bit supplied with the jig in your router. Use the jig's depth-of-cut notch as an aid to setting the router bit's cutting depth.

Routing the mortise

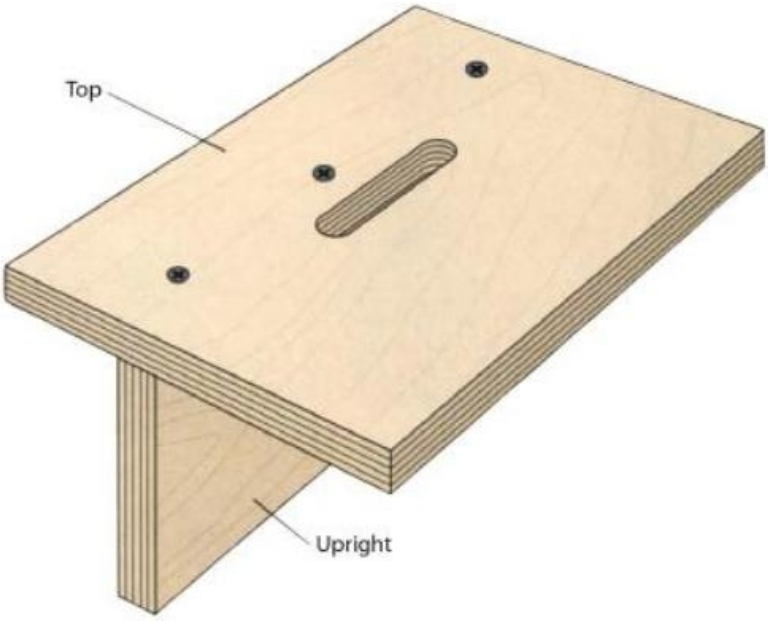
If you are using a plunge router, hold the router flat on the jig template with the bit centered over one end of the mortise slot. Turn on the tool and plunge the bit into the stock *(right)*. With a standard router, you will need to angle the tool and slowly lower the bit into the workpiece. In either case, feed the tool along the template to the other end of the slot to finish the cut, pressing the bit pilot against the inside edge of the slot throughout the cut. Keep the cutting edge from touching the template at any time. Unclamp the stock from the jig and remove the jig from the vise.

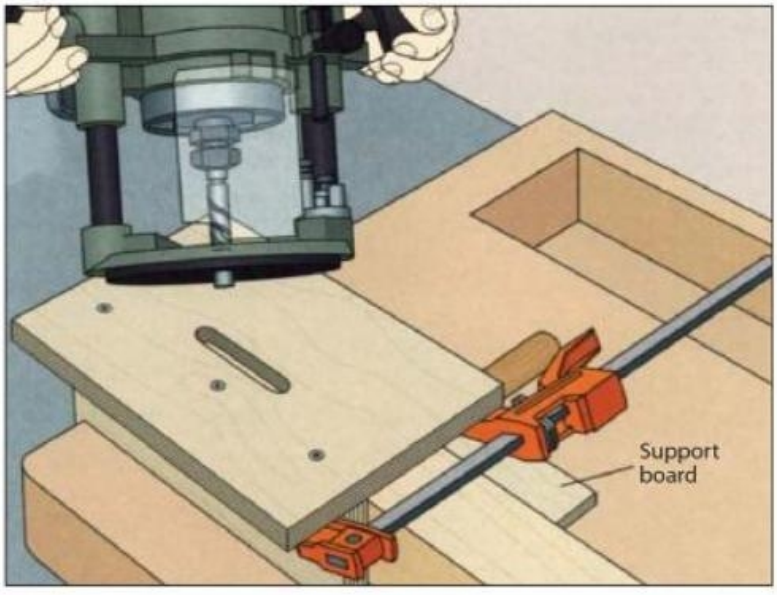


Making a Mortise-and-Tenon with a Router

Making the mortising jig

Assembled from ¾-inch plywood, the jig shown at right will help you rout mortises. Make the top and upright about 10 inches long and 6 inches wide. Cut an oval slot in the middle of the top, making it slightly longer than the mortise outline and wide enough to contain the outline and the template guide you will use with the bit. Screw the pieces together in a T shape, countersinking your fasteners; make the gap between the slot and the upright measure at least one-half the thickness of the thickest stock you plan to mortise. This will enable you to center the mortise outline under the slot with the board face flush against the upright; you can center thinner stock by placing shims between the workpiece and the upright.

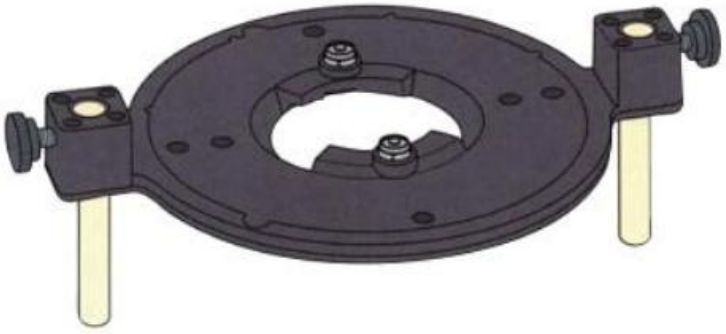




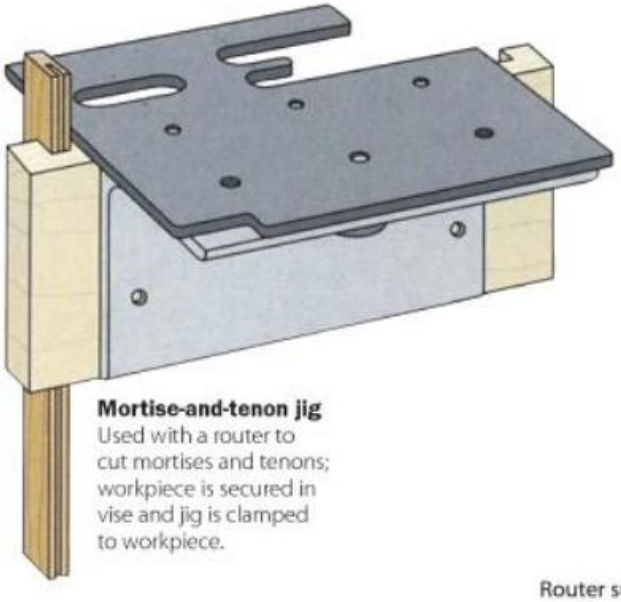
Routing the mortise

Clamp the jig to the workpiece with the mortise outline centered under the slot; place shims between the workpiece and upright, if necessary. Secure the upright in a bench vise, setting a support board under the workpiece to hold it snug against the top. Install a ⅜-inch mortising bit in a plunge router, attach a template guide to the sub-base, and adjust the cutting depth so you can rout the mortise in two or three successively deeper passes *(left)*. Hold the router flat on the jig top with the bit centered over one end of the slot. Turn on the tool and plunge the bit into the stock. Then feed the tool to the other end of the slot to finish the cut, pressing the template guide against the inside edge of the slot throughout the procedure.

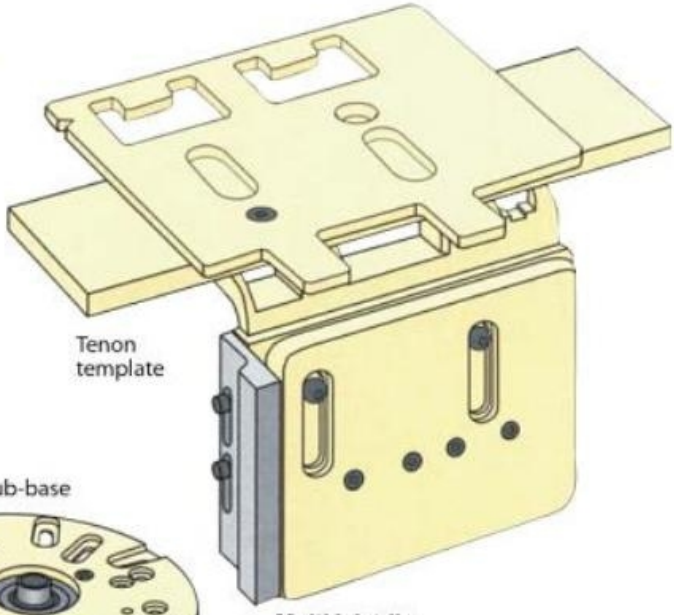
Mortise-and-Tenon Jigs



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



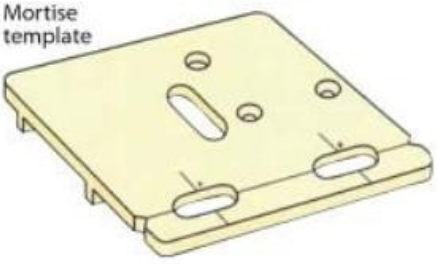
Mortise-and-tenon jig
Used with a router to cut mortises and tenons; workpiece is secured in vise and jig is clamped to workpiece.



Tenon template

Router sub-base

Mortise template

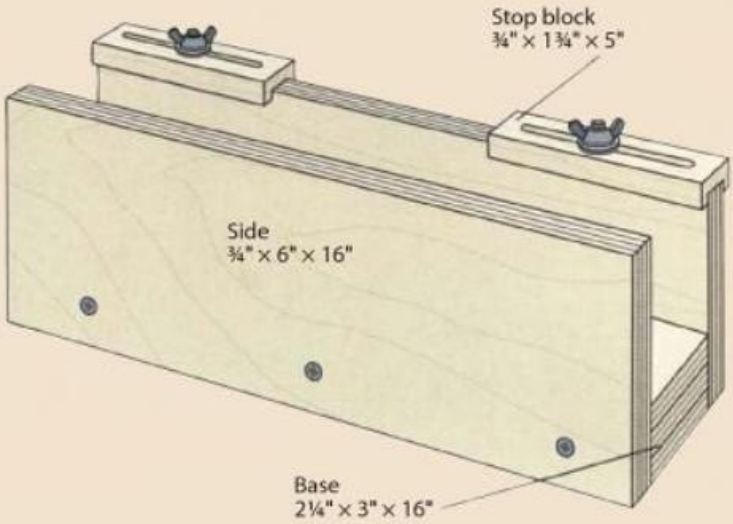


Multi-joint jig
Used with router to cut mortise-and-tenon joints. L-shaped bracket is fastened to backup board and secured in vise; appropriate template is attached to bracket. Comes with guide bushing, router sub-base, and bits.

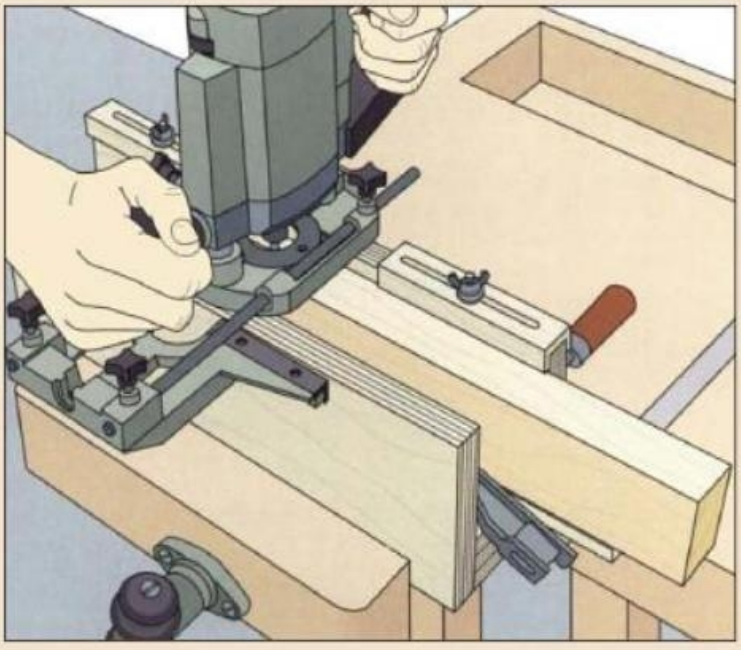
A Mortising Jig for the Router

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 ¾- 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 ⅜ inch deep and ¾ inch wide, then cut a 4-inch-long slot to accept a ¾-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)*.

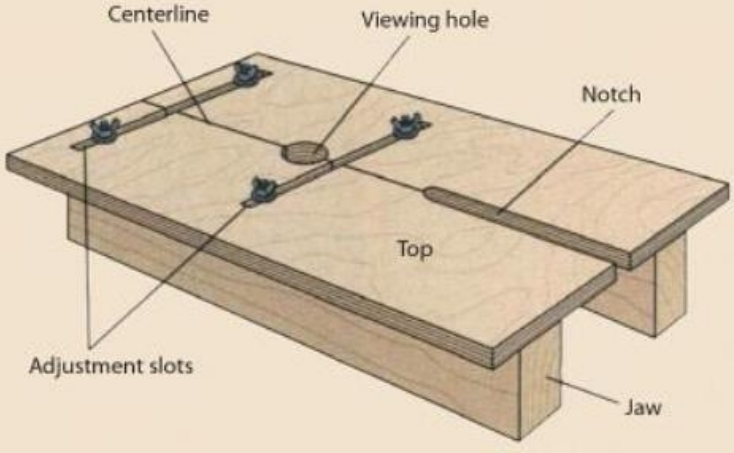


A Mortising Jig

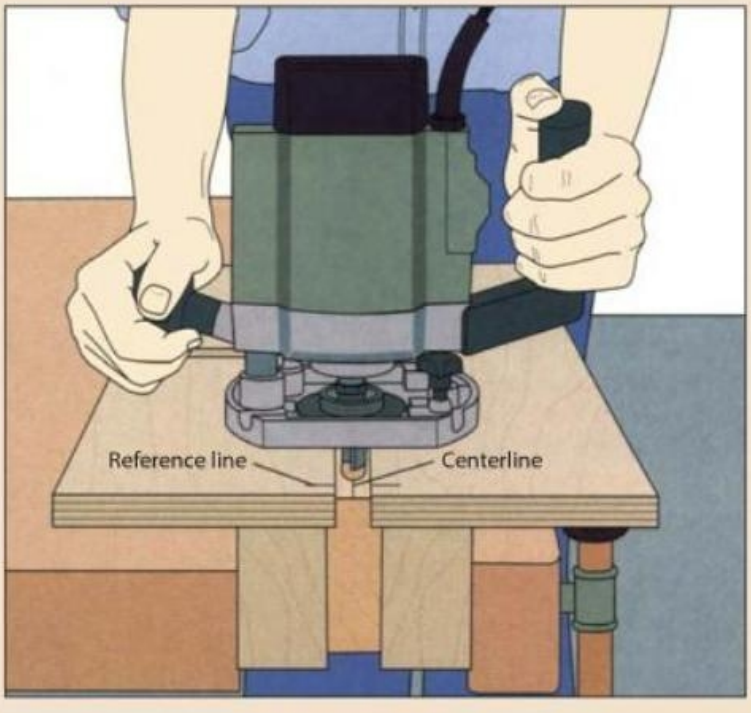
The jig at right allows you to rout a mortise in stock of any thickness. Its adjustable jaws ensure that the mortise will be positioned properly, normally centered in the edge of the board.

Cut the jig top from ¾-inch plywood; make the piece about 15 inches long and wide enough to accept the thickest stock you expect to mortise. Cut the two jaws from 2-by-4-inch stock, sawing the pieces to the same length as the top. To prepare the top, mark a line down its center, then cut a notch along the line at one end using a router. The notch should be as wide as the template guide you will use with your router bit. (If you are using a top-piloted bit, rather than a non-piloted straight bit with a template guide, size the notch to accommodate the bearing.) The notch should be long enough to accommodate the longest mortise you expect to cut. Next, rout two adjustment slots perpendicular to the centerline. Finally, bore a viewing hole between the two slots. To assemble the jig, screw hanger bolts into the jaws, then fasten the top to the jaws with washers and wing nuts.

To use the jig, outline the mortise on the workpiece and mark a line down its center. Loosen the wing nuts and secure the stock between the jaws so the centerline is aligned with the line on the jig top; make sure the top edge of the workpiece is butted up against the top. Tighten the wing nuts. Align the bit with one end of the outline, then mark reference lines on the jig top along the edge



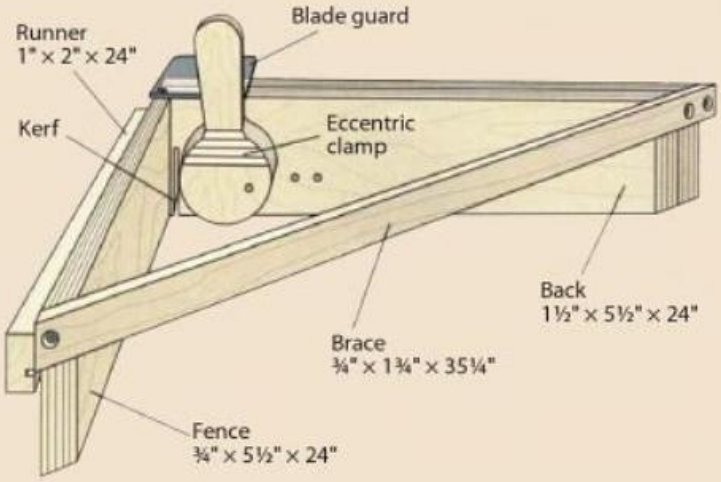
of the router base plate. Repeat to mark lines at the other end of the outline. Rout the mortise *(below)*, starting the cut with the base plate aligned with the first set of reference lines and stopping it when the plate reaches the second set.



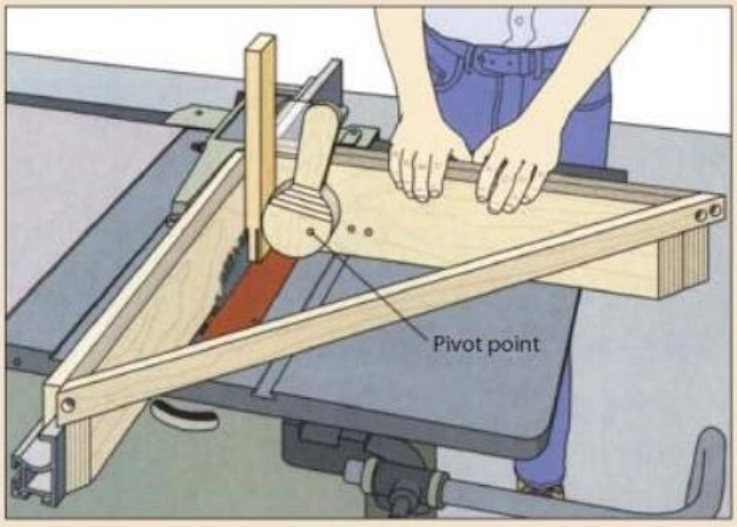
A Table-Saw Tenoning Jig

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 ¾-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 ¾-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 *(below)*. (Refer to page 134 for instructions on making and using another style of jig that can cut open mortise-and-tenon joints.)



A Tenoning Jig

Made of solid wood and plywood, the jig shown at right allows your router to cut square, two-shouldered tenons. The stock sits face-down under the jig while the router rides along a fence on top, removing waste in two passes.

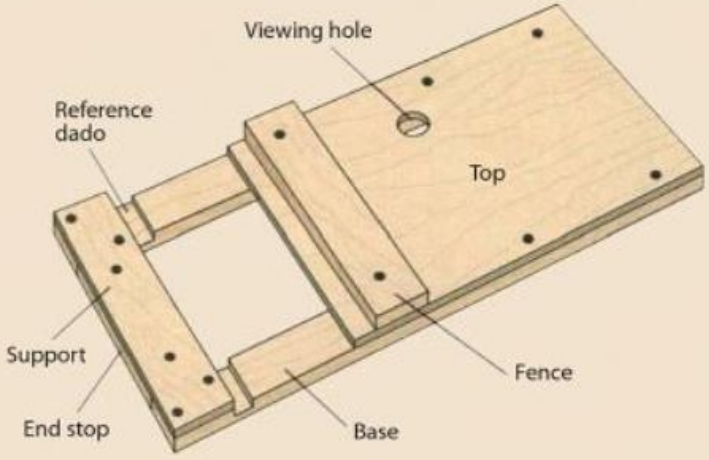
The jig consists of two parallel base pieces, an end stop, and a fence—all made of wood the same thickness as the workpiece, in this case 1-by-3 stock—and a top and support made of ½-inch plywood.

The base pieces should be about 16 inches long; cut the plywood top about 8 by 10 inches and screw it to the base strips as shown at right. Screw the end stop in place underneath the support, and attach the ends of the support to the base strips. Fix the fence about 1 inch from the end of the top.

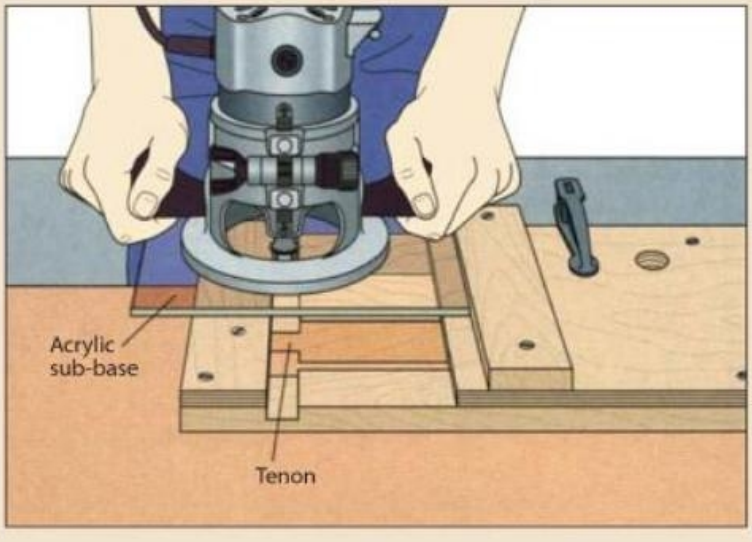
Countersink all screw heads and be sure to make all angles square. Bore a viewing hole through the top to help you position the workpiece against the base.

You will also need to construct an acrylic sub-base for your router. It should be at least as wide as your router's base and long enough to extend from the fence beyond the end stop; a 10- or 12-inch-square piece will serve well.

Install a ¾-inch bit in the router, then remove the standard sub-base from the tool and use it as a template to mark the screw holes and bit clearance hole in the acrylic sub-base. The new sub-base must be attached to the router so that the edge of the bit lines up with the inner edge of the support and end stop when it rides along the fence. Bore the holes and attach the sub-base to the router.

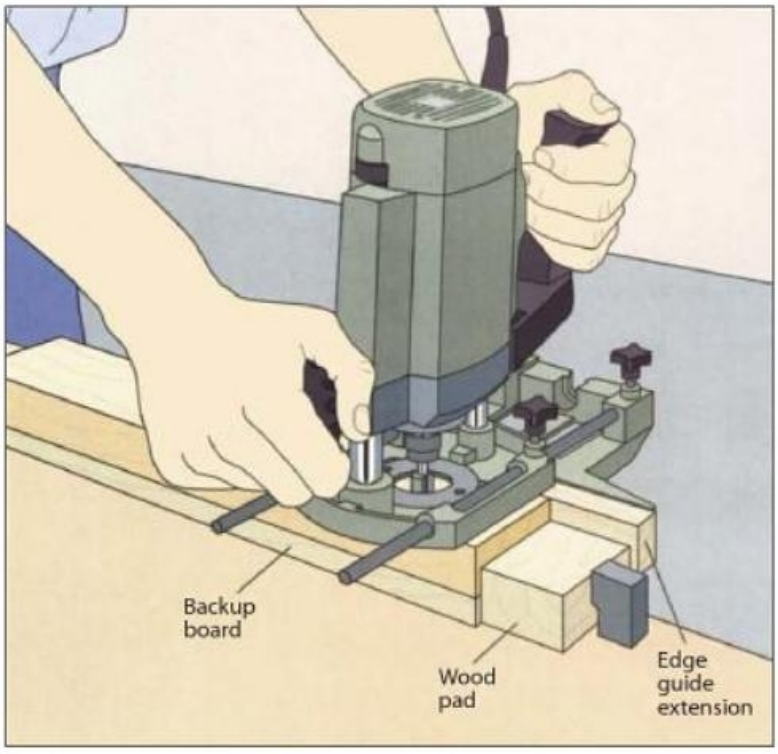


To use the jig, butt the end of your workpiece against the end stop and the edge flush against the base. Clamp the assembly in place. Set the router's cutting depth and rout out the waste for half the tenon, riding the sub-base along the fence throughout the cut. (You will rout reference dadoes into the base pieces at the same time.) Turn the workpiece over and repeat the cut to complete the tenon *(below)*.



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.



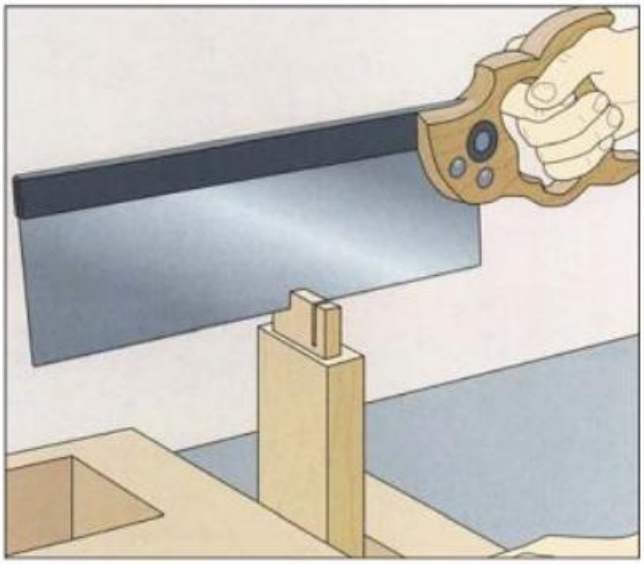
Making a Wedged Through Mortise-and-Tenon

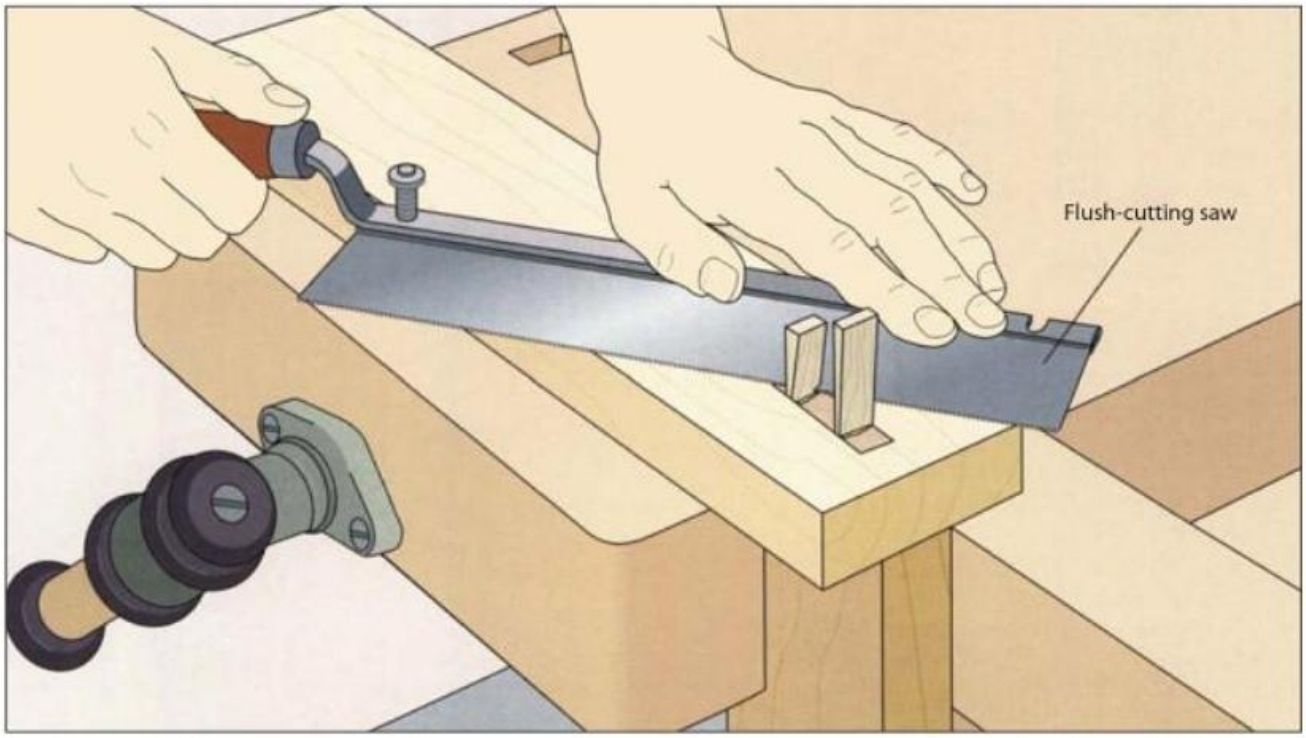
Routing out the mortise

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.

Sawing the slots in the tenon

Cut a four-shouldered tenon *(page 124)*, 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 ¼ 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.





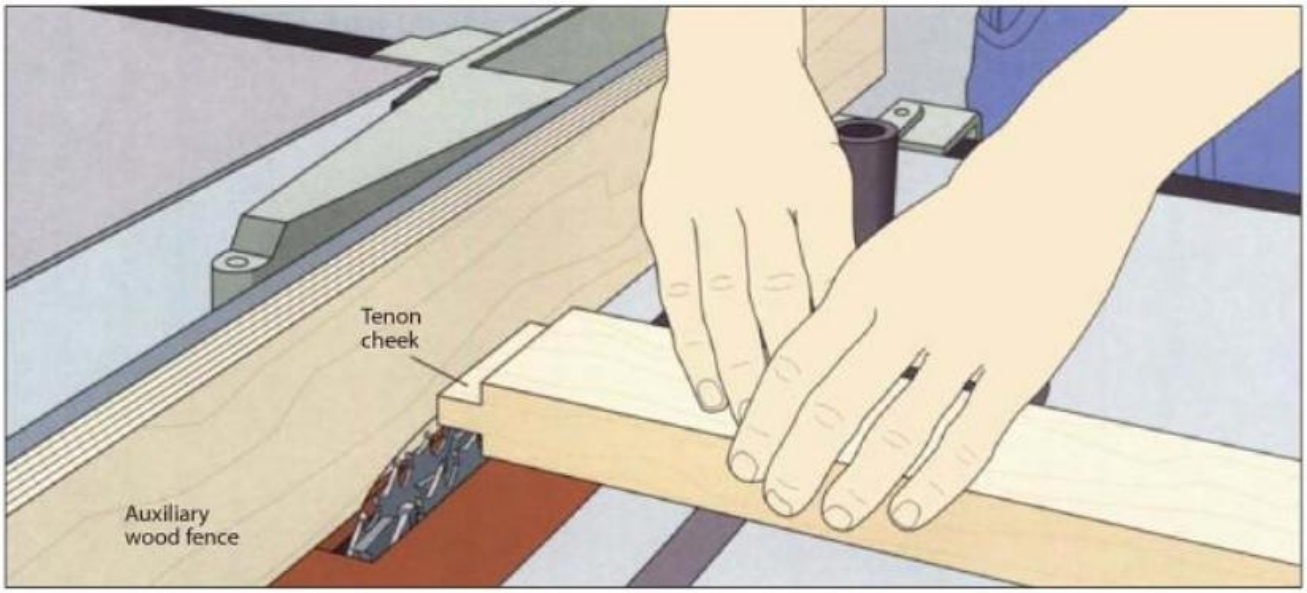
Inserting the wedges

Saw two hardwood wedges to fit into the slots cut before; make them as wide as the tenon, but a few inches longer, and no thicker than ¼ 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.

Haunched Mortise-and-Tenon Joints

The haunched mortise-and-tenon features mating notches cut in the tenon cheek and mortise. The result is a joint that provides more resistance to twist than the blind mortise-and-tenon. The haunched joint is often used in frame-and-panel construction, where the haunch fills the end of the groove that is cut for the panel, eliminating the need for stopped grooves.

Making a Haunched Mortise-and-Tenon

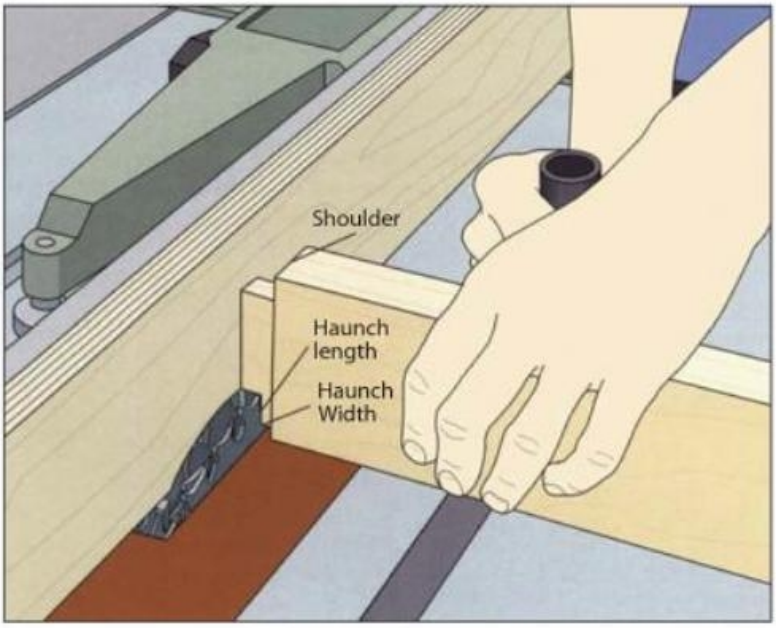


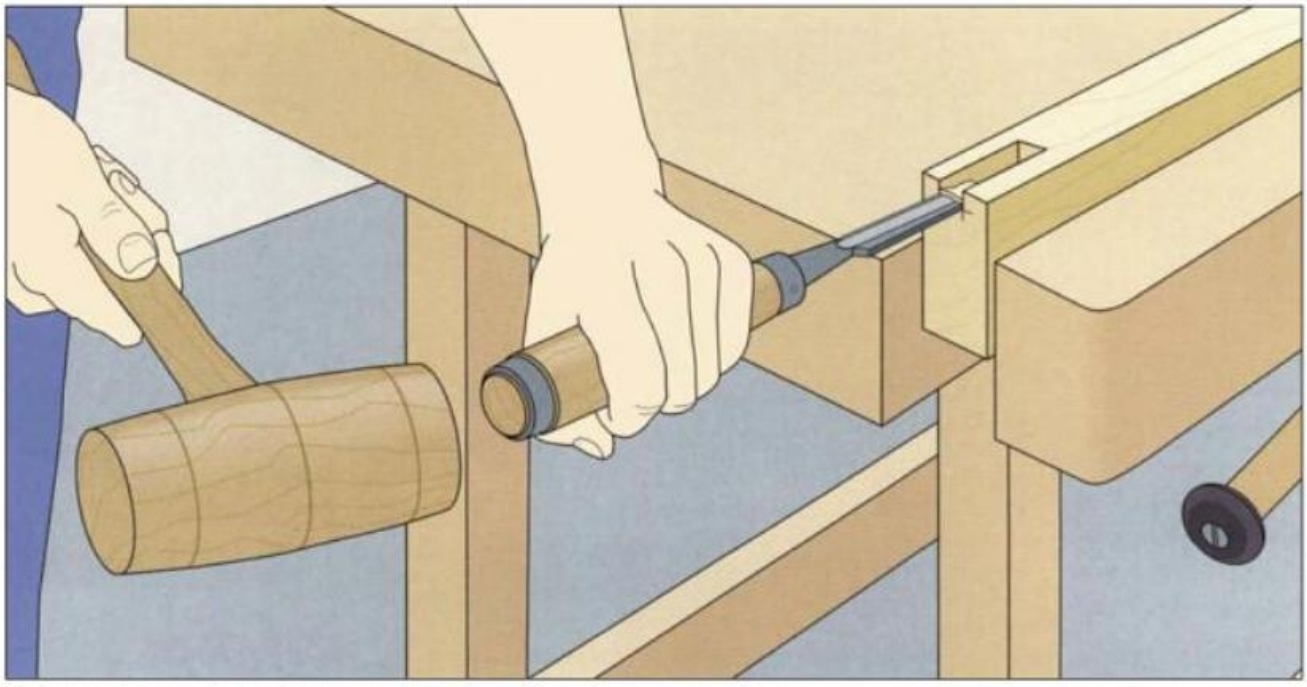
Cutting the tenon cheeks

On a table saw, install a dado head slightly wider than the length of the tenon, then attach and notch an auxiliary fence. Set the width of cut equal to the tenon length; adjust the cutting height to leave a tenon the same thickness as the width of the mortise chisel or router bit you will be using. Feed the stock face-down into the dado head, holding the workpiece firmly against the fence and the miter gauge. Turn the workpiece over and repeat the cut on the other side *(above)*.

Cutting the haunch

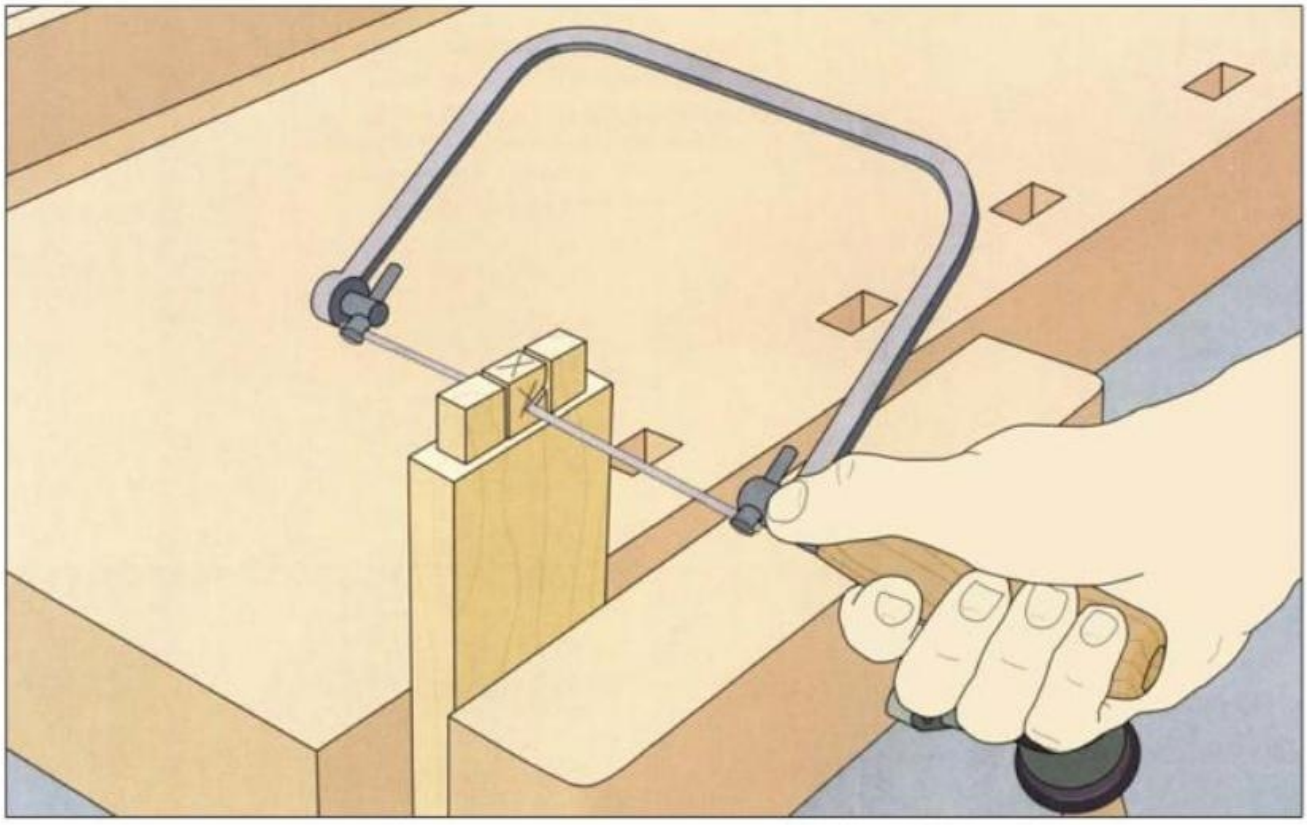
Set the blade height to cut a shoulder on the inside edge of the workpiece. Once the cut is made, advance the rip fence to cut the haunch in the tenon. The haunch should be approximately as wide as the tenon is thick. (If you are making the rails and stiles of a frame-and-panel assembly, the width of the haunch should equal the depth of the groove for the panel.) With the workpiece on edge, use the fence and the miter gauge to guide it over the dado head *(right)*. If there is no panel groove in the mating workpiece, you must next notch the mortise.





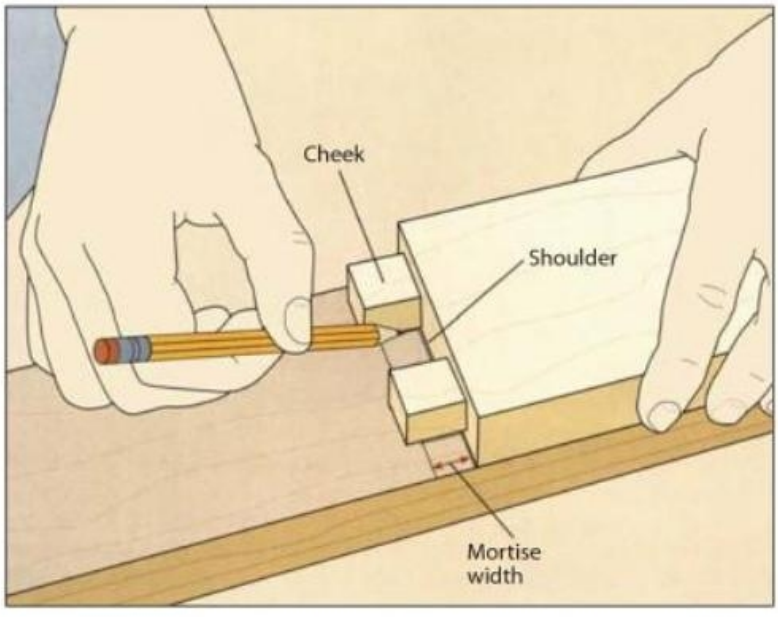
Notching the mortise for the haunch

Secure the workpiece in a vise and chop out a mortise as you would for a blind tenon *(page 122)*. Use the haunched tenon as a guide to outline the width and depth of the notch on the workpiece, then kerf the edges of the outline with a backsaw. Use a chisel to split off the waste in ⅛-inch layers between the cuts until you reach the required depth. Holding the blade bevel-up and parallel to the surface, strike the handle with a mallet *(above)*. Pare the sides of the notch with the chisel, if necessary.



Cutting out the waste

Clamp the tenon workpiece end-up in a vise and cut along the edges of the waste section with a backsaw, stopping at the shoulder. Then use a coping saw to remove the waste *(above)*, taking care to avoid cutting into the shoulder. Use a chisel to pare to the line.



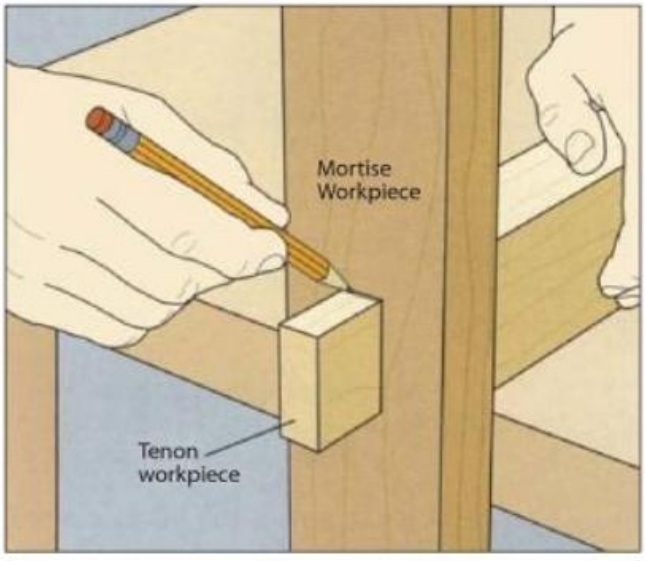
Laying out the mortises

Draw two lines representing the width of the twin mortises on the face of the mortise workpiece, then set both workpieces on a work surface with the tenon workpiece on top. Align the tenon shoulder with one of the marked lines and outline the two mortises using the tenon cheeks as guides *(left)*, then remove the waste as you would for any deep through mortise.

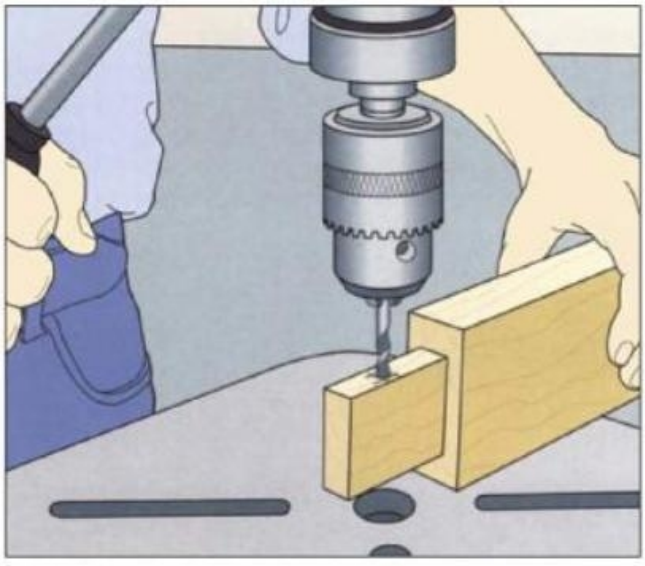
Tusk Tenon Joints

The tusk tenon is commonly used to join the legs and stretcher of a trestle table. The tenon extends beyond the through mortise so that a tusk-like wedge can be inserted to lock the joint while enabling it to be disassembled. Depending on the length and width of the tenon, the wedge can be inserted through either its thickness or its width.

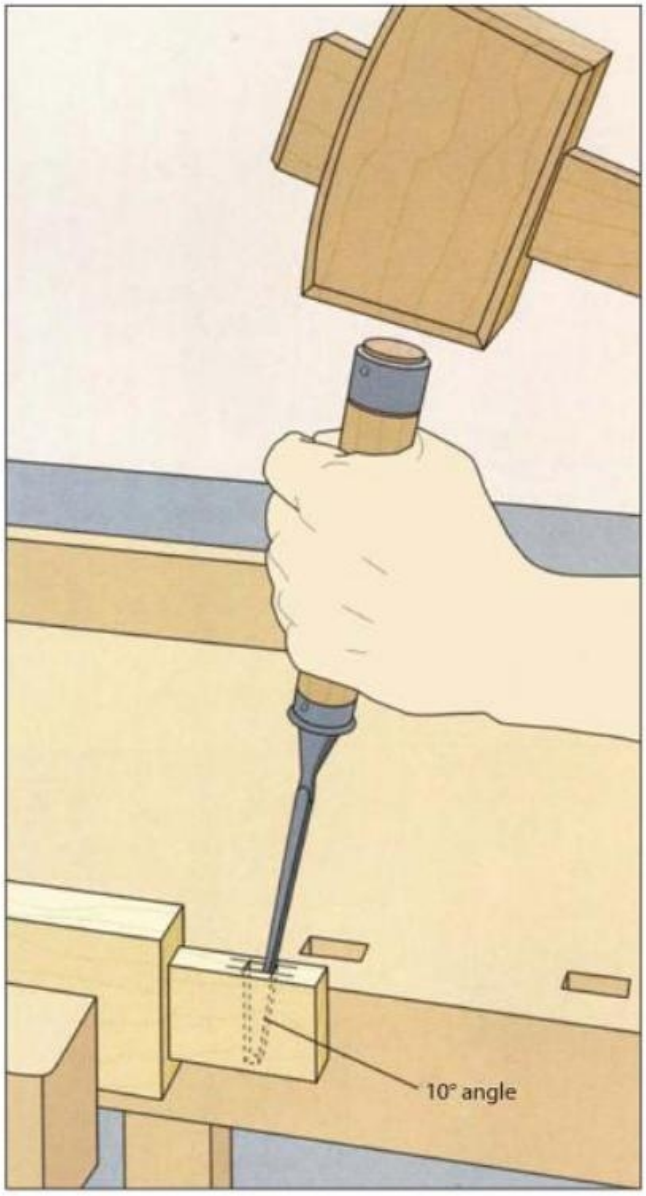
Making a Tusk Tenon Joint



Marking the location of the tenon wedge
Cut a four-shouldered tenon *(page 123)*, but make it long enough to extend from the mortise workpiece by at least 1 inch. This will provide sufficient stock to resist being split by the wedge. Cut a through mortise to accommodate the tenon and assemble the joint. Then, holding the pieces together on a work surface, mark a line along the top of the cheek where the tenon emerges from the mortise *(above)*.

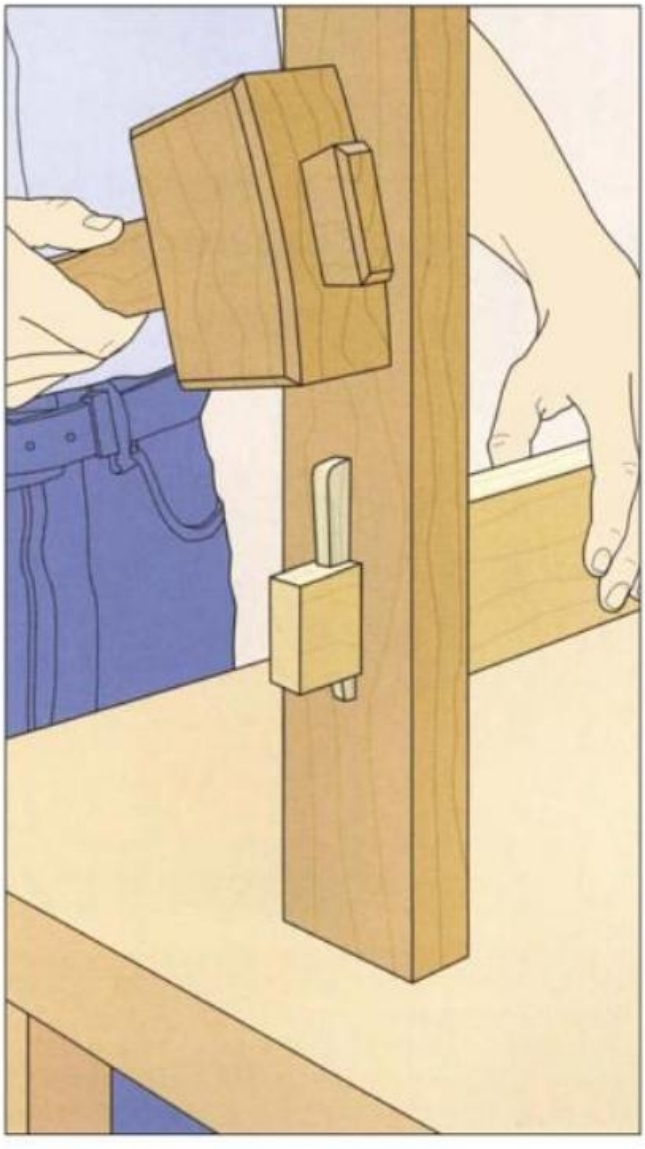


Drilling the hole for the wedge
Disassemble the joint and make a drilling mark 1/16 inch on the shoulder side of the scribed line; this will ensure a tight fit when the wedge is driven into place. Set a mortise gauge to one-third the thickness of the tenon and use the gauge to outline the hole in the middle third of the top cheek, bordering on your mark. Using a bit slightly smaller in diameter than the outline, bore the hole through the tenon on the drill press *(above)*.



Angling the wedge hole

Enlarge and square the hole you drilled to accommodate the wedge. Holding a mortise chisel at a 10° angle away from the tenon shoulders, cut a tapered slot, as indicated by the dotted lines in the illustration. Chop out the waste as you would cut a blind mortise *(page 122)*.



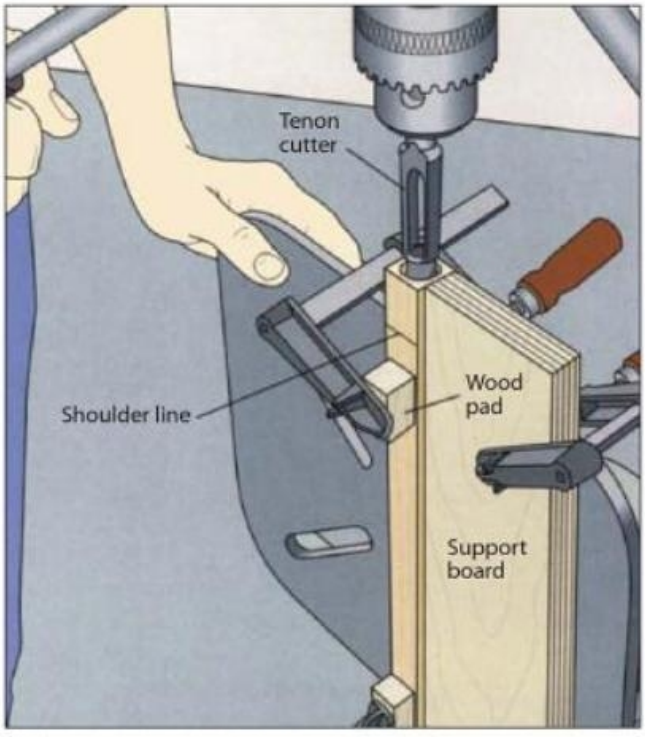
Inserting the tenon wedge

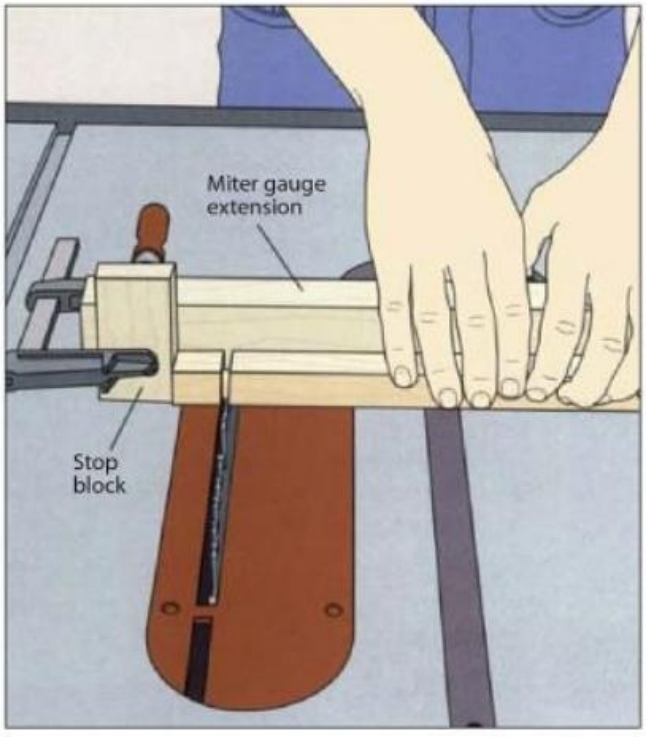
Cut a triangular hardwood wedge that is tapered to fit the slot you chopped out before, its length can be up to twice the tenon width. To assemble the joint, slide the tenon into the mortise and strike the wedge firmly with a mallet until the joint is tight *(right)*. Do not use glue, as this joint is designed to be disassembled.

Round Mortise-and-Tenon Joints

Round tenons are often produced on turned workpieces such as chair legs and rungs with the help of a lathe or hand saw, but they can also be cut in square stock with a drill press and tenon cutter. The mortise is also bored on a drill press.

Making a Round Mortise-and-Tenon





Cutting a round tenon on a square workpiece

Make a round tenon in two steps, starting on the drill press and then removing the waste on the table saw. Install a tenon cutter on the drill press and tilt the table to 90°. Clamp the workpiece and a support board to the table, using pads to protect the wood, then bore the hole to the depth of the shoulder *(above, left)*. On the table saw, adjust the cutting height to cut away the waste encircling the tenon and screw a board as an extension to the miter gauge. Align the shoulder line with the blade, butt a stop block against the end of the workpiece and clamp it to the extension. Holding the stock flush against the extension and the stop block, make a cut on each edge of the workpiece *(above, right)* to sever the waste. Make the mating mortise on the drill press.

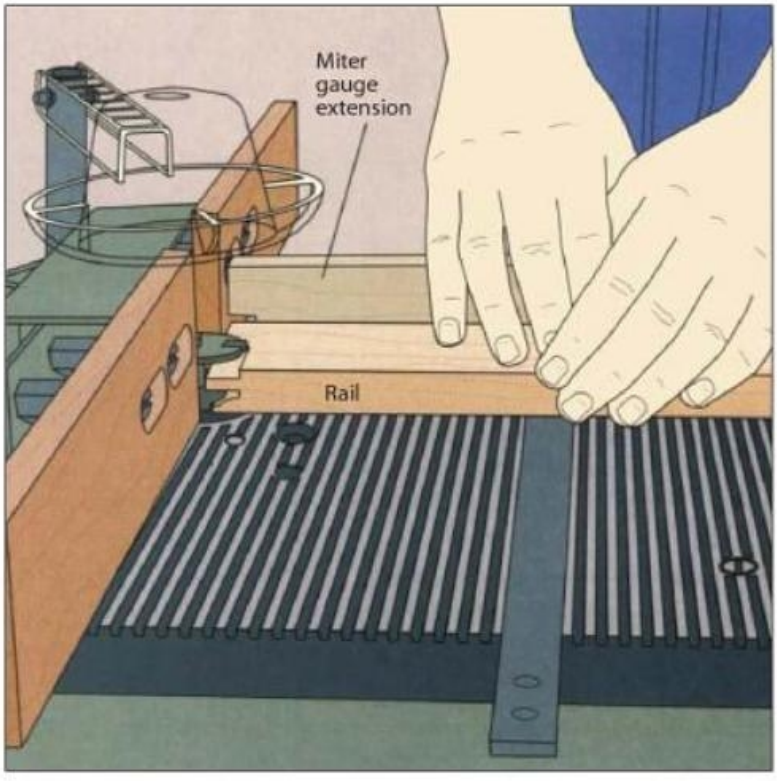
Cope-and-Stick Joints

Used in frame-and-panel construction, the cope-and-stick joint provides strength comparable to the mortise-and-tenon while adding a decorative touch. The router hit that cuts the grooves for the panel and tongues also carves a decorative molding along the inside edges of the frame.

Routing a Cope-and-Stick Joint on the Router Table

Cutting the tongues in the rails

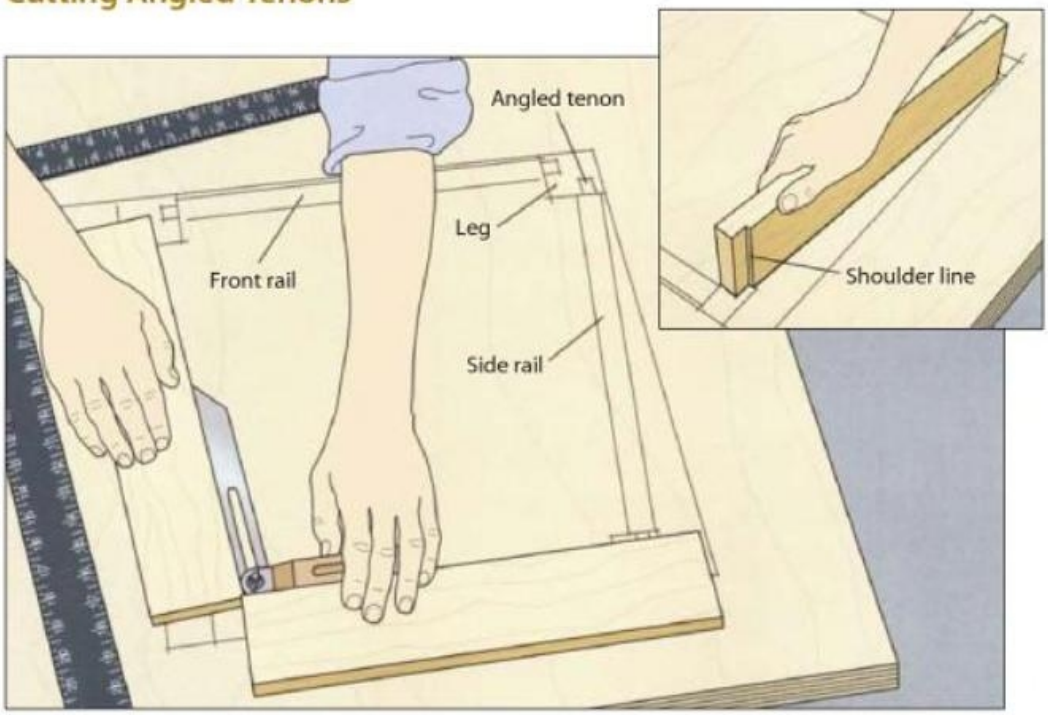
Make a cope-and-stick joint by first cutting tongues in the ends of both rails. Then rout grooves for the panel along the inside edges of all four frame pieces; the grooves in the stiles will accommodate the rail tongues at the same time. To cut the tongues, install a piloted coping bit—or rail cutter—in your router and mount the tool in a table. Set the cutting depth by butting the end of a rail against the bit and adjusting the router's depth setting so that the top of the uppermost cutter is slightly above the workpiece. Position the fence parallel to the miter gauge slot and in line with the edge of the bit pilot. Fit the miter gauge with an extension and press the outside face of the stock flat on the table; keep the ends of the workpiece and extension butted against the fence throughout each cut *(right)*.



Angled Mortise-and-Tenon Joints

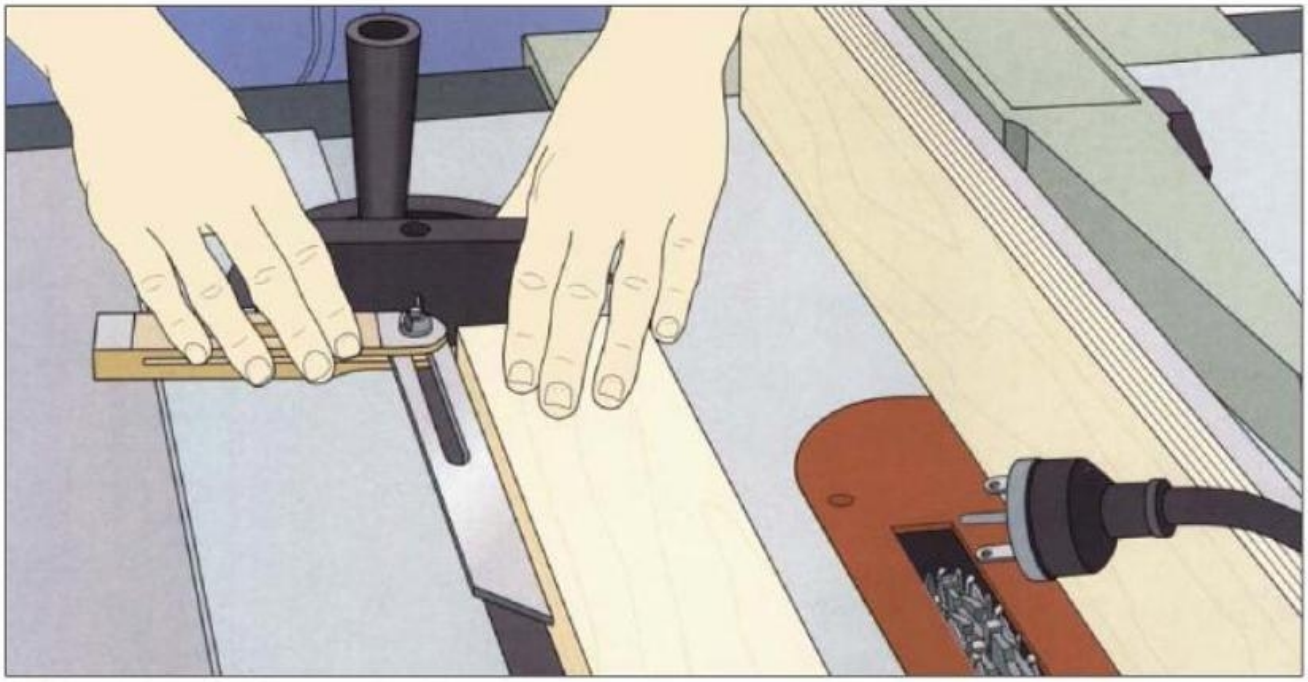
Angled tenons are often used in building chairs to get around the joinery problem caused by seats that are wider at the front than at the back—a traditional design feature. To accommodate the angled side rails, tenons must be cut at opposite ends at opposing angles, while the tenon shoulders must be parallel to each other. Although the tenon is tricky to mark out and produce, it fits into a standard mortise.

Cutting Angled Tenons



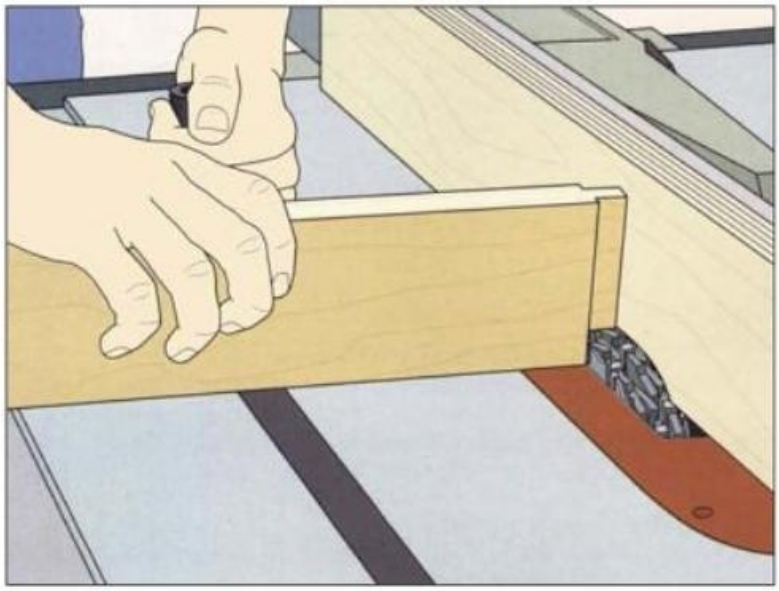
Planning the job

To mark out angled tenons, sketch the project full-size on a piece of plywood or hardboard. In this example, the underside of a chair frame has been drawn, including the legs and rails. Standard blind tenons are needed on the front and back rails; angled tenons must be cut on the side rails; and standard mortises must be chopped out in the legs. To set the blade angle on your table saw for cutting the angled tenon cheeks, align two boards along one corner of the outline and adjust a sliding bevel to the angle formed by the boards *(above)*. Install a dado head and transfer the angle to the blades. Install and notch an auxiliary fence and set a cutting width of ¾ inch and a height of ⅛ inch. Feed a scrap piece the same size as your stock face-down into the dado head to make test cuts across both ends. Then position the test piece on your outline *(inset)*. The shoulder lines on the piece and the drawing should line up; if not, increase the cutting width and make another set of cuts, continuing until the shoulders align. Adjust the cutting height until the tenon cheeks on the piece line up with the drawing.



Setting up the saw for the tenon shoulders

Adjust the angle of the dado head to 90°. Holding a board parallel to the miter slot, use the sliding bevel to set the miter gauge to the same angle used to adjust the blades *(above)*. Butt the workpiece on edge against the miter gauge. The shoulder should be parallel to the rip fence; if not, flip the workpiece over to its other edge. Set the width of cut to the width of the cheek and adjust the dado head to the desired cutting height.



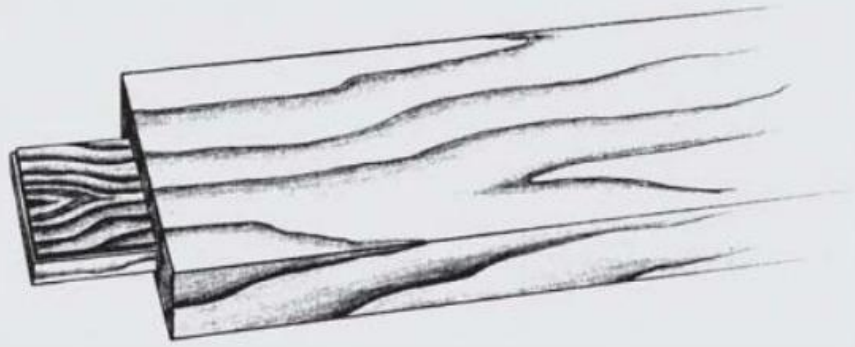
Cutting the tenon shoulders

Like the tenon cheeks, the shoulders are cut in two steps. For the first set of cuts, guide the workpiece on edge using the miter gauge and fence *(left)*, then turn the board end-for-end and repeat the cut. To make the second set of cuts, use the sliding bevel to angle the miter gauge in the opposite direction. Cut the last two shoulders on the other edge the same way you made the first two.

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.



Dovetail and Box Joints

The dovetail joint was developed centuries ago to compensate for the unreliable adhesives available at the time. Compared to the costly, hand-wrought fasteners then available, the interlocking pins and tails of the dovetail offered a practical and attractive solution to a construction problem. Although its execution requires considerable skill and time, no joint can match the dovetail's ability to hold a corner joint together without additional reinforcement.

Modern adhesives have made the dovetail almost unnecessary, but it is still called upon to hold the corners of carcases and drawers together. Today, the rationale for using it is esthetic; the dovetail is visual shorthand for durability and woodworking skill.

The joint consists of tapered pins that fit around flared tails resembling the tail feathers of a dove, which gives the joint its name. The joint provides good long-grain gluing surface, which adds to its strength.

Several varieties of the dovetail joint are shown in this chapter. The through dovetail *(page 160)* is the strongest, since the tails and pins are cut through the full thickness of the boards. The curved and outlined through dovetail joints, shown on pages 178 and 180 respectively, are decorative variations of the basic design. Half-blind *(page 172)* and blind dovetail joints provide comparable strength while concealing end grain. This feature makes the half-blind joint a favorite for attaching drawer fronts.

Box and finger joints came into extensive use in the 19th Century for production-line assemblies like telephone boxes, sewing machines, and packing crates. They are easy to cut and, although they are not self-locking, these joints provide a large area of long-grain contact for gluing.

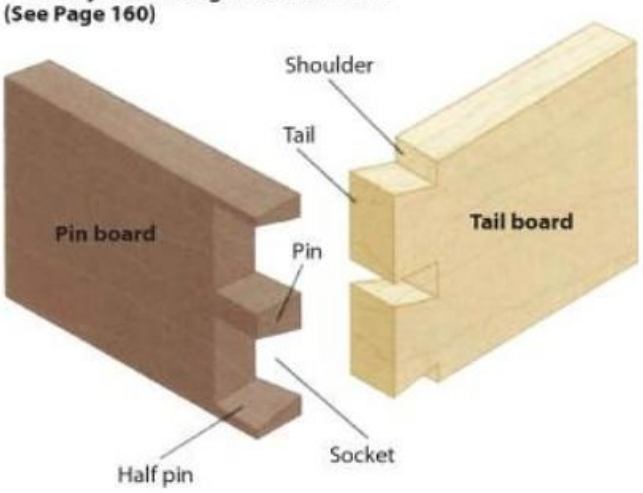
Fitted with a straight bit, a table-mounted router cuts the notches for a box joint. A hardwood key glued into the miter gauge extension guarantees uniform spacing between the cuts.

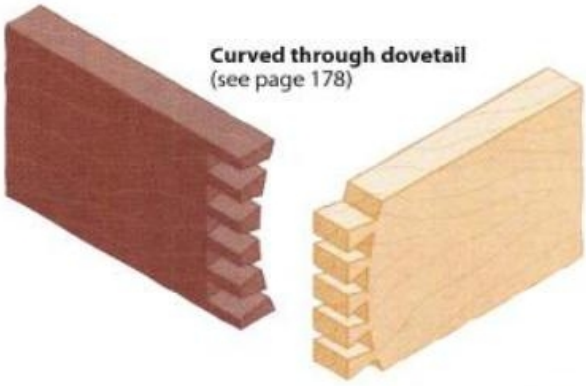
Both dovetail and box joints can be cut by hand or machine. Box and finger joints can be cut equally well with the router *(page 168)*, the table saw *(page 166)*, or the band saw *(page 167)*. Hand-cutting a dovetail joint is often considered a rite of passage for apprentice woodworkers. It takes more time and effort than machine cutting, but the technique allows complete control over the layout of the joint. Dovetails can be produced quickly and accurately on the router using a commercial jig. In many cases, however, the spacing and angle of the pins and tails cannot be varied, and some woodworkers find that the resulting joint lacks the esthetic appeal of a handcut joint.

A coping saw is used to cut away the waste between the pins of a dovetail joint. The narrow blade allows the saw to curve sharply from the side of the pins to the shoulder line. The remaining waste will be pared away with a chisel.

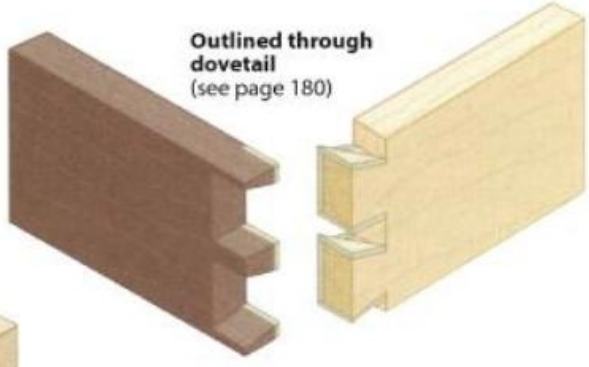
A Selection of Dovetail and Box Joints

Anatomy of a Through Dovetail Joint
(See Page 160)



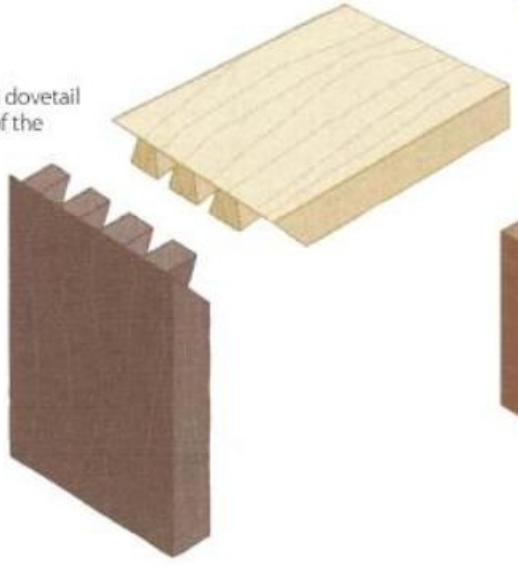


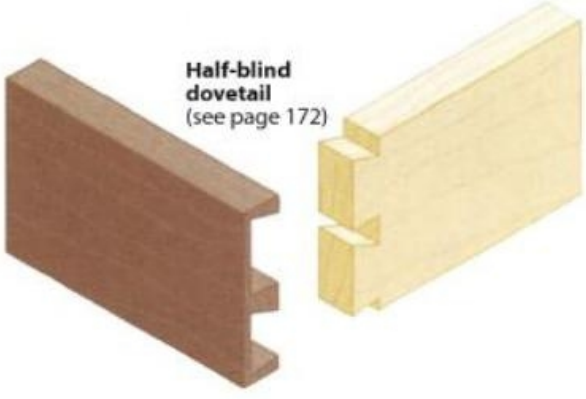
Curved through dovetail
(see page 178)



Outlined through dovetail
(see page 180)

Blind dovetail
Similar to the half-blind dovetail joint, except the ends of the boards are rabbeted and the edges are mitered before the pins and tails are cut, concealing the end grain of both pieces





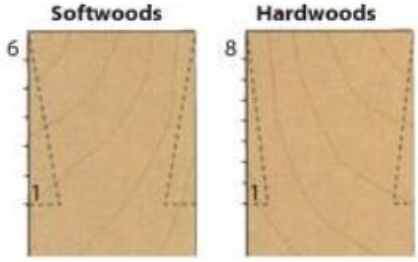
Half-blind dovetail
(see page 172)

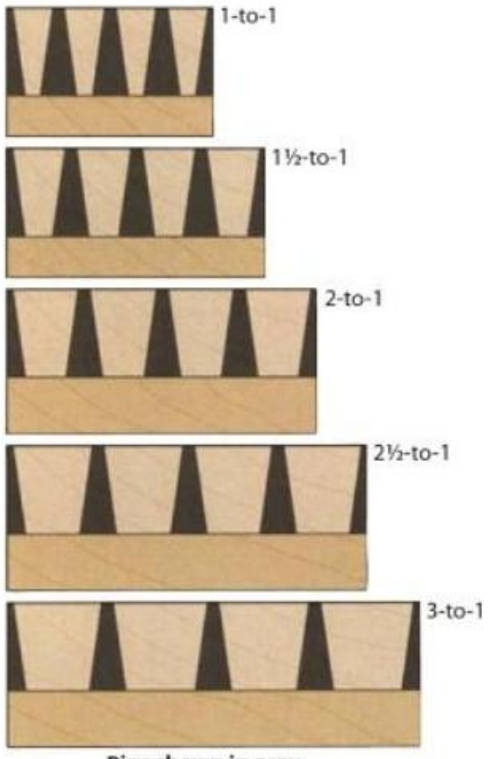
Designing and Marking Dovetails

Spacing and angling the pins

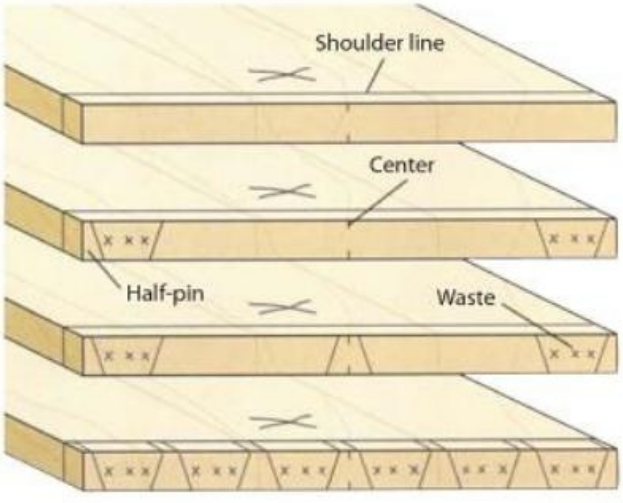
The space between the pins and tails of a dovetail and the slope angle of the pins affect both the strength of the joint and its esthetic appeal. Several common spacing ratios—expressed as tail-to-pin size—are shown at right. The 1-to-1 ratio creates the strongest joint, but results in the least attractive layout. The other spacing ratios illustrated are more attractive and virtually as sturdy. The 3-to-1 ratio is a good choice for a joint that will feature prominently on a piece. Pin-spacing ratios greater than 3-to-1 are weak and should be avoided.

There is less latitude in marking the angle of the pins. Too small an angle will prevent the pieces from locking together, allowing the joint to pull apart; too great an angle stresses the corners of the tails, causing them to break off. For softwoods, a ratio of 1:6 or 80° is required; for hardwoods, the ratio normally used is 1:8 or 83° *(inset)*. Using a dovetail square to mark the pins will automatically give you the correct angle.





Pins shown in gray



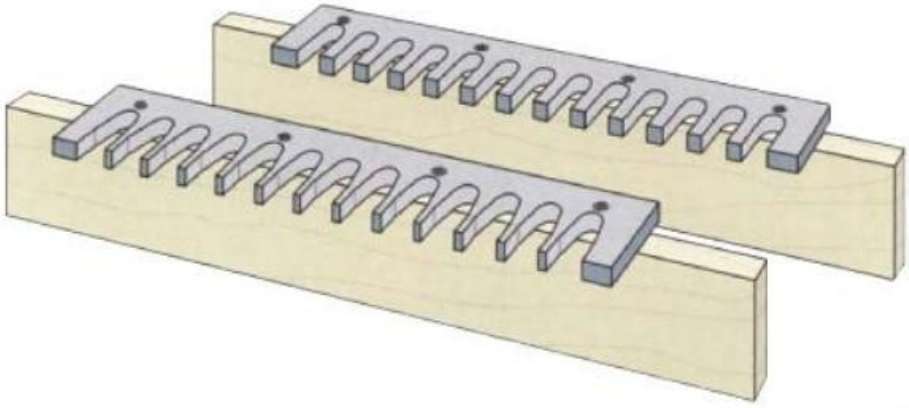
Outlining the pins

The construction of a dovetail joint begins with laying out, marking and cutting the pins, then using them to outline the tails on the mating board. Begin laying out the joint by marking the outside face of the workpiece with a big X, then use a cutting gauge to scribe the shoulder line of the joint *(page 160)*. Next, use a dovetail square to lay out the pins on the ends of the board as shown in the sequence at left. (See page 161 for instructions on making a dovetail square in the shop.) Begin with half-pins at each edge, making sure the narrow ends of the pins are on the outside face of the board. Next outline the waste sections adjacent to the half-pins. On a wide workpiece, such as the one in the illustration, you next mark the center of the board end. Outline a pin at the center mark, then outline the remaining pins, marking all the waste sections with Xs.

Jigs and Accessories

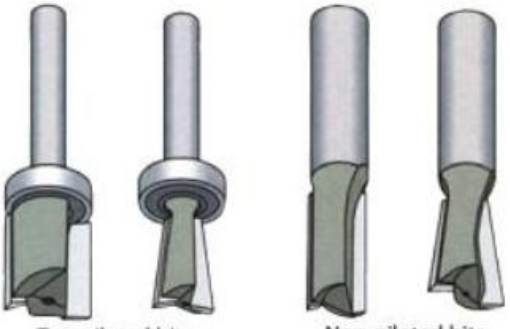
Commercial dovetail jigs are ideal for producing a series of identical joints. This model consists of two templates fastened to backup boards. The workpiece is secured to the jig and a stop block helps with positioning for repeat cuts. Here, a router fitted with a dovetail bit moves in and out of the slots of the tail board template.

Box joint jig
Plastic jig attached to a router table for cutting finger or box joints; ridge in center of jig functions as a key to make precise repeat cuts.



Dovetail templates
A set of two fixed templates fastened to backup boards to rout through dovetail joints; one template is for pins and the other for tails. Three models are available for routing different-sized pins; uses top-piloted bits.

Interchangeable-template jig
With the use of interchangeable templates, jig allows router to cut dovetail and box joints with a single setup; comes with guide bushing and router bits.



Top-piloted bits

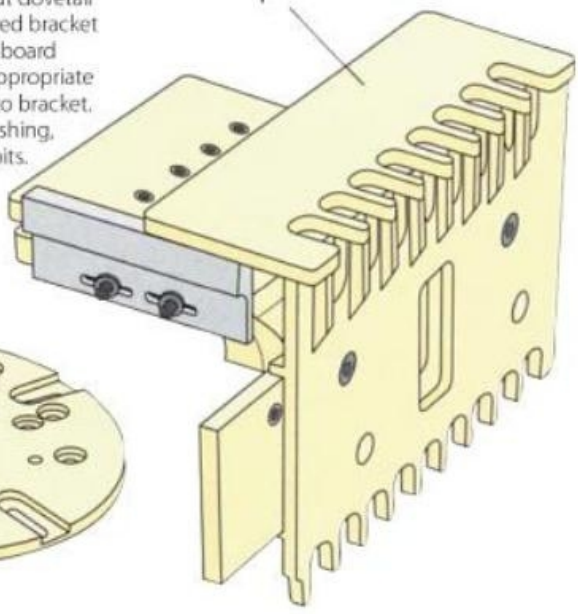
Non-piloted bits

Dovetail bits, straight bits and template guides
A selection of straight and dovetail bits *(left)* used with routers and commercial templates to cut dovetail joints. Non-piloted bits require a template guide *(right)* affixed to the sub-base to keep the bit a uniform distance from the edge of the template; top-piloted bits are equipped with ball-bearing pilots to guide cuts.

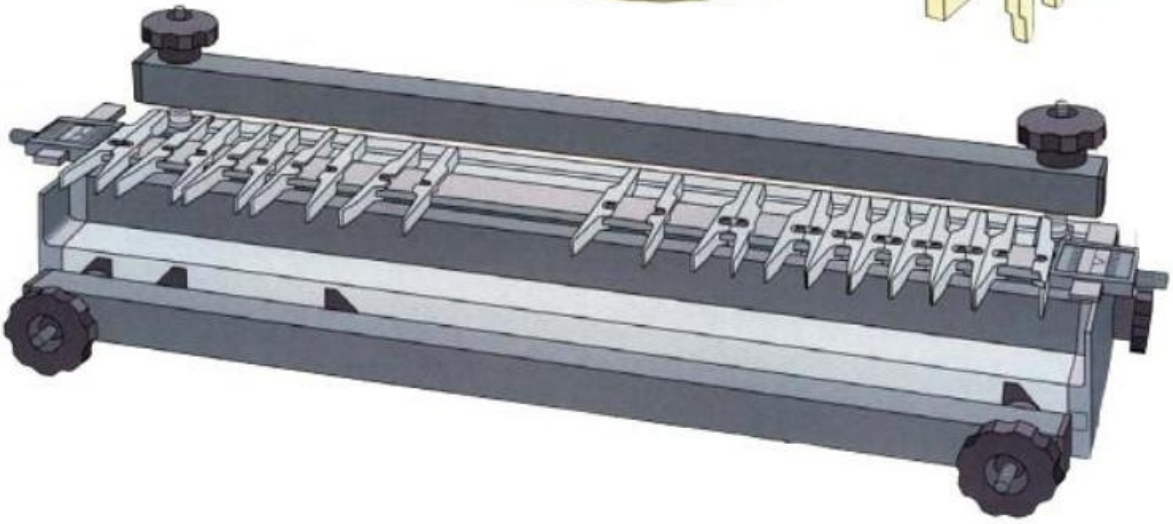
Template guides and locking ring

Dovetail square
Used to mark the pins of dovetail joints; available in ratios of 1:6 (80°) for softwood and 1:8 (83°) for hardwood.

Multi-joint jig
Used with router to cut dovetail and box 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.

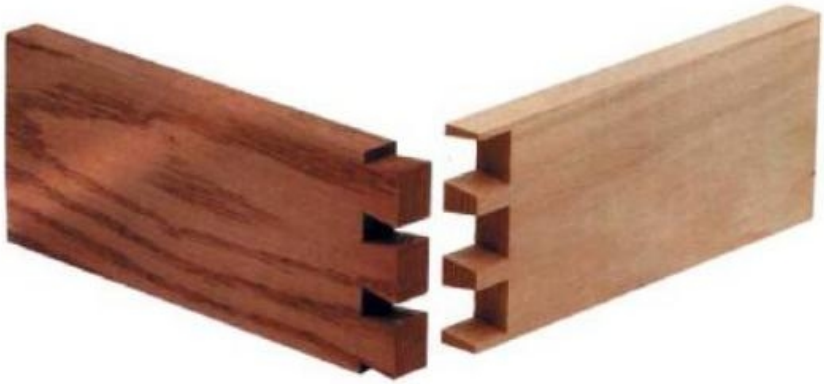


Adjustable dovetail jig
Adjustable template used to rout half-blind and through dovetail joints; width of pins and tails is set with a single adjustment. Includes guide bushing and router bits.

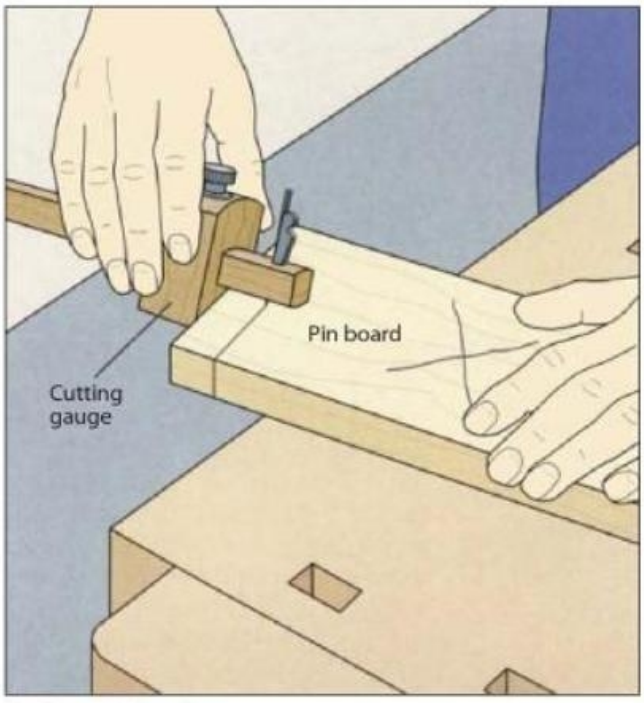


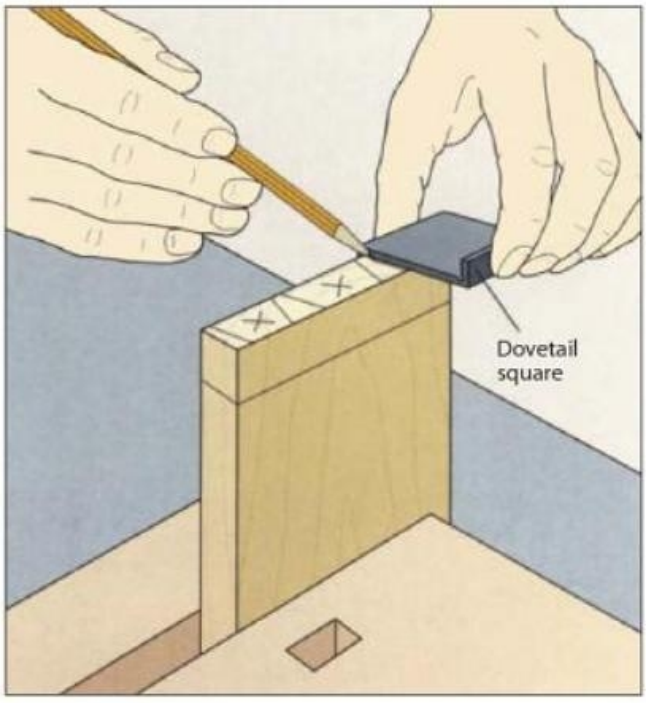
Dovetail Joints

Combining enduring strength with an attractive apperance, the through dovetail is often used in fine furniture to join car-case corners. The half-blind version of the joint shown starting on page 172 is a good choice for assembling drawers because the drawer front conceals the end grain of the sides. Traditionally, the joint was cut using a handsaw and chisel, but many woodworkers now make it with a router. There are a raft of jigs on the market that, paired with a router, enable you to cut a variety of dovetail joints *(page 156)*. But you can also make them by using the techniques shown in this section, producing both through and half-blind dovetails.



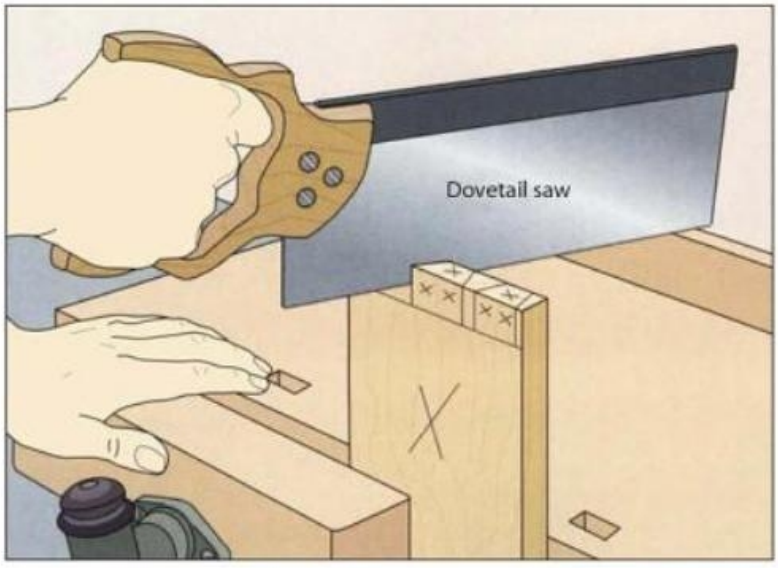
Cutting a Through Dovetail by Hand





Laying out the pins

Mark the outside face of the board with an X. Then set a cutting gauge to the thickness of the stock and scribe a line along the end of the board to mark the shoulder of the pins and tails *(above, left)*. Next, secure the stock end-up in a vise and use a dovetail square to outline the pins on the end of the board. You can follow the sequence illustrated on page 157, but for stock of the width shown above—typical for a drawer—a half-pin at each edge and two evenly spaced pins in between will make a strong and attractive joint *(above, right)*. Mark the waste sections with an X as you go. Finally, use a combination square to extend all the dovetail marks down both faces of the board to the shoulder lines.



Cutting the pins

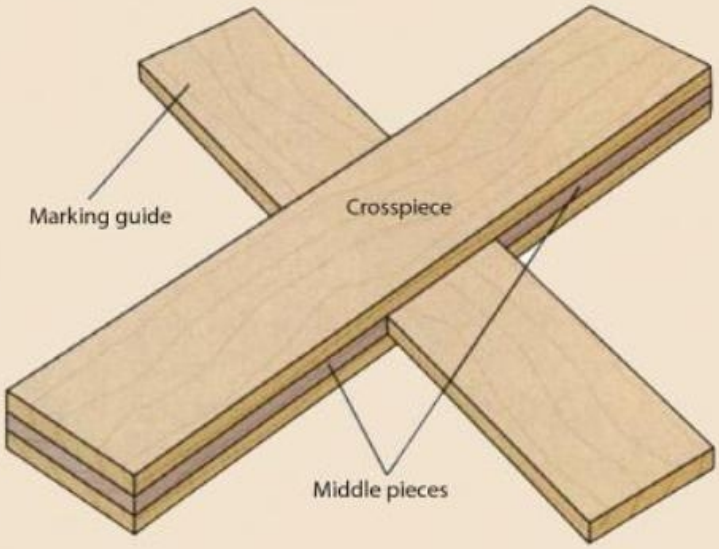
Leave the pin board in the vise with its outside face toward you. Use a dovetail saw to cut along the edges of the pins, aligning the saw blade just to the waste side of the cutting line. Cut all the right-hand edges first *(left)*, then complete the left-hand edges. Use smooth, even strokes, taking care to keep the blade perpendicular as you cut to the shoulder lines.

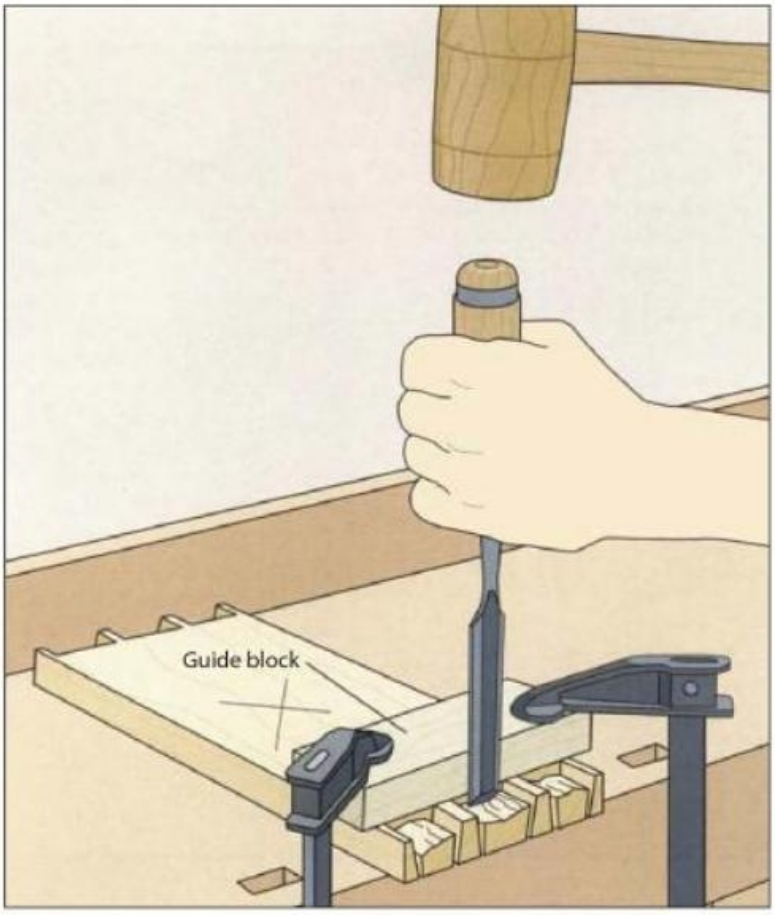
Dovetail Square

Instead of buying a dovetail square, you can make your own by face-gluing four pieces of scrap wood together at the required dovetail angle. Cut the pieces of the jig about 6 or 8 inches long and 1½ inches wide.

To prepare the pieces, adjust the miter gauge of your table saw to the appropriate angle—1:6 (or 80°) for softwood or 1:8 (or 83°) for hardwood. Then make a cut across the center of the piece, slicing it in half. Make the same cut at both ends of the marking guide. Spread some glue on all the contacting faces and assemble the jig, butting the cut ends of the middle pieces against the marking guide, while aligning their edges with the other two boards of the crosspiece above and below. Trim the ends of the middle pieces flush with the crosspiece.

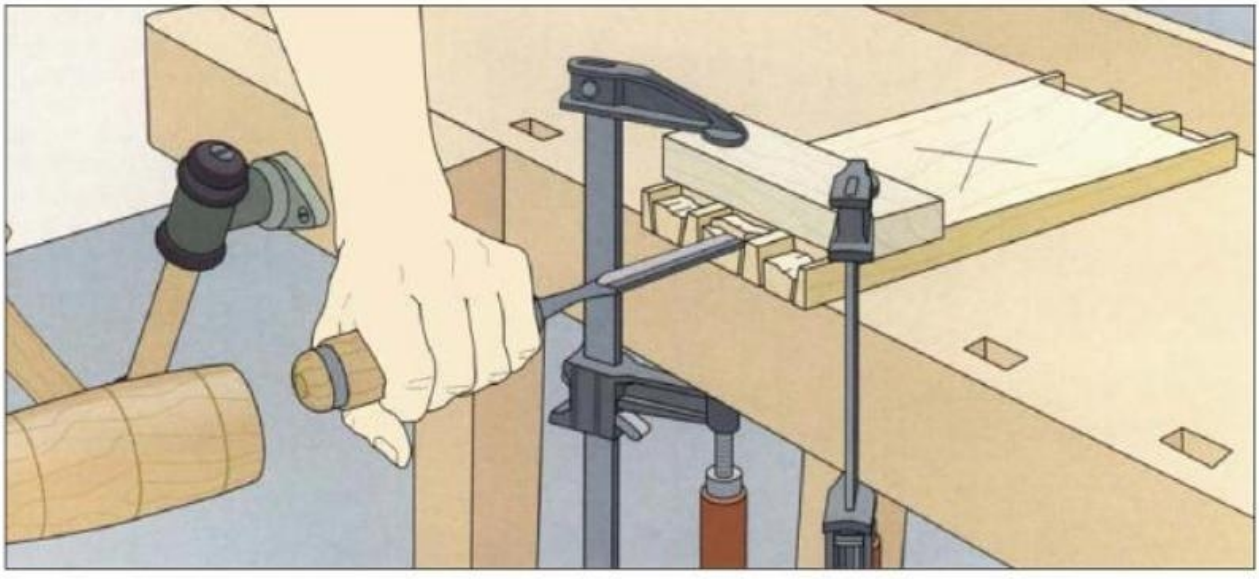
To use the jig, lay the marking guide across the end of the pin board while butting the edge of the cross-piece against the face of the board.

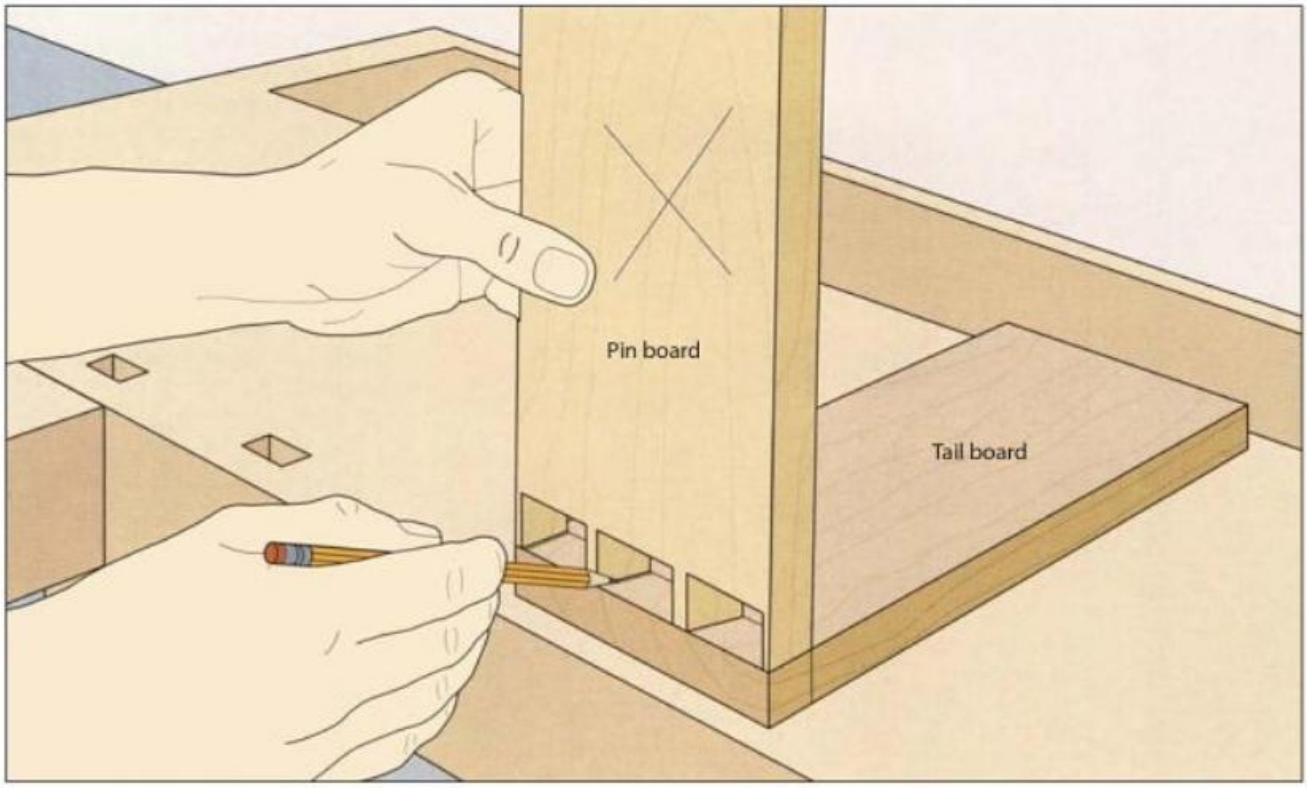




Chiseling out the waste

Most of the waste wood between the pins can be removed with a coping saw *(page 155)*, and a chisel used only to clean up the gaps. However, it is not much more difficult to chisel out all the waste. The key is to work patiently, removing thin slivers of wood with each cut. Set the pin board outside-face up on a work surface and clamp a guide block on top so the edge is aligned with the shoulder line. Use a wood chisel no wider than the narrow side of the waste section. Holding the chisel bevel-out against the guide block and perpendicular to the face of the workpiece, score a ⅛-inch-deep cut *(left)*. Then butt the chisel blade against the end of the board to shave off a ⅛-inch layer of waste *(below)*. Continue removing the waste until you are about halfway through the stock. Once you have removed all the waste from one side of the board, turn it over, reposition the edge of the guide block directly over the shoulder line and remove the waste from the other side.





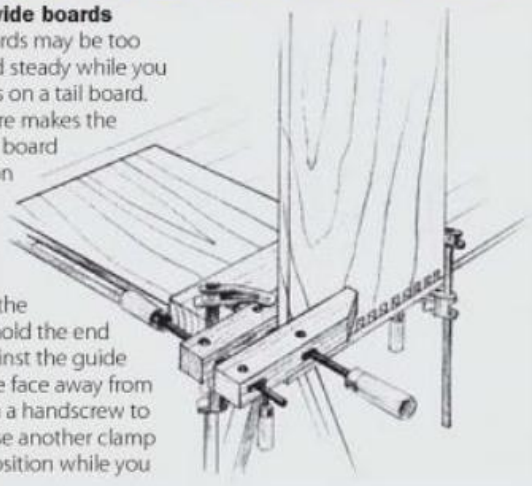
Laying out the tails

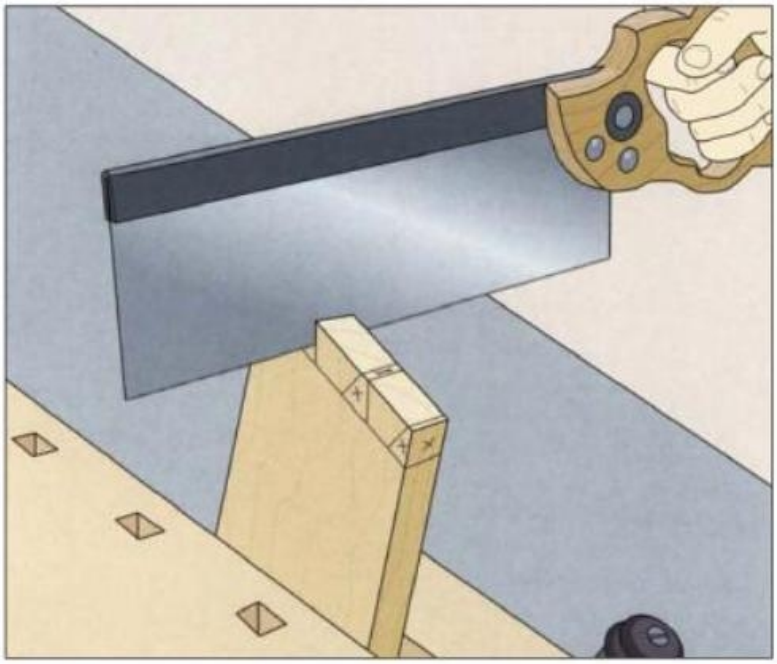
Set the tail board outside-face down on the work surface. Hold the pin board end-down with its inside face aligned with the shoulder line of the tail board, making certain the edges of the boards are flush. Outline the tails with a pencil *(above)*, then use a try square to extend the lines on the end of the board. Mark all the waste sections with Xs.

Shop Tip

Marking tails on wide boards

Panels and wide boards may be too cumbersome to hold steady while you are outlining the tails on a tail board. The setup shown here makes the task easy. Set the tail board outside-face down on a work surface and clamp a guide block on top of it with the edge of the block flush with the shoulder line. Then hold the end of the pin board against the guide block with its outside face away from the tail board. Fasten a handscrew to the pin board and use another clamp to hold it firmly in position while you outline the tails.



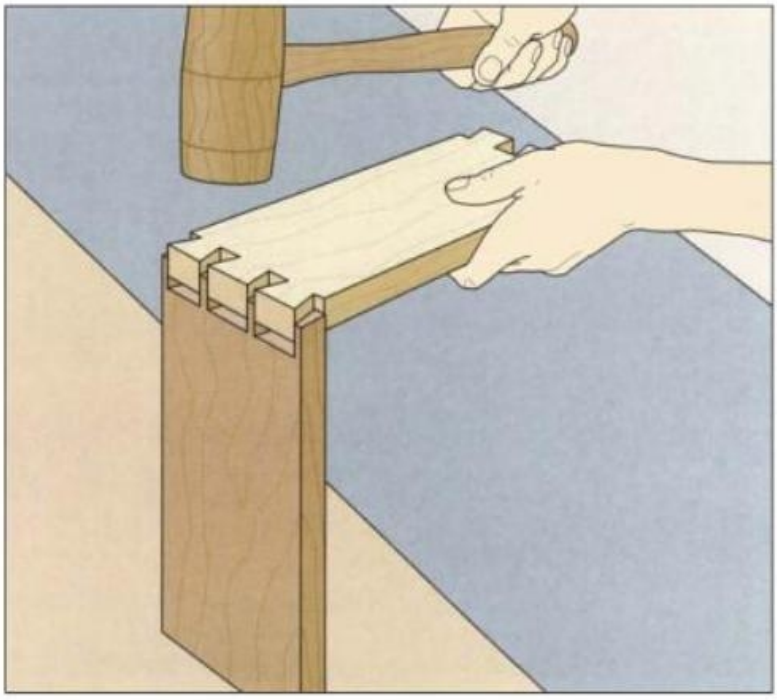


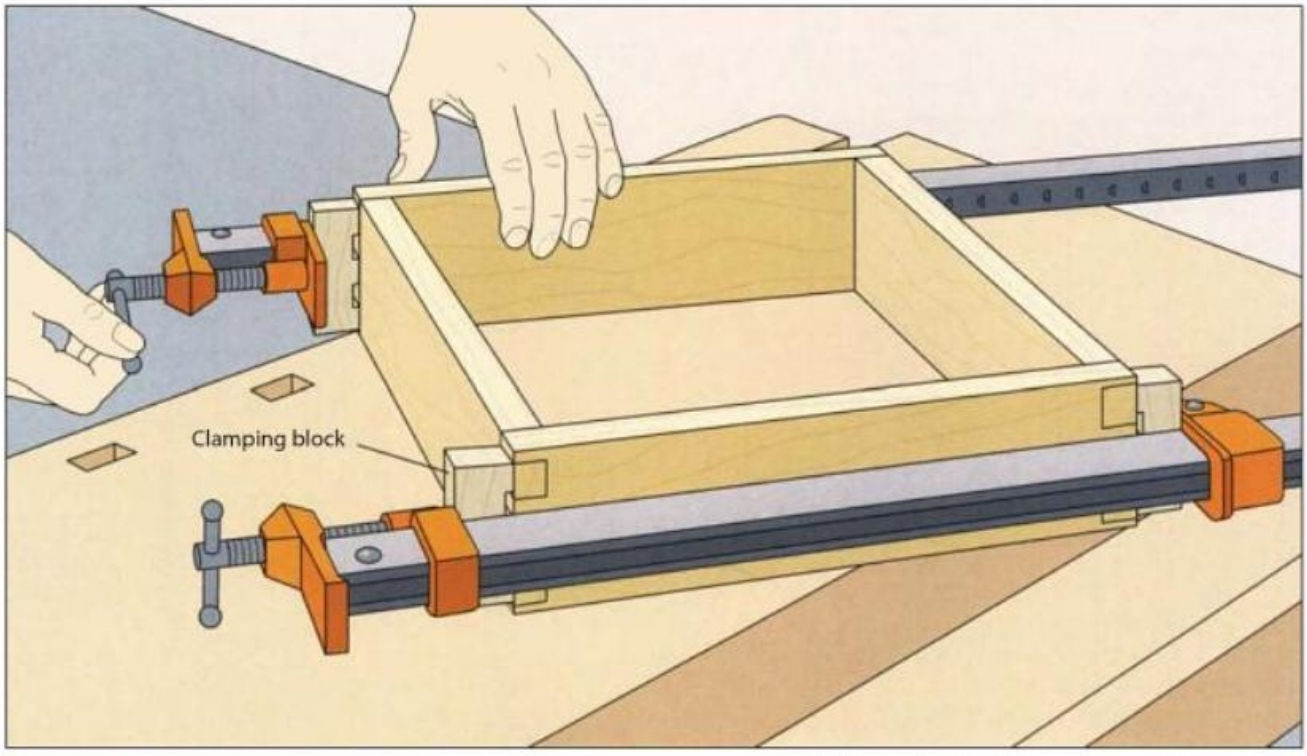
Cutting the tails and removing the waste

Use a dovetail saw to cut the tails the same way you cut the pins. Angling the board *(left)*, rather than the saw, makes for easier cutting. Secure the board so that the right-hand edges of the tails are vertical. Saw smoothly and evenly along the edges of the tails, stopping at the shoulder line. Reposition the board in the vise to cut the left-hand edges. Once all the saw cuts have been made, remove the waste with a chisel.

Dry-fitting the drawer

Before gluing up the joint, assemble it to check the fit. Stand the pin board on end on a work surface, then align the tail board with it. Press the joint together by hand as far as it will go, then use the mallet to tap the boards the rest of the way into position *(right)*. To avoid marring the pins and tails, close the joint evenly along its entire length. The pins and tails should fit snugly, requiring only a light tapping. If the joint is too tight, mark the point where it binds, disassemble the boards, and use a wood chisel to pare away a little more wood at the mark. Dry-fit the joint again and adjust it further, if necessary.





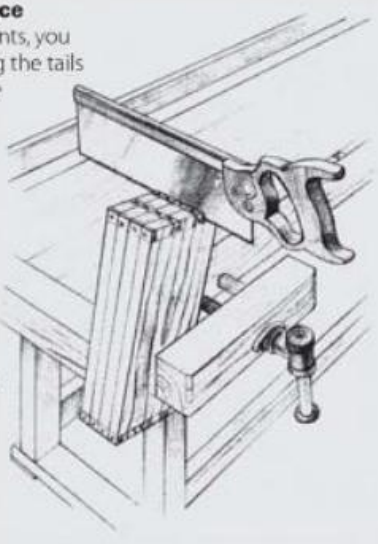
Gluing up dovetails

When gluing up a dovetail joint, clamping pressure is applied to the tail boards. To distribute clamping pressure properly, make a specially notched clamping block for each joint. The blocks should be as long as the width of the stock and notched so that they only touch the tails and do not exert pressure on the pins. Spread glue evenly on all the contacting surfaces of the boards, then assemble the joints. Install a bar clamp along each pin board, then tighten the clamps a little at a time *(above)*. Check the carcase for square and adjust the clamping pressure, if necessary.

Shop Tip

Cutting several tail boards at once

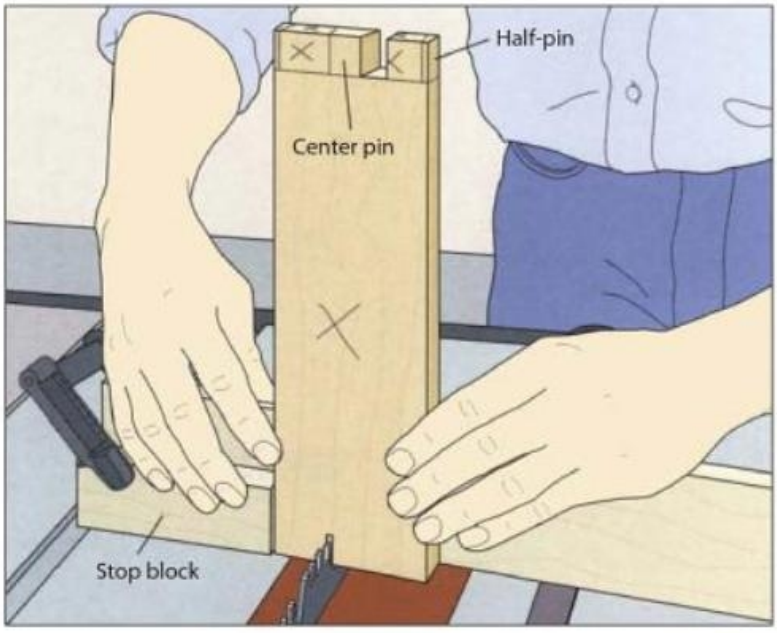
If you are making several dovetail joints, you can streamline the process of cutting the tails by sawing them all at once. Mark the tails on the boards, then stack the pieces together, making sure their edges and ends are aligned. Clamp the stack in a vise, angling the pieces so the right-hand edges of the tails are vertical. Cut the right-hand edges of all the tails, then leave the saw blade in the last kerf as you reposition the stack to cut the left-hand edges. The saw blade will keep the boards in alignment as you shift the stack in the vise.

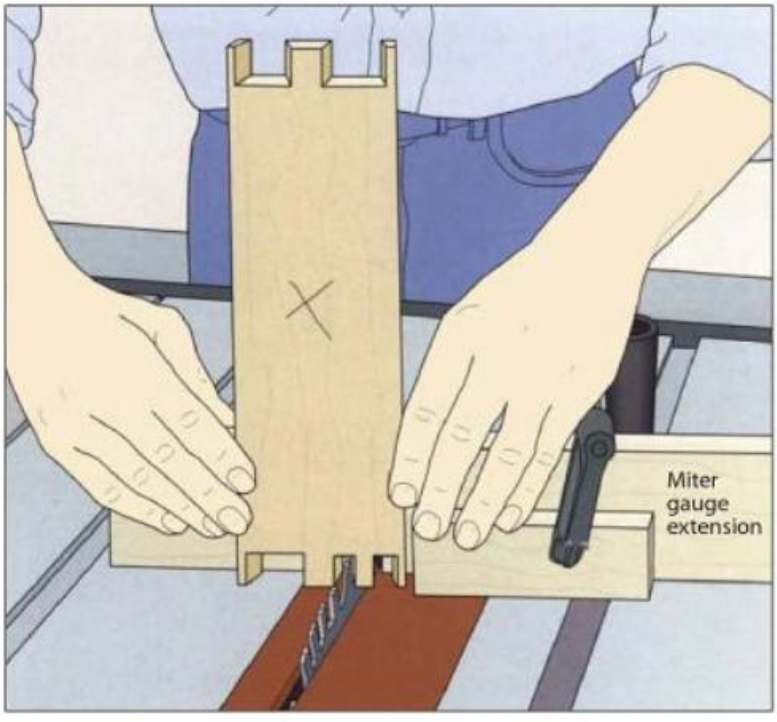


Cutting a Through Dovetail on the Table Saw

Cutting the pins

Lay out the pins *(page 157)*, but mark only one end of the board. Then, screw an extension board to the miter gauge that is high enough to support the workpiece during the cuts. Set the angle of the miter gauge to cut the right-hand edges of the pins; use a dovetail square as a guide. To make the cuts, hold the pin board with its inside face against the extension and the marked end on the table, then raise the blade to the shoulder line of the pins. Align the blade with the waste side of the right-hand edge of the center pin, then clamp a stop block on the extension flush against the right-hand edge of the board. Make a cut at the edge of the pin, then clear out about half the waste by cutting a series of kerfs, sliding the piece slightly to the left with each pass. Turn the board end-for-end, butt it against the stop block and the extension and repeat the procedure to make a mirror image of the first cut at the other end *(right, top)*. (Repeat the process for all other identical workpieces.) Then, after turning the board back to the marked end, align the blade with the right-hand edge of the next marked half-pin, reposition the stop block against the edge of the workpiece, and repeat the cutting process on both ends of the board. When the right-hand edges of all the pins are cut and half the waste has been cleared away, reverse the angle of the miter gauge and repeat the procedure to cut the left-hand edges of the pins. This time, continue cutting kerfs into the waste until it is cleared, sliding the board to the right with each pass *(right, bottom)*. To complete the joint, trace the pins on the tail board *(page 160)* and cut the tails by hand *(page 161)* or using a band saw *(page 167)*.

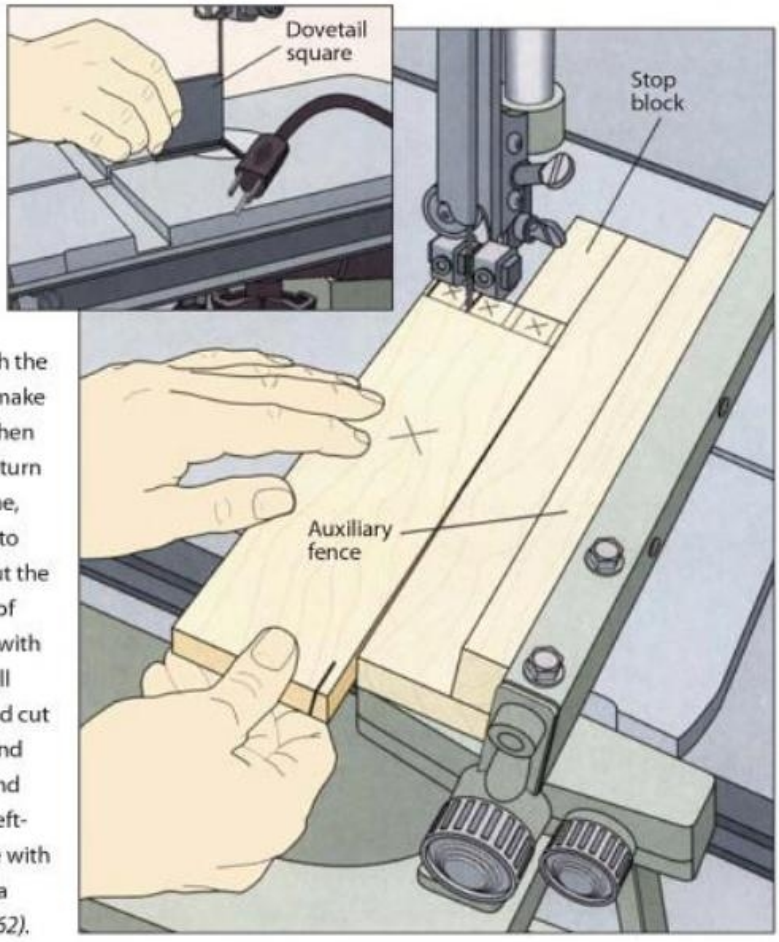


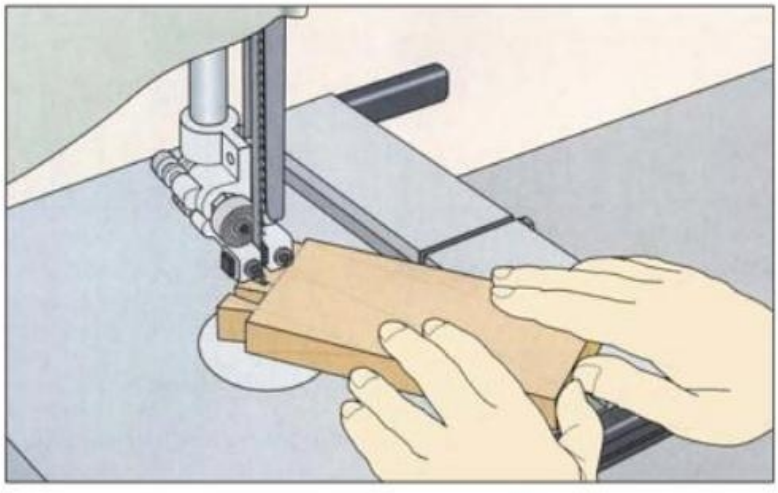


A Through Dovetail Joint on the Band Saw

Cutting the pins

Mark the pins on one end of the workpiece *(page 157)*, then cut them in two stages, first angling the table to the right for one series of cuts, and then to the left for the final ones. Start by tilting the table to match the angle of the dovetail square *(inset)*. Install the rip fence and fasten a wooden L-shaped auxiliary fence to it. Then, set the workpiece outside-face up on the saw table and align the right-hand edge of the first half-pin with the blade. Butt the auxiliary fence against the piece and make the cut, keeping the board flush against the fence. When the blade reaches the shoulder line, stop the cut and turn off the saw. With the blade butted on the shoulder line, hold a stop block against the workpiece and screw it to the auxiliary fence. Turn the piece end-for-end and cut the right-hand edge of the first half-pin at the other end of the board. Turn the workpiece again, align the blade with the marked line for the right-hand edge of the first full pin, butt the auxiliary fence against the workpiece and cut to the stop block *(right)*. Continue turning the work and shifting the rip fence as necessary to cut the right-hand edge of the pins on both ends of the board. Cut the left-hand edge of each pin following the same procedure with the table tilted downward to the left. Finish by using a chisel to remove the waste between the pins *(page 162)*.

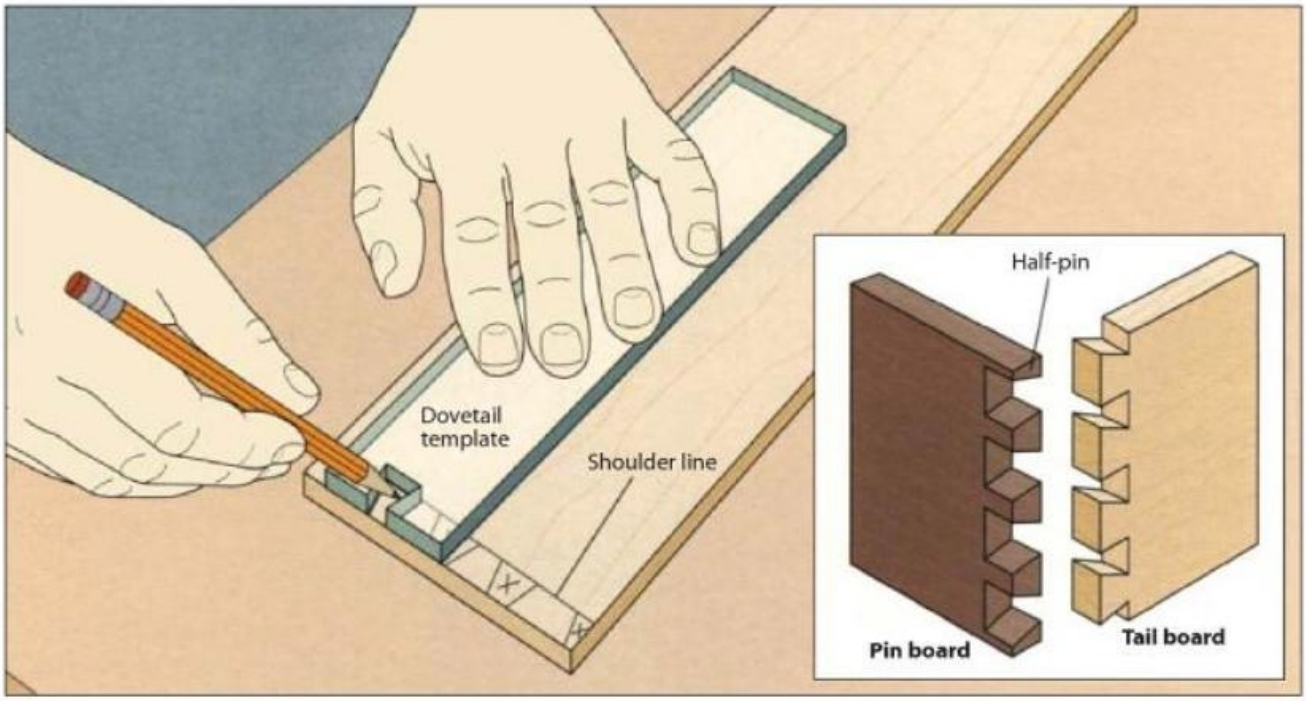




Cutting the tails

Use the completed pin board as a guide to outline the tails on the tail board *(page 160)*. To make the cuts and remove the waste, return the table to the horizontal position. Start by sawing out the waste at both edges of the piece with two intersecting cuts. To clear the waste between the tails, nibble at it with the blade, pivoting the piece as necessary to avoid cutting into the tails *(left)*. Test-fit the joint and make any necessary adjustments with a chisel.

Cutting Through Dovetails on a Router Table

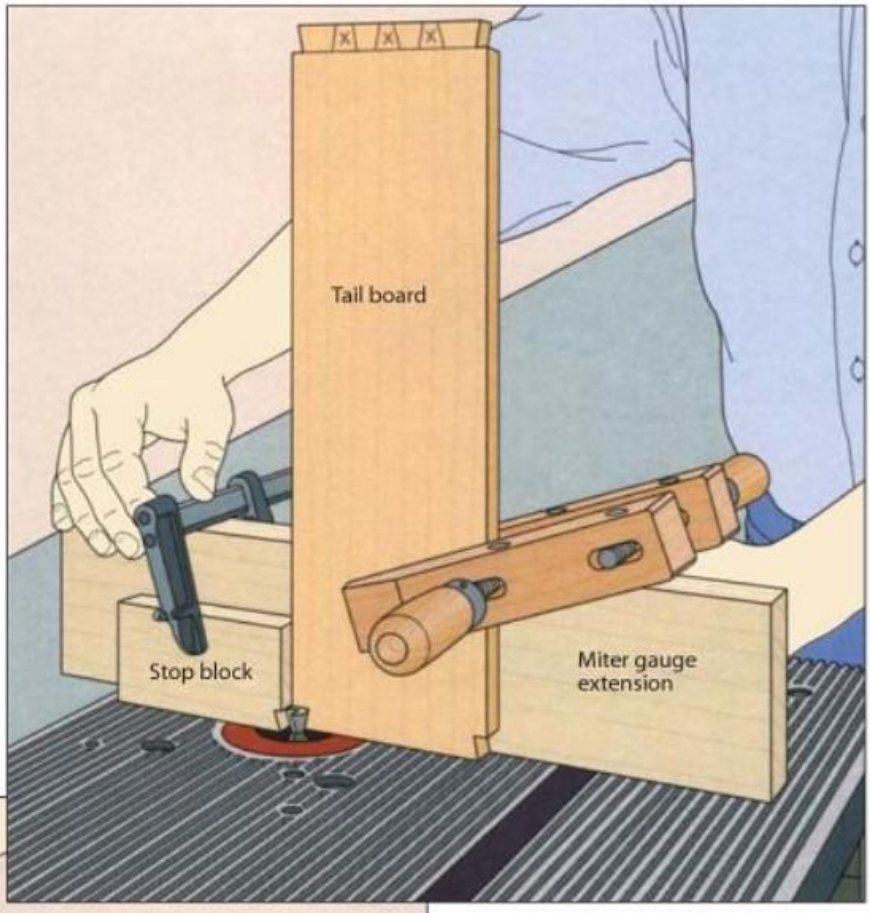


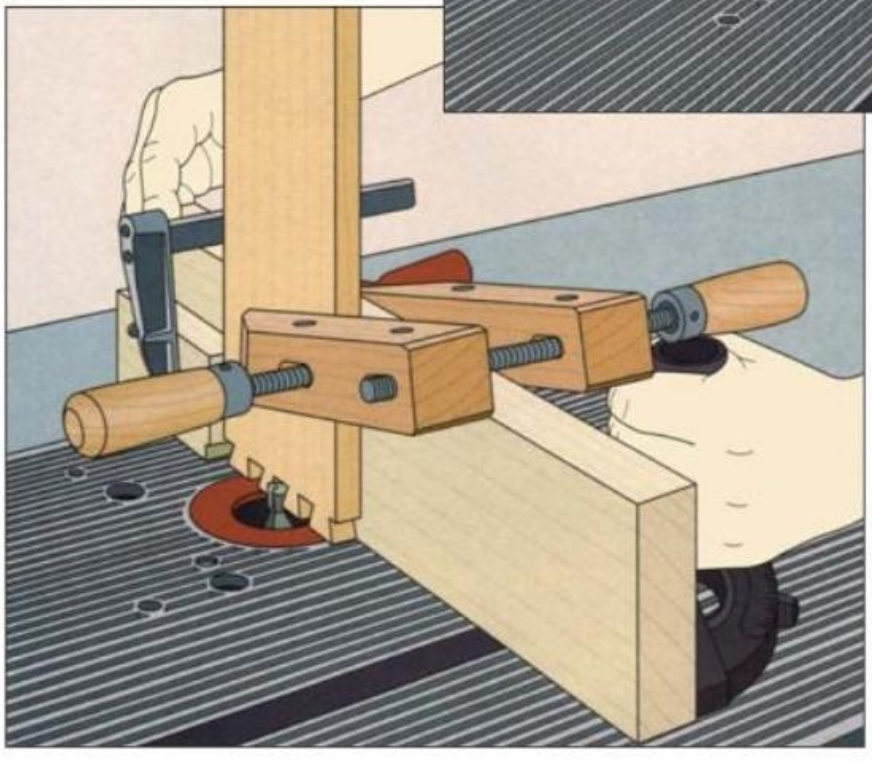
Marking the tails with a shop-made template

A dovetail joint consists of a tail board and a pin board with half-pins at each end *(inset)*. To rout the joint, start by using a cutting gauge adjusted to the stock thickness to scribe a shoulder line across one end of the tail board. To mark the tails, use a shop-made template; cut a piece of clear acrylic plastic about 3 inches wide and 8 inches long, then rout a notch into one end with the same dovetail bit you will use to cut the joint. The size and shape of the notch will correspond to the waste sections between the tails—that is, the pins. Set the tail board on a work surface, position the template on top, and start by marking waste sections equal to one-half the notch width at each edge; be sure to align the template's notched end with the board end and hold its edges parallel to those of the workpiece. Outline the remaining waste sections *(above)*, marking them with an x as you go. There are no rigid guidelines for the number of tails required, but evenly spaced tails that are at least twice the size of the waste sections between them produce an attractive and sturdy joint.

Routing away the waste from the tail board edges

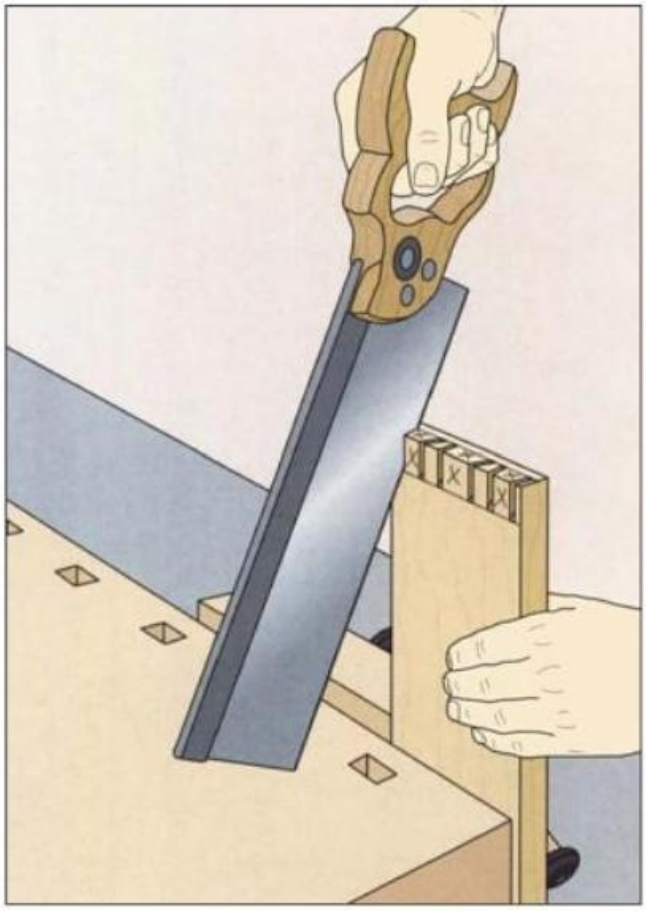
Mount your router in a table with the bit used to notch the dovetail template and screw an extension board to the miter gauge. Securing the tail board on end, adjust the cutting height so the bit will cut to the shoulder line. Then align one of the waste sections at the edge of the board with the bit and clamp the workpiece to the extension. Butt a stop block against an edge of the board and secure it to the extension so you can rout the waste sections at each corner of the board using the same setup. To cut the first waste section, slide the miter gauge forward. Then turn the board around, butt it against the stop block, reclamp the workpiece to the extension and repeat the cut. Cut the waste sections at the other end of the board the same way *(right)*.





Routing the remaining tails

Once the waste at all four corners of the tail board has been cleared, remove the stop block, then align one of the remaining waste sections with the bit, secure the workpiece to the miter gauge extension, and reclamp the stop block against the edge of the stock. Rout the waste section, then flip the board end-for-end to cut the corresponding section at the other end. Repeat the process to cut away the remaining waste sections *(left)*.

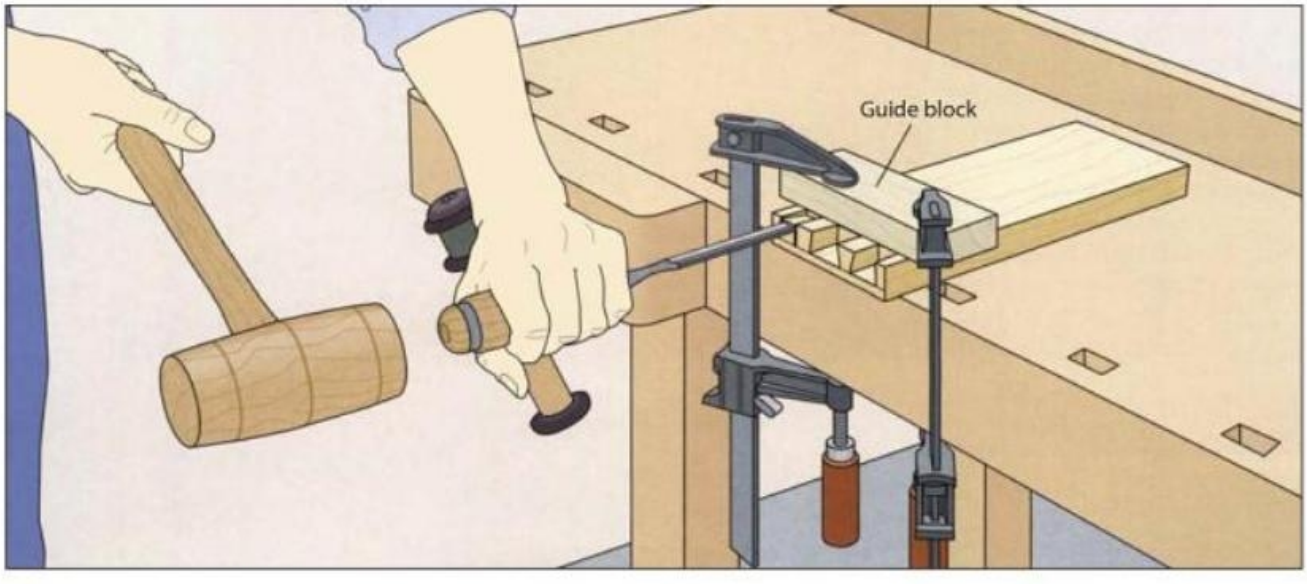


Cutting the pins

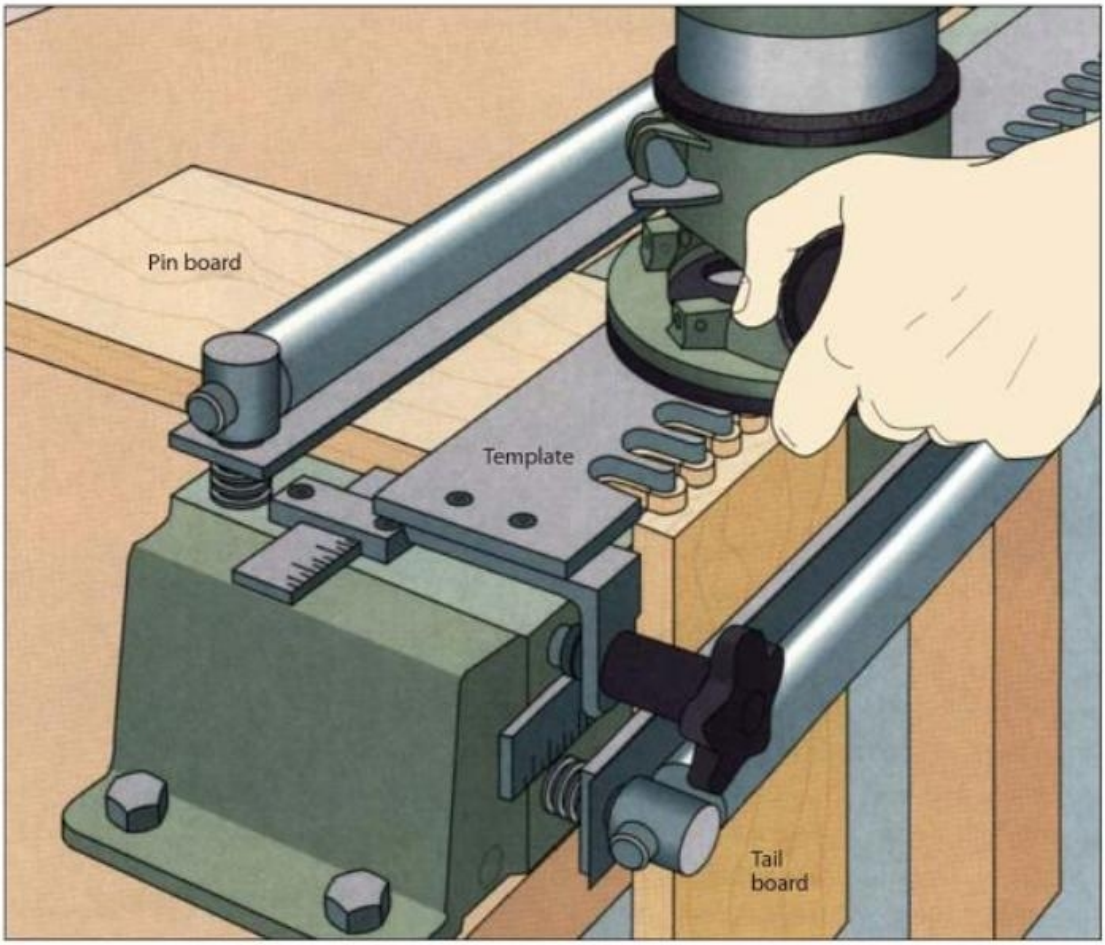
Secure one pin board in a vise with the outside face of the stock toward you, then cut down along the edges of the pins with a dovetail saw, working from one edge of the board to the other. Hold the board steady and align the saw blade just to the waste side of the cutting lines *(left)*. Use smooth, even strokes, continuing the cuts to the shoulder line and the line on the board end.

Removing the waste

Lay the pin board inside-face up on a work surface and clamp a guide block along the waste side of the shoulder line. Use a chisel that is no wider than the narrowest part of the waste area. Starting at one edge of the stock, hold the flat side of the chisel against the guide block. With the chisel perpendicular to the board face, strike the handle with a wooden mallet, making a ⅛-inch-deep cut into the waste. Then hold the chisel bevel-up and square to the board end about ⅛ inch below the top surface and peel away a thin layer of waste. Continue until you reach the scribed line on the board end, then pare away any remaining waste. Repeat the process with the remaining waste sections *(below)*. Finish the joint by marking and cutting the tails as you would for a through dovetail joint *(page 160)*. When marking, remember that the tails of this joint will be shallower than those of a through joint because they extend only to the bottom of the blind pins.



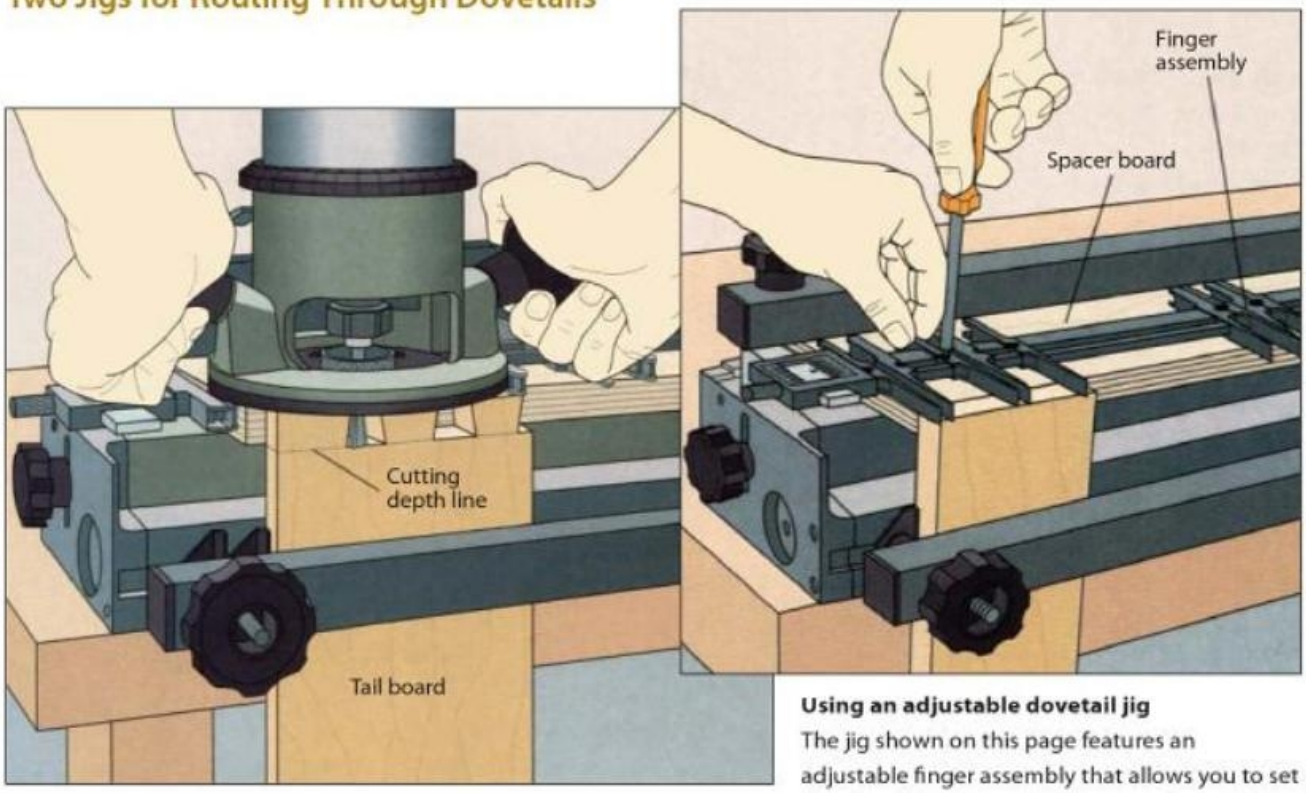
Routing Half-Blind Dovetails

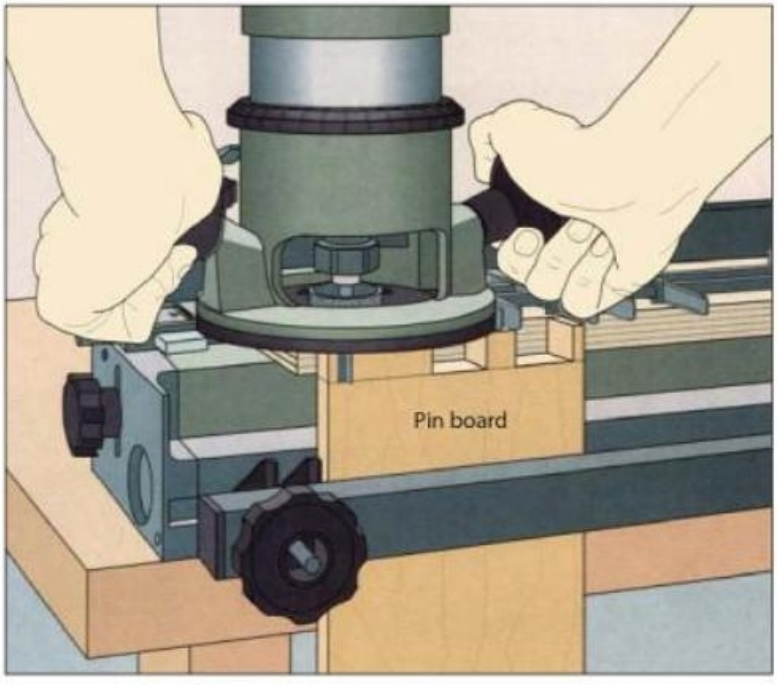


Using an interchangeable-template jig

Set up a commercial jig for half-blind dovetails following the manufacturer's instructions. On the model shown, this involves clamping the pin and tail boards in position against the body of the jig, and securing the appropriate template atop the workpieces. Install the proper bit and template guide on your router, then rout the pins and tails in two passes: Start from the right-hand edge and make a light cut along the edge of the tail board. This will reduce tearout and ensure that all the waste around the tails will be removed. Then make a second full pass starting at the left-hand end of the workpieces, following the contours of the router's template and moving in and out of the slots *(above)*; keep the template guide flush against the edges of the fingers at all times. This will cut the pins and complete the tails simultaneously.

Two Jigs for Routing Through Dovetails



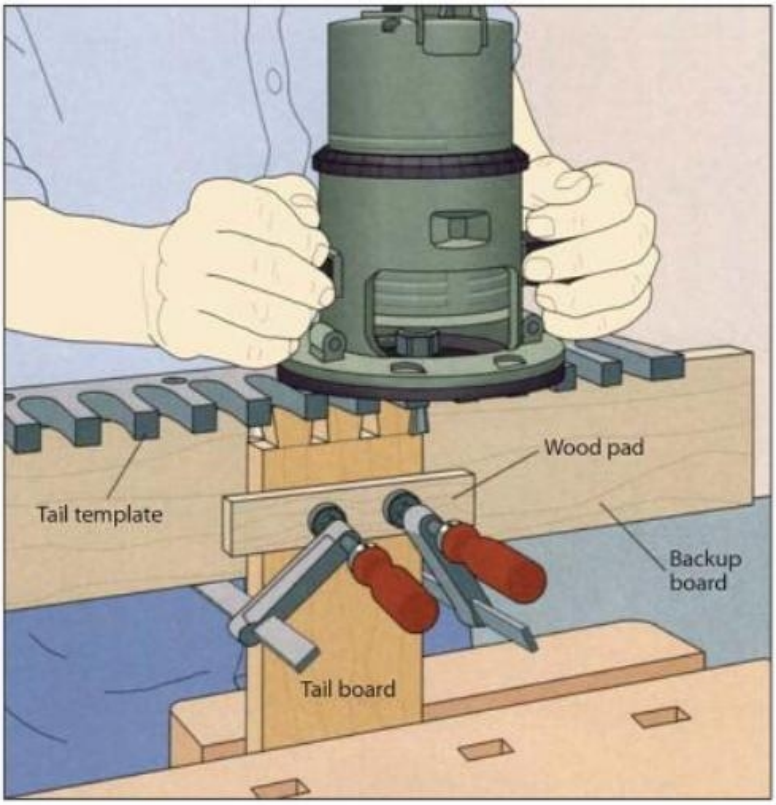


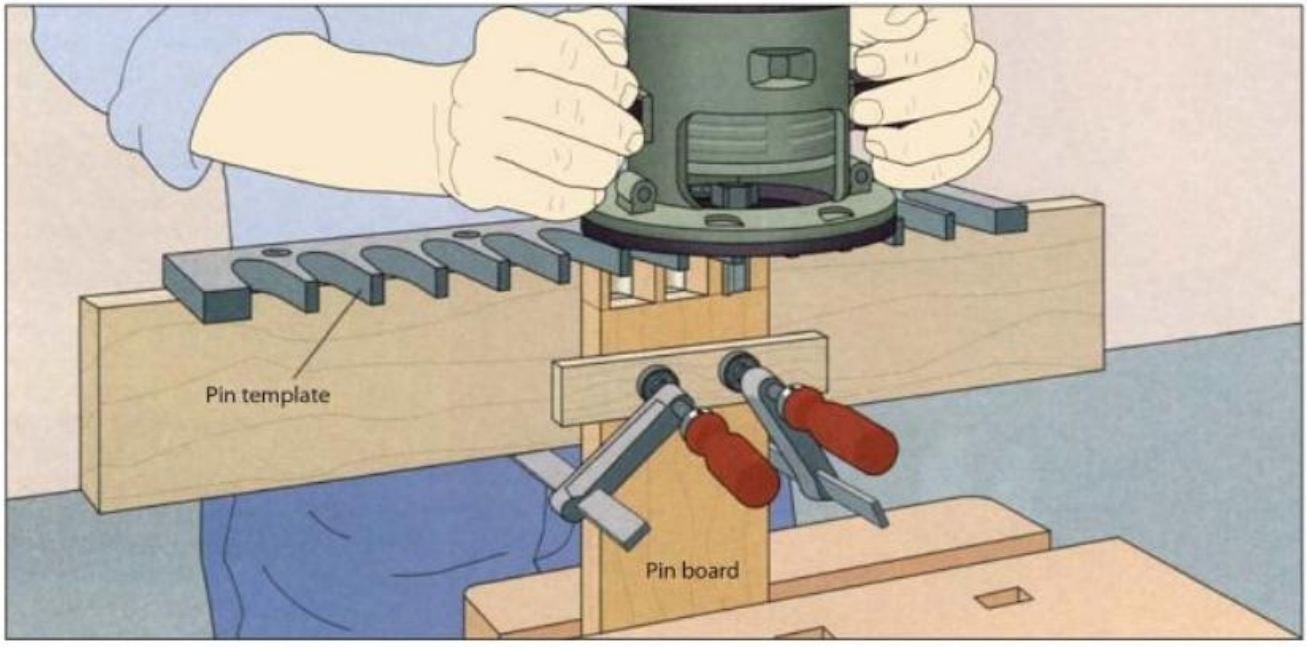
Using an adjustable dovetail jig

The jig shown on this page features an adjustable finger assembly that allows you to set the size of the pins and tails you rout as well as the space between them. Adjusting the assembly for the tails automatically gives you the proper size and spacing of the pins. Install a dovetail bit in your router, then set up the jig following the manufacturer's instructions: Clamp a spacer board of ¾-inch plywood to the top of the jig body, and secure the tail board outside-face out. Once the fingers are laid out over the tail board according to the size and spacing you want *(above)*, use the thickness of the pin board as a guide to mark a cutting depth line across the tail board. Flip over the finger assembly and set the depth of cut on the router to cut the tails *(left, top)*. Rout from right to left, keeping the base plate flat on the fingers. To cut the pins, remove the tail board and turn over the finger assembly. Install a straight bit in the router and clamp the pin board to the jig. Mark a cutting depth line on the board, set the router's depth adjustment, and rout the pins *(left, bottom)*.

Using dovetail templates

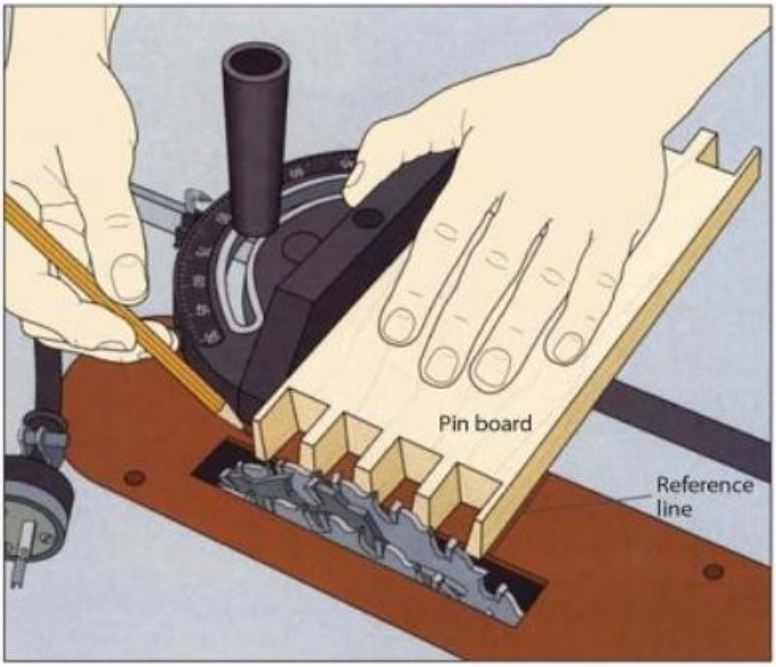
To rout through dovetails with the dovetail templates shown on this page, attach the pin and tail templates to backup boards following the manufacturer's instructions. Secure the tail board in a vise end-up and clamp the backup board to it, making sure there will be half-tails at both edges; the template and backup board should be flush against the workpiece. Protect the stock with a wood pad. If you are cutting several workpieces, butt a stop block against the first workpiece and clamp the block to the backup board. Install the dovetail bit and template guide supplied with the jig and cut the tails, feeding the tool in and out of the template slots *(right)*. Unclamp the tail board from the vise and use it to outline the pins on the pin board. Secure the pin board in the vise and clamp the pin template to the stock, aligning the jig fingers with the marked outline. Remove the dovetail bit from the router, install the straight bit supplied with the jig, and rout out the waste between the pins *(below)*.

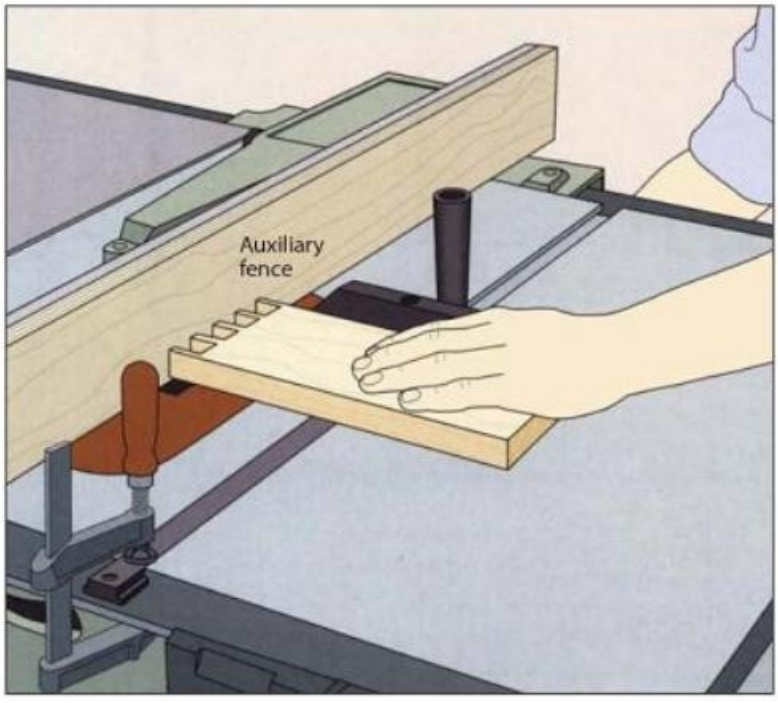




Preparing to rabbet the pin board

Install the dado head on your table saw and adjust its width to slightly more than the length of the pins. Also install an auxiliary fence and notch it up to the thickness of the pin board. Next, set the pin board outside-face up on the saw table and center the end of the piece against the outside blade of the dado head, using the miter gauge to keep the board perpendicular to the blade. Adjust the cutting height so the points where the dado head emerges from the table are aligned with the edges of the workpiece. Then mark reference lines on the table insert, using the board edges as a guide *(right)*. Adjust the fence so that the actual cutting width equals the length of the pins, then lower the dado head beneath the table.

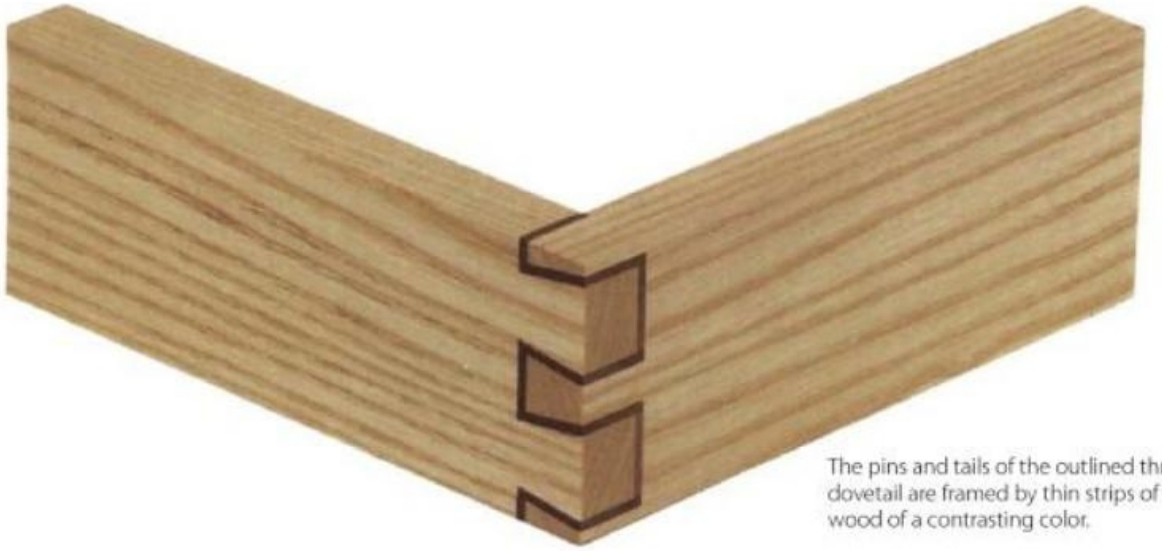




Cutting the rabbets

Butt the end of the pin board against the fence and center its edges between the reference lines on the table insert. Slide the miter gauge up against the workpiece, then clamp the gauge in place. Holding the stock firmly in position, turn on the saw and raise the dado head to make a shallow cut in the pins *(left)*. Turn the saw off and test-fit the joint. Make a slightly deeper cut and test again, continuing to cut and test until the joint fits. The process is painstaking, but the results can be well worth your effort.

Outlined Through Dovetail Joints

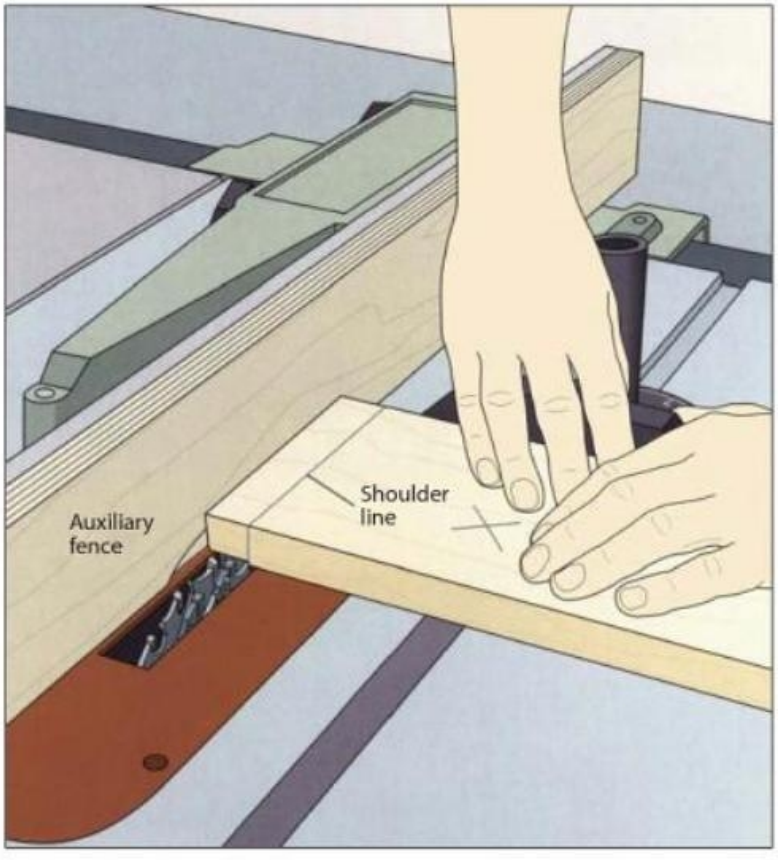


The pins and tails of the outlined through dovetail are framed by thin strips of wood of a contrasting color.

Making an Outlined Through Dovetail

Rabbeting the pin and tail boards

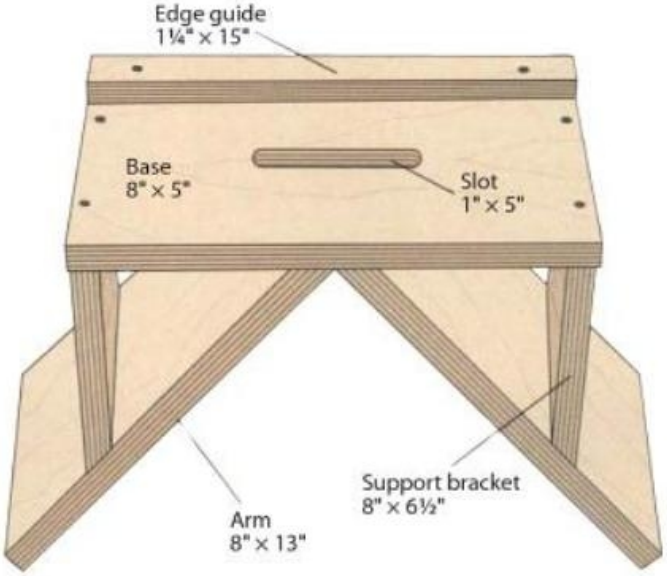
An outlined through dovetail is like the conventional joint, except that space must be created for the contrasting wood—usually a veneer—around and below all pins and tails. The process is fairly simple. Start by cutting rabbets in the inside faces of both mating pieces of the joint. Set a cutting gauge to the stock thickness and scribe a shoulder line around the ends of the boards. Then install a dado head on your table saw and adjust its width so that it is slightly wider than the stock thickness. Also install and notch an auxiliary fence, and adjust it so that the width of cut equals the stock thickness. Raise the cutting height to the thickness of the veneer. Make a test cut on a scrap board and adjust the cutting height until the veneer fits perfectly in the rabbet. Then cut rabbets at both ends of your stock, feeding each board with the miter gauge *(right)*.

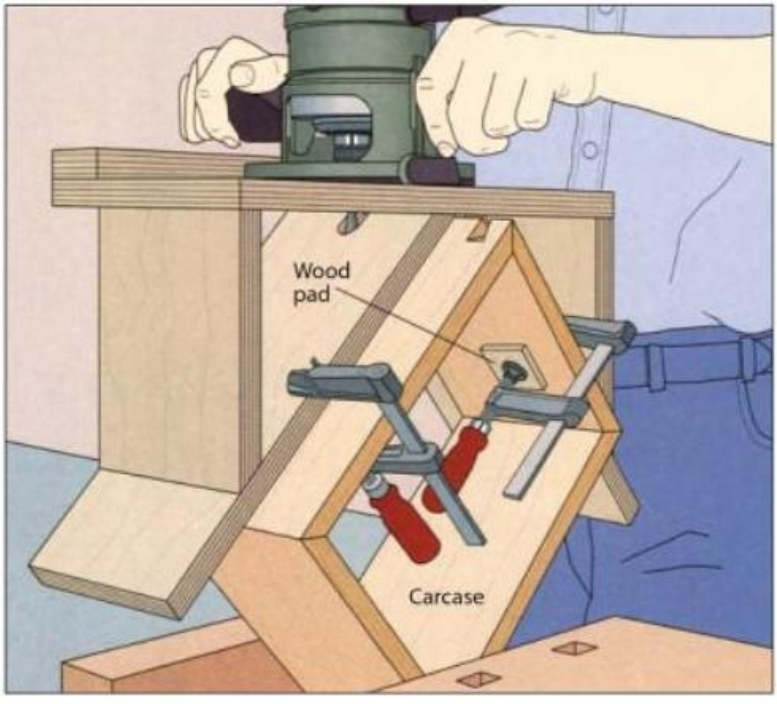


Routing a Dovetail Spline Joint

Making the jig

The jig shown at right, built from ¾-inch plywood, will help you cut grooves for dovetail spline joints in the corners of a carcase. Refer to the illustration for suggested dimensions. Before assembling the jig, cut the oval slot in the middle of the base to accommodate your bit. Cut 45° bevels at the top ends of the arms and the bottom ends of the support brackets. Attach the arms to the base and the brackets to the base and arms, making the arms perpendicular to each other and centering them under the slot. Install a dovetail bit in your router, secure the jig in a vise and, with the bit in the slot, position the edge guide against the tool's base plate and screw it down. Then, with the base plate pressed against the guide, rout a channel across the top ends of the arms.



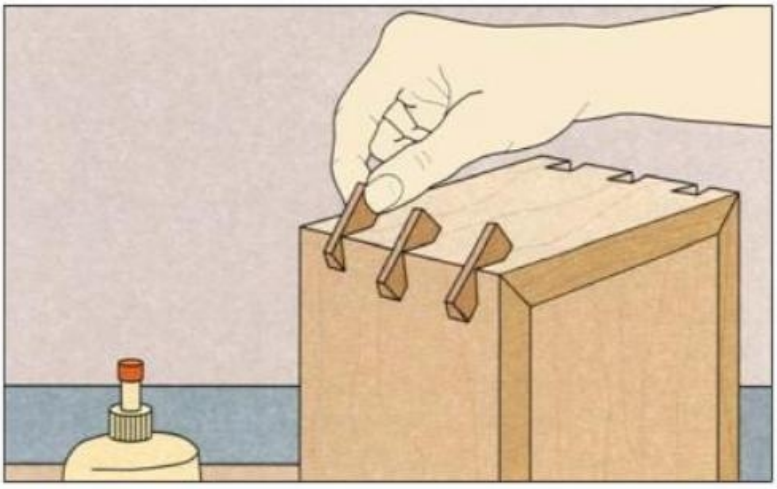


Routing the grooves

Mark cutting lines for the grooves on the corners of the workpiece. Secure the carcase diagonally in a vise and set the jig on top, aligning the edges of the channel you routed before with one of the cutting marks. Clamp the jig to the carcase, protecting the stock with wood pads. Rout the grooves by repeating the cut you made to rout the channel, feeding the bit through the corner of the carcase. Be sure to keep the router flat on the jig base and flush against the edge guide until the bit is well clear of the carcase. Reposition the jig and repeat to rout the other grooves *(left)*.

Inserting the splines

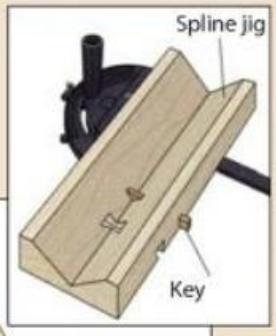
To make enough splines for several grooves, rout a dovetail slide on the edge of a board, just as you would for a sliding dovetail joint *(page 107)*. Rip the slide from the board on a table saw, then cut individual splines from it. For a snug fit, use the same dovetail bit that cut the grooves earlier. Install the splines by spreading some glue in the grooves and on the splines and sliding them in place *(right)*. Once the glue has dried, trim off excess wood with a handsaw and sand the surface flush with the carcase.

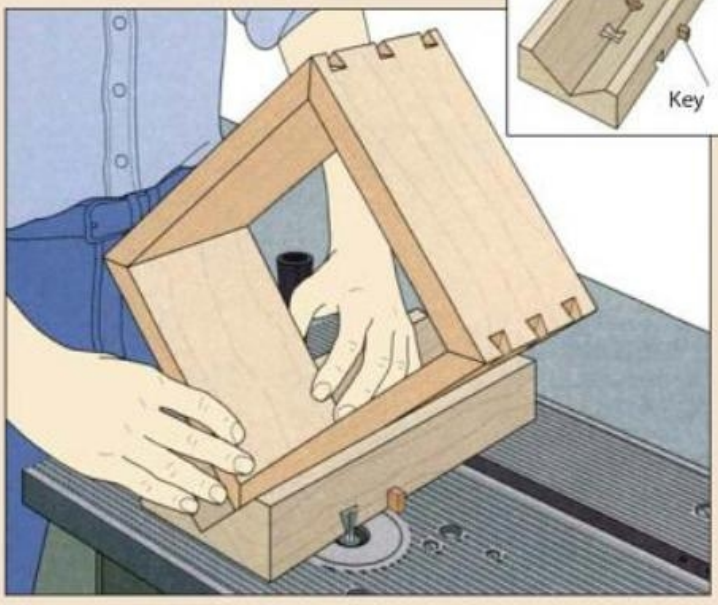


A Router-Table Jig

The jig shown below allows you to rout a series of evenly spaced grooves for straight or dovetail splines. Cut a V-shaped notch into the face of a board, then install a ¼-inch straight bit in your router and mount the tool in a table. Screw the jig to a miter gauge and feed it into the bit to make a notch. Fit and glue a wood key in the notch, then reposition the jig on the gauge so the distance between the key and the bit equals the spacing you want between the spline grooves. Feed the jig into the bit to rout a second notch. Install a ½-inch dovetail bit and set the depth of cut so the full dovetail shape is visible above the bottom of the notch.

To use the jig, seat the workpiece in the V with an edge butted against the key and rout the first groove. To cut subsequent grooves, fit the groove over the key and slide the workpiece into the bit *(below)*.

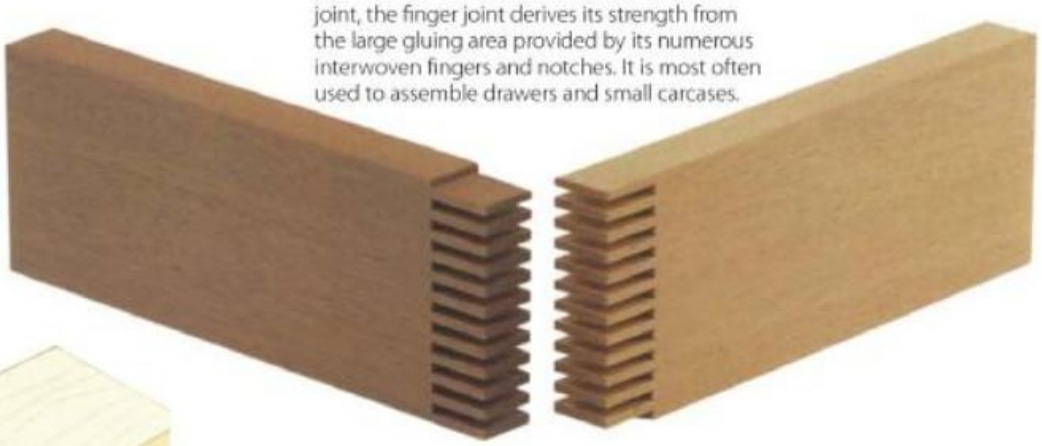




Box Joints

The box joint, also known as a finger joint, is ideal for making drawers or cabinets. The joint derives its strength from the large gluing area of the interlocking pins and notches.

Finger Joints



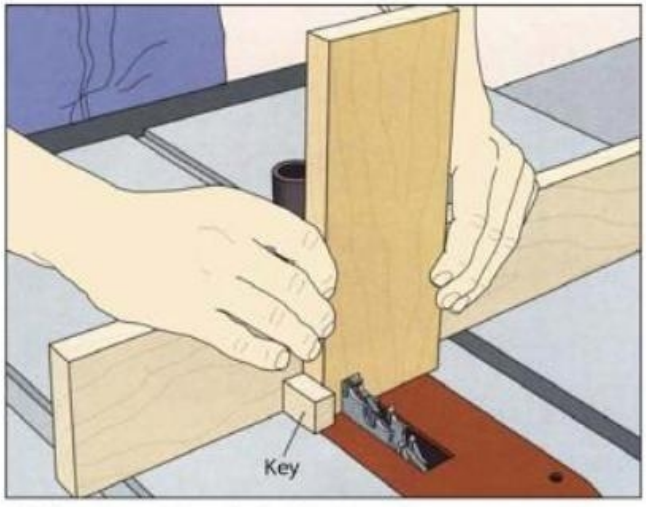
An attractive and solid variation of the box joint, the finger joint derives its strength from the large gluing area provided by its numerous interwoven fingers and notches. It is most often used to assemble drawers and small carcases.

Half-blind box joint
Similar to the standard box joint with the shoulder of one board and the pins of the mating piece mitered at 45°; the end grain of one board is hidden

Cutting a Box Joint on the Table Saw

Making the jig

The notches for a box joint are cut one after another on the table saw using a dado head and a simple jig made from an extension board clamped to the miter gauge. First adjust the width of the dado head so that the pins and notches on the edges of the pieces will all be the same size. Make the cutting height equal to the stock thickness, clamp the extension onto the miter gauge, and feed it into the dado head to cut a notch. Slide the extension along the miter gauge so the gap between the notch and the dado head is equal to the notch width, then screw the extension to the gauge. Feed the extension into the blades to cut a second notch *(right)*. Then, insert a tight-fitting wooden key in the first notch so it projects at least 1 inch from the extension.



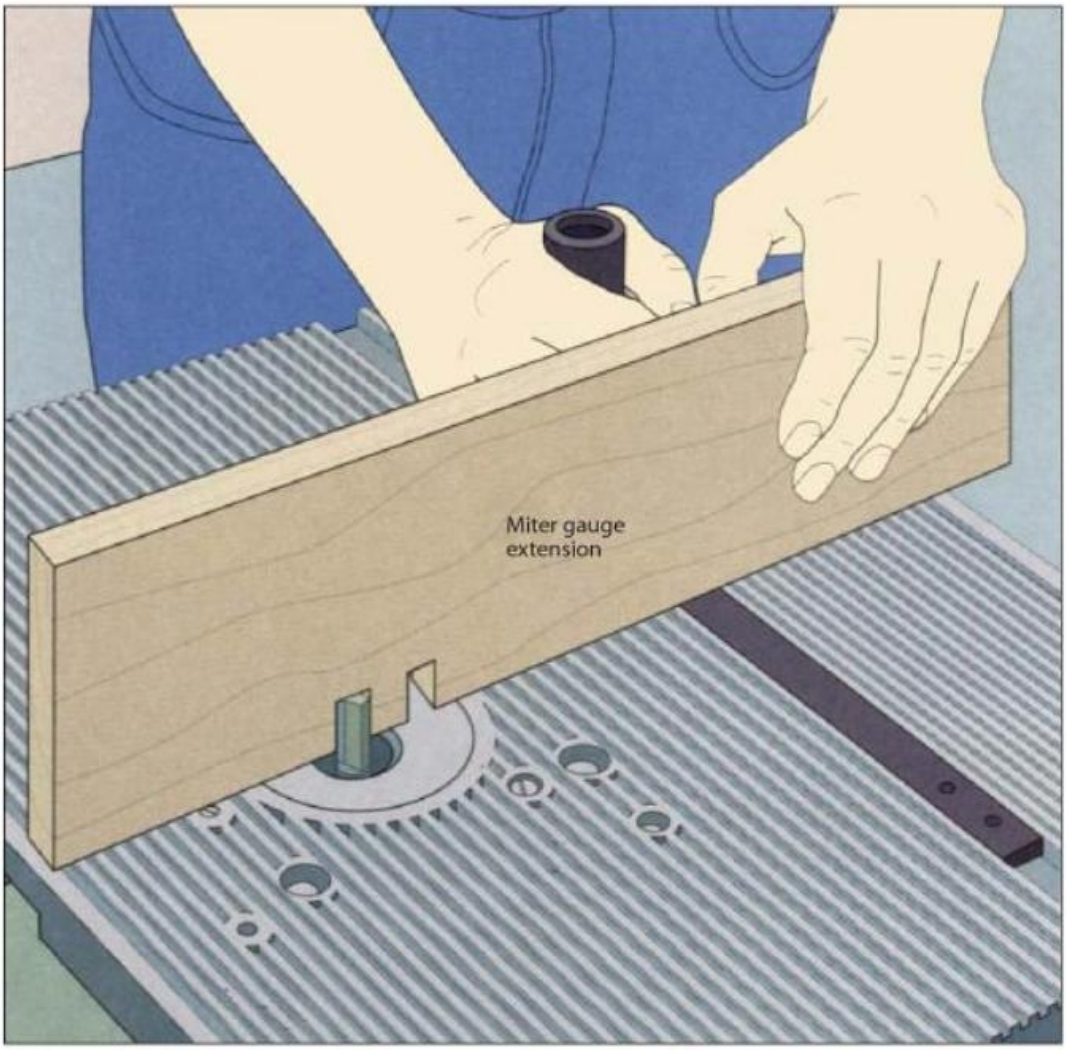
Cutting the notches in the first board

Butt the edge of the board against the key and hold its face flat against the extension. Turn on the saw and feed the piece into the dado head, hooking your thumbs around the extension to steady the piece during the cut *(above)*. Lift the workpiece and return the miter gauge to the front of the table. Fit the notch you just cut over the key and make the second cut. Repeat.

Cutting the notches in the mating board

Fit the final notch you cut in the first piece over the key, then butt one edge of the mating board against the first board. Holding both boards firmly against the extension, feed the mating piece into the dado head *(above)*. Continue cutting notches in the mating board following the same procedure you used on the first board.

Routing a Box Joint



Setting up the jig

The jig shown at right allows you to cut the notches for a box joint one at a time on a router table. The jig is simply an extension board screwed to the miter gauge and fitted with a key to determine the spacing of the notches. Install a straight bit with the same diameter as the desired width of the notches; mount the router in a table. Set the depth of cut to equal the thickness of your stock and feed the extension into the bit to rout a notch. Then unscrew the extension from the miter gauge and reposition it so that the gap between the notch and the bit equals the width of the bit. Feed the extension into the bit again, cutting a second notch *(above)*. Fashion a wood key to fit in the first notch and glue it in place so it projects about 1 inch from the extension board.

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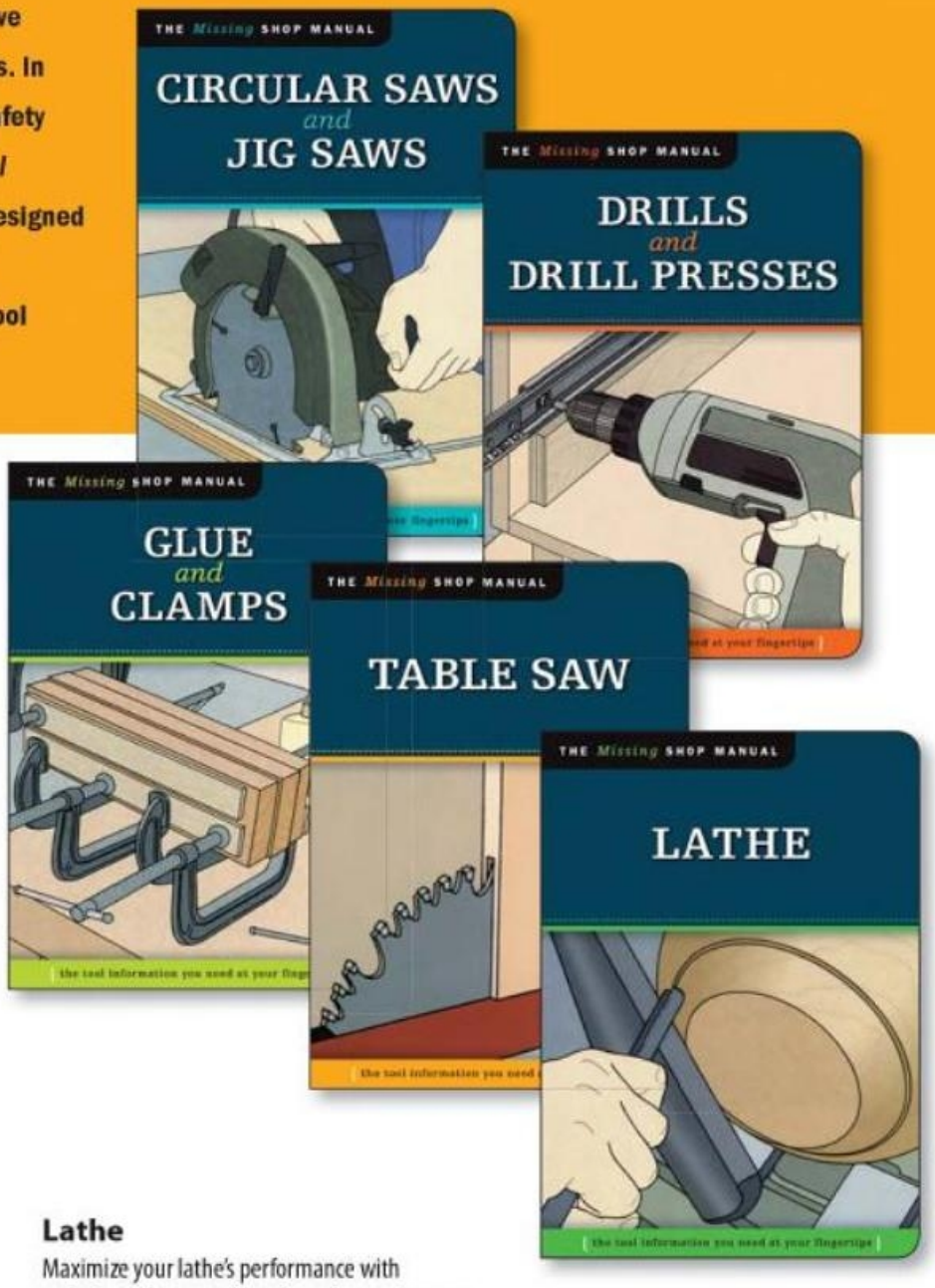

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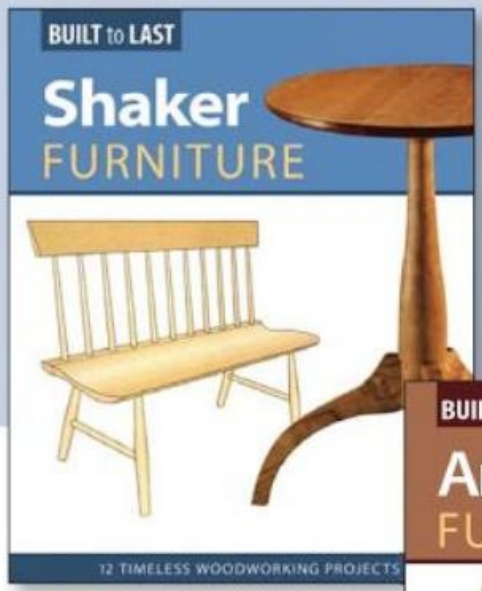

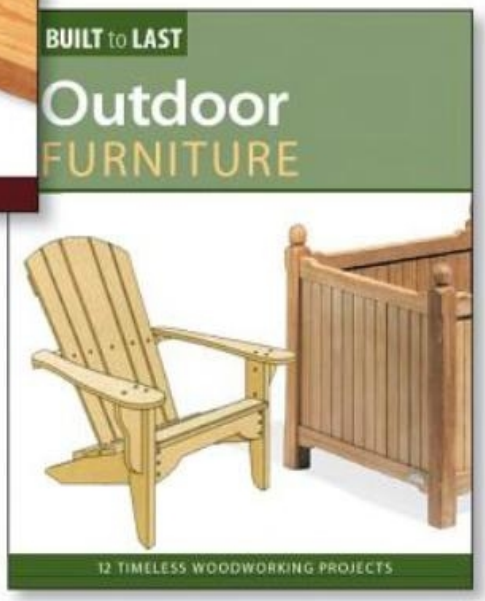

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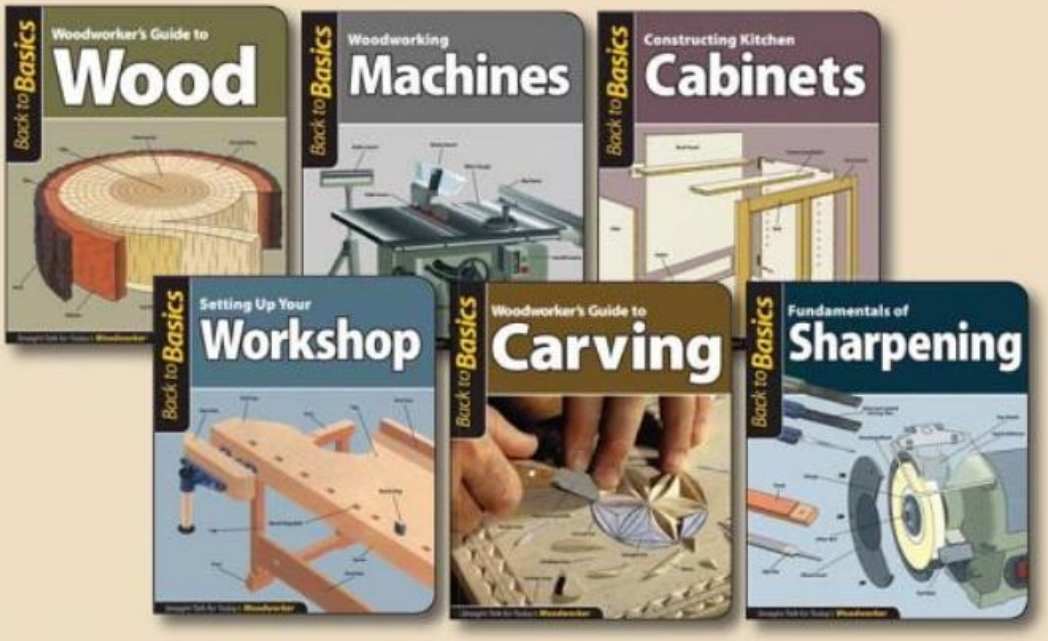

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