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Arts & Crafts Workbench

In this plan you will be getting:

- Step by Step construction instruction.
- A complete bill of materials.
- Exploded view and elevation drawings.
- How-to photos with instructive captions.
- Tips to help you complete the project and become a better woodworker.

Published in Woodworker's Journal "From Start to Finish: Quality Plans and Techniques for the Home Woodworker"

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WJ057

Arts & Crafts Workbench

When our longtime contributor Ian Kirby sets out to design a sturdy and practical workbench, rest assured it will be a shop fixture that will stand the test of time. Ian's bench will provide not only a proper workstation, but also essential feedback on the flatness of your stock as well as your planing technique.

To begin making this elegant and eminently practical bench, start with its top. Glue 16 laminations together to create a solid and stable surface.

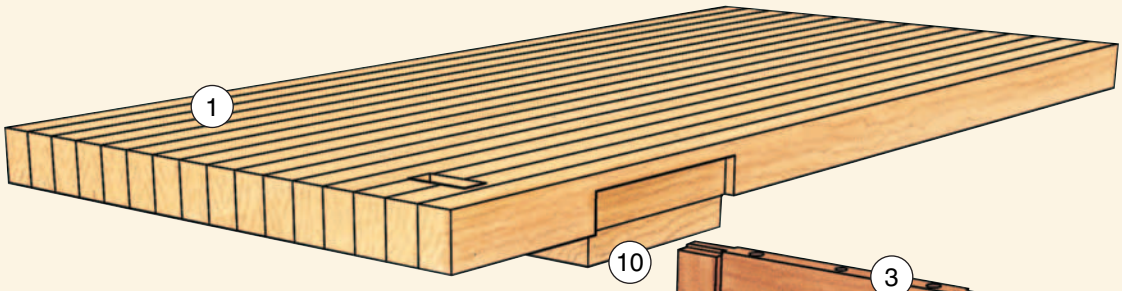
The workbench top is to the woodworker what a face plate is to the machinist—a surface used as a reference. In wood terms, it's a dead-flat, hard surface. Its edges and ends are square. It won't sag under load. About every two or three years, any distortion due to movement, wear, or dings can be skimmed back to accuracy by planing. It needn't be babied like a piece of furniture, but you don't cut into it by chiseling, sawing or drilling. Apply oil to keep it clean and protected from spills. If you must use it for glue-ups, protect it from clamp heads and glue drips with a sheet of Masonite®.

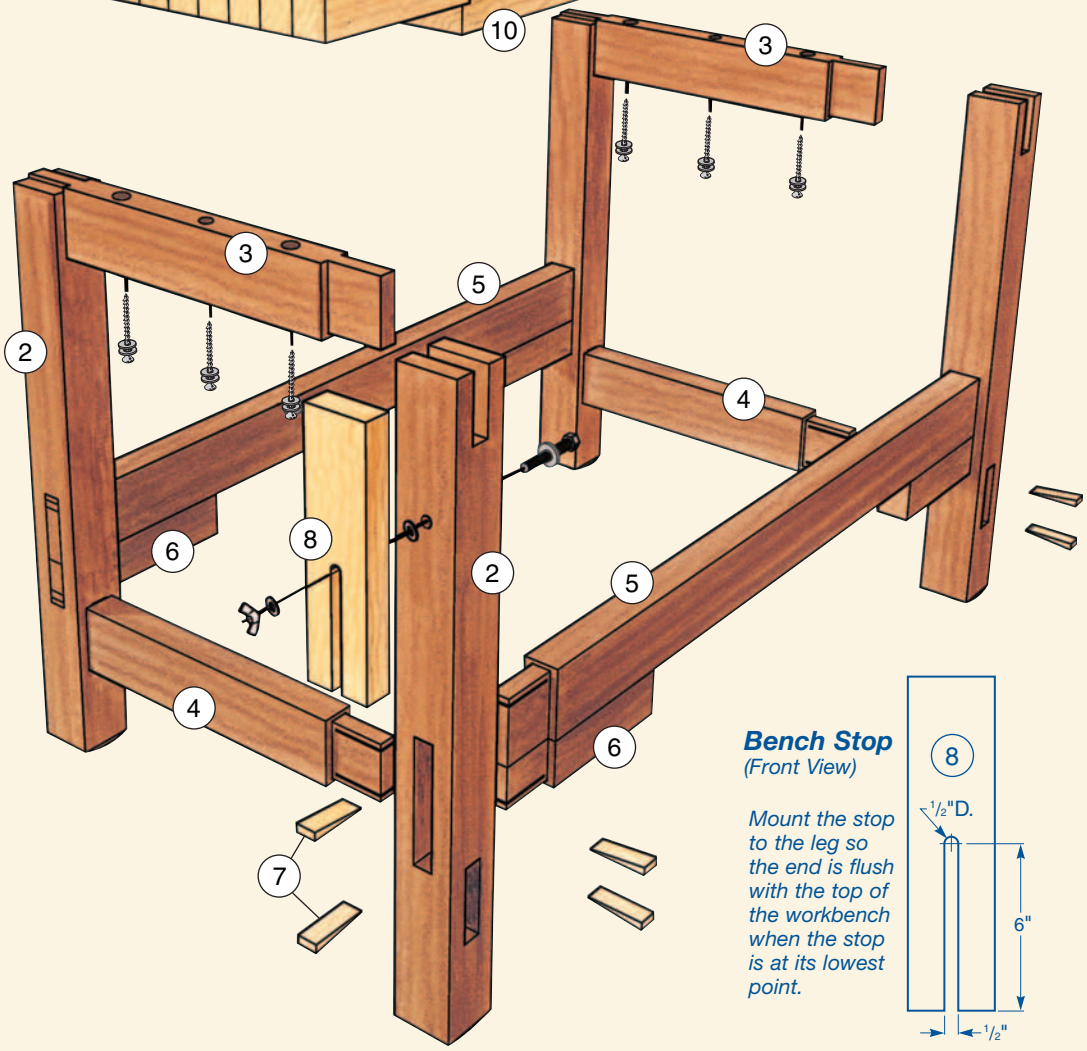
Benchtop Characteristics

Tool Well: Many contemporary benches include a well in the top to serve as a place to put your tools. My experience is that the tool you want ends up in the well under the board that you just carefully clamped into place to do the work that requires the tool! Therefore, this bench has no well.

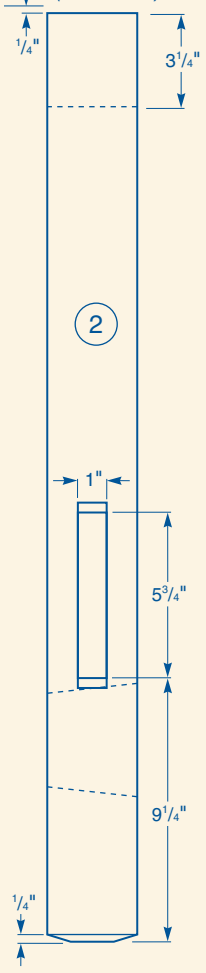
Structure: In the past, benchtops were made of two or three thick slabs of readily available quarter-sawn hardwood: maple in the U.S., beech in

Workbench Exploded View





Leg
(Side View)



Bench Stop
(Front View)

Mount the stop to the leg so the end is flush with the top of the workbench when the stop is at its lowest point.

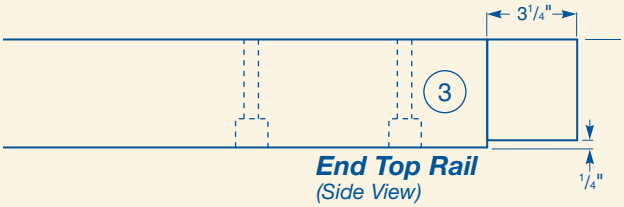
MATERIAL LIST – *Workbench*

		T x W x L
1	Benchtop Laminations (16)	1¾" x 2¾" x 60"
2	Legs (4)	3⅛" x 3⅛" x 32¼"
3	End Top Rails* (2)	1⅞" x 3¾" x 23½"
4	End Bottom Rails* (2)	1⅞" x 3¾" x 23½"
5	Long Rails** (2)	1⅞" x 3¾" x 50"
6	Long Rail Blocks (4)	1⅞" x 2½" x 11⅜"
7	Wedges (16)	Cut to fit
8	Bench Stop (1)	1⅜" x 3⅛" x 12"
9	Vise Cheeks (2)	1" x 4¼" x 14"
10	Vise Spacer Block (1)	1½" x 5½" x 10"

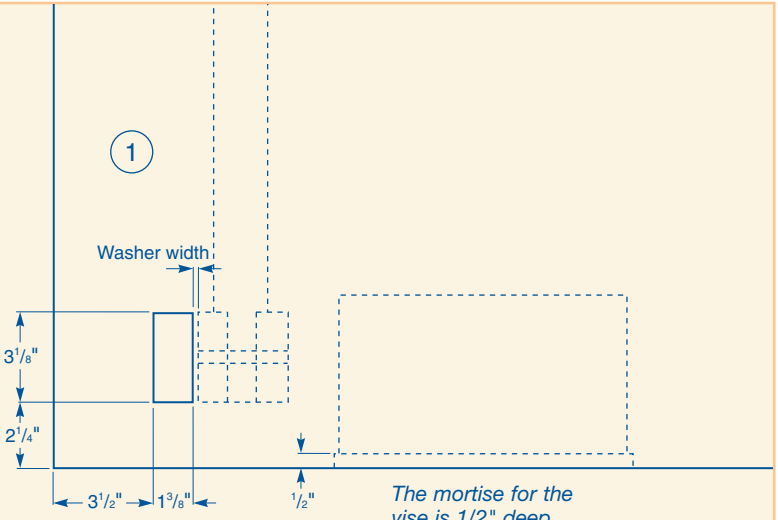
**Distance between shoulders is 17".*
***Distance between shoulders is 43½".*
Note: Cut the rails slightly long and trim flush with legs after glue-up.

Wedge
(Side View)

The wedges are custom-fit to each tenon. See the sidebar on page 17 for details.

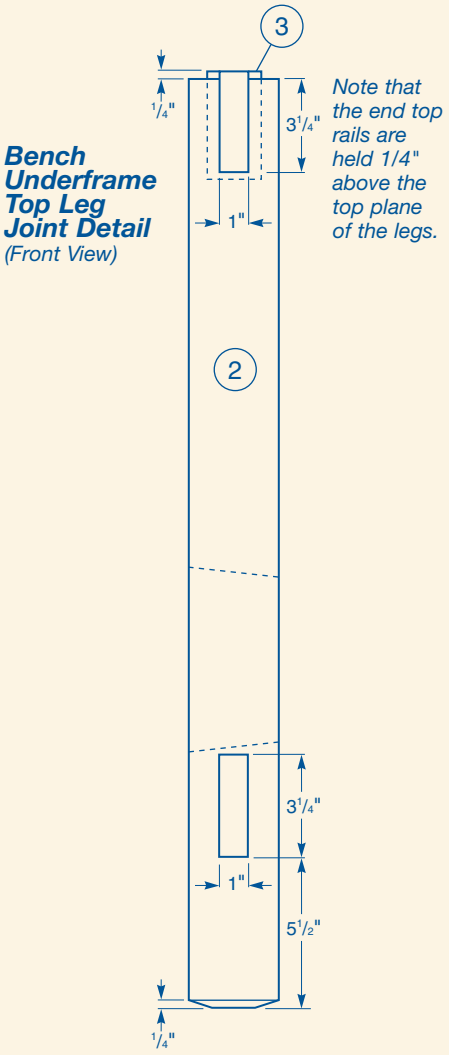


End Top Rail
(Side View)



Workbench Top
(Top View)

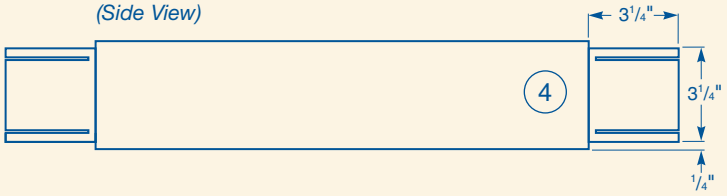
The mortise for the vise is 1/2" deep. The spacer block is mounted right behind the mortise.



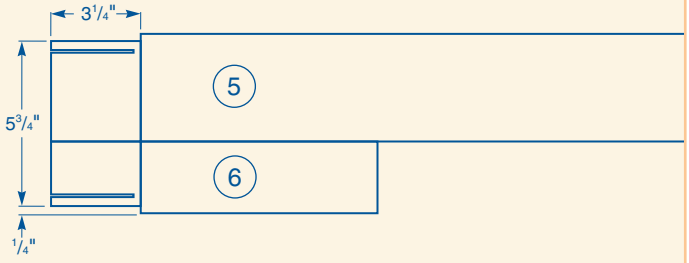
Bench Underframe Top Leg Joint Detail
(Front View)

Note that the end top rails are held 1/4" above the top plane of the legs.

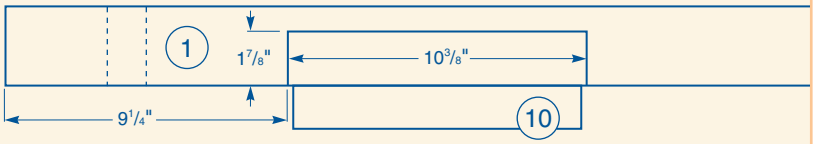
End Bottom Rail
(Side View)



Long Rail and Long Rail Block Assembly
(Side View)



Workbench Top
(Side View)



Europe. Both are light-colored woods that reflect light well and thus greatly help when setting a plane or using a try square. Making fine visual adjustments over a dark bench is like working in a badly lit room. The days of big slabs are gone, so an excellent alternative is to laminate strips of flat-sawn material. Their combined edges then create a "quartersawn" surface. Use 8/4 flat-sawn soft maple 6" wide, sawn down the center, then planed and thick-nessed to yield as big a section as possible. Ian managed 1¾" x 2¾" strips.

Cross-grain planing produces these typical "fold-up" shavings, which are thick in the middle and thin at the edges due to the curve in the plane blade that prevents plane marks. Clearly evident is the glue line that connects the two laminations.

Making the Top

Lay the strips out to choose the best color and grain pattern, then number them for an orderly glue-up. For the bench you see here, 16 strips make the top 28" wide. Gluing this many strips together requires a flat, solid surface on which to work, such as an existing bench or sheet stock supported by battens and sawhorses. Ian used 11 bar clamps, augmented by upwards of a dozen fast-acting clamps to align the edges.

Apply Titebond® II glue with a 3" paint roller. Pressing firmly to wet the surface, roll a light coat on each face. The squeeze-out should show as small beads, not drips. Between jobs, store the roller and tray in a plastic bag, folded over to make an airtight seal. How many strips you glue in one clamp-up depends on whether you work alone or with a helper. The real dividend of a helper is having someone at the other end of the board to lift and shift and at the other end of a clamp to attend to its positioning and other tasks. Working as two, you could begin with as many as six center strips. Working alone, begin with three center strips. Position five clamps equally spaced on the work surface. The remaining six clamps sit on top of the work, spaced between the bottom five. Using fast-acting clamps, align the surface of the laminates by keeping both heads of the clamp centered on the glue line. Also align the ends. After the first glue-up dries, add one strip to each side to allow ample time for precise alignments before the glue cures. By carefully managing the assembly this way, it's possible to make three glue-ups a day: morning, noon, and evening. The more carefully you align each new glue-up, the less you'll have to flatten the top once you're through.

The top is flattened by cross-grain planing. Begin with a 6" to 9" band at one end and flatten band-by-band to the other end. The straightedge and winding strips are essential for accuracy, and the bench brush ensures cleanliness.

Flattening the Top

Make the top flat by planing across the grain. This may seem counterintuitive, but it's the best way to remove the slight but inevitable unevenness in the laminations. As well, all woods plane well across the grain with minimal tearout. It's important to follow a planing pattern. Begin at one end and concentrate on a band 6" to 9" wide. Move to the next band as flattening occurs. After flattening the final band at the other end of the top, set the blade finer and start again. Use your straightedge from the very beginning and check every direction. Use a bench brush repeatedly to avoid planing over shavings. And keep the blade sharp. As the surface becomes more refined and the depth of cut is reduced, the shavings become like duck down and the planed surface is left very smooth. Don't sand the benchtop because the residual abrasive grit will dull your blade after only a few plane strokes when the

Locate the numbers so they are undisturbed when the joints are cut. The numbers read clockwise and are marked on the side where the long rails meet the legs. The arrows point to where the short rails meet the legs.

occasional re-flattening is required.

The top must be flat in length, flat in width, and out of winding. Use a two-foot straightedge to check your flattening progress at close intervals across the top. Use a long bar level to assess the flatness of the overall length. Check the top with winding strips end to end, middle to end, and across the top to make sure there is no twist.

The maple bench stop is a sliding fit through a hole in the top and is anchored to a leg of the underframe by a coach bolt. A wingnut on the bolt allows for easy locking of the stop at the desired height. You will need to chop the hole in the top to accommodate this feature.

Designing the Underframe

The bench underframe must be sturdy enough to support the mass of the top and any of the work that goes on the top, and it must resist racking when it has to be moved or during bench operations such as planing. Almost any softwood or hardwood will fit the bill. The one shown here is made of mahogany and put together using through-wedged mortise and tenon joints and bridle joints. It calls for legs over 3" square with rails almost 2" thick.

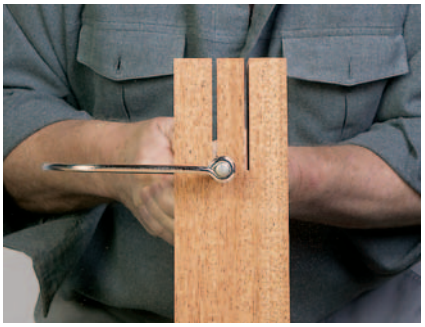
The end frames are sized sufficiently inboard from the edges of the top so that fast-acting clamps can be used all around it. The deliberate absence of a long top rail allows long clamps to pass unimpeded under the top to hold assembled furniture parts firmly to the edge of the bench to be further worked on. The top itself provides the anti-racking benefits of a top rail when it's attached to the underframe.

Attaching the Top to the Underframe

Typically you'll see bench vises attached to benchtops with machine bolts and nuts. This method requires lots of work boring accurate holes and fitting neat wood plugs to cover the bolt heads. Many benches ago, Ian began using lag screws, and his confidence in their lifelong holding power remains firm. On this bench, the top has six lag screws, one in the center of the end top rail and one as far to each edge of the end top rail as is practical. He used 3/8"-diameter lags that extend to within 1/2" of the benchtop surface. The center lags have a 3/8" clearance hole and the four outer ones have a 5/8" clearance hole to allow the top to move unhindered through its expansion and contraction cycles.

Mortise and Tenon Underframe

This underframe uses through mortise and tenon joinery—a typical furniture maker's joint—but on a big enough scale to qualify as post-and-beam construction. Because of its large size, the joint is cut with a mixture of hand and machine tools rather than hand tools alone. There are many ways to achieve the end result and each depends on the machines



Ian removed the waste in the leg's open mortise with a coping saw.

Glue the rail blocks to the long rails and clean up with a smoothing plane.

The rail numbers match the leg numbers. Top rails are marked on the top edge and bottom rails on the bottom edge.

you have available. For example, provided you get the geometry of the joint correct, you may cut the tenons on a band saw. Ian used a table saw.

Making the Underframe

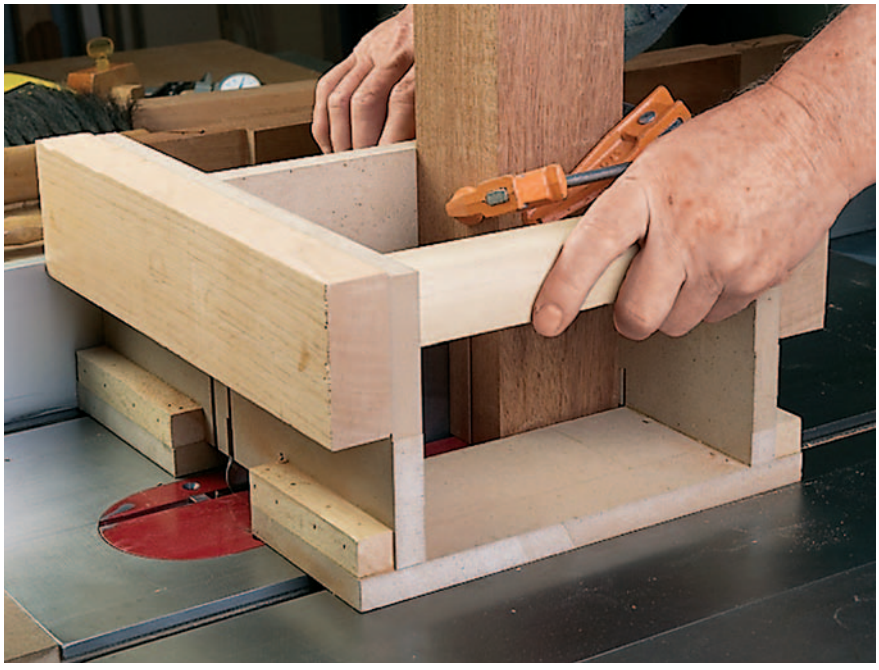
Start off by marking out each joint as though it were to be made by hand. The first thing to do once the parts are milled is to decide on the layout (which parts go where) and mark each part clearly. Use numbers and arrows marked with large with a felt pen. The numbers and arrows tell you the inside faces, which is important to know when you cut the slopes on the ends of the mortises to accommodate the wedges. None of the marks are planed or sanded off after assembly, but they will be hidden. Record them on paper as a precautionary backup.

Mark out the joints with a marking knife, try square and mortise gauge. The top joint doesn't have a unique name. It's a variation on a bridle joint which in the U.S. is often called an "open mortise and tenon." The top edge of the rail sits proud of the top end of the leg by 1/4" to avoid the following problem: If the leg and rail are made flush and shrinkage in the rail occurs after the top rail is attached, the ends of the legs would be proud of the rail. The shrunken rail would then pull the top into a cupped or curved state.

The bottom edge of the joint has a 1/4" cosmetic shoulder. Ian coins the word "cosmetic" here because the main purpose of the shoulder is to hide shrinkage and to cover any less-than-perfect edge you may have made on the bridle opening. Both parts of the joint can be cut on the table saw.

Cutting the Leg and Rail Joints

Cut the leg mortises first in the tenoning jig shown in the *photos*. In each case, the rectangular peg and the rectangular hole are centered, so after you cut one side, turn the part around and cut the other side. This procedure can only produce cuts that are correct and alike if the parts have exactly the same thickness. That's why careful preparation of your stock is so important. Clean up the bottom of the joint with a chisel. Cut from each side shoulder line to leave a mound in the middle. Once you have established both shoulder lines, remove the mound by horizontal paring. The jig is guided by the fence and advanced by your hands, safely distant from the saw blade. The fence controls the setting. To effect a slight adjustment when setting up the cut, slacken the fence locking handle, then lightly tap the fence with a hammer. Because the saw is set at full height, it would cut deeply into the jig, so glue on a couple of thick bridge pieces front and back to stiffen its structure (see *photo*, below). Because the rail thickness differs from the leg thickness, you must change the set-



Clamp a rail square and upright in a beefed-up shop made tenoning jig. The jig guides the cut and keeps your hands safe during the operation.

tings. However, the tenon is centered on the rail, so this setting stays unchanged. Turn the workpiece around to make the second cut. The tenon should fit tight.

Offer the uncut rail to the completed leg part of the joint and assess how close you need to be to the mortise gauge line. Set the blade only 1/2" high. Set the work in the tenoning jig so the cut will err on the rich side. Saw both faces. Clamp the work in the miter gauge and set the blade to the correct height to remove the newly cut face. Now test the 1/2" stub tenon against the mortise. If the tenon is too rich, release the fence lock handle halfway, adjust the fence with hammer taps, and re-test the setup.

Because the rail is too wide to fit inside the tenoning jig, it's mounted instead on the outside at the front. Although you can cut shoulder lines directly from the saw, getting consistent results on every piece is risky business. Take the slower but surer route: knife shoulder lines, saw within a 1/16", and clean up with a wide chisel.

A block clamped in place on the front of the jig positions the rail to cut the cosmetic shoulder and avoids sawing into the jig.

Making Mortise and Tenon Joints

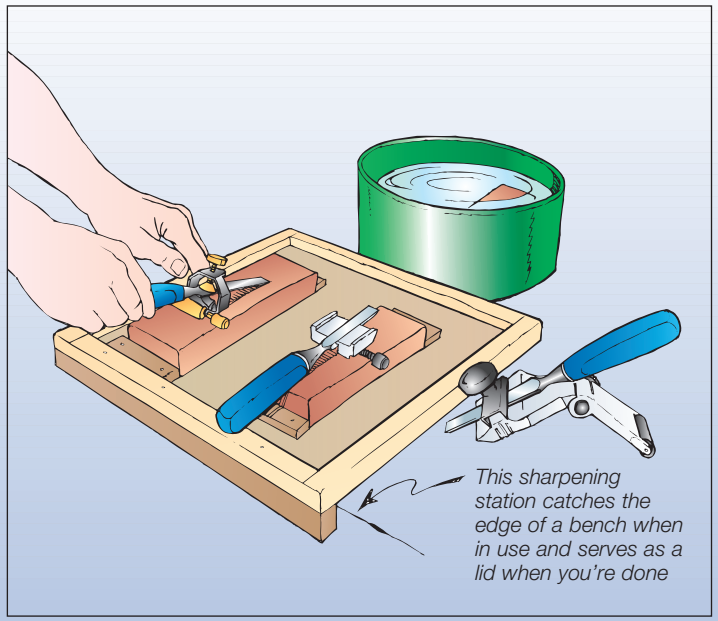
The normal order of cutting a mortise and tenon by hand or machine is to cut the mortise first, because it's easier to adjust the tenon thickness to match the mortise width than vice versa.

Cutting the tenons on the bottom end rail employs the same jig and technique as cutting the tenon on the bridle joint, with the difference that there is a cosmetic shoulder on all edges and saw kerfs for the wedges. Cut the tenons now.

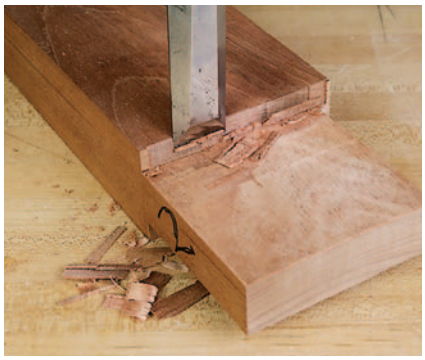
QuickTip

Sharpening Station

You'll be more likely to sharpen chisels and plane irons when they need it if you have a sharpening station. Begin by cutting 6" off the bottom of a 5-gallon bucket and use this to keep your stones immersed in water or oil. Cut a 20" square plywood base and rout a circular groove in the bottom to turn it into a lid for the bucket. Nail strips of wood around the top so water or oil won't escape while you work. Nail a small strip at either end of each stone to hold them when they're not immersed and a final strip under the front edge to catch the edge of your bench; this will hold the station steady as you sharpen because the lid won't slip when you push on the stones.



This sharpening station catches the edge of a bench when in use and serves as a lid when you're done



Slower is surer: knife the shoulder lines and clean up with a wide and sharp chisel.

Making the Mortises

Only the final walls of the mortise are cut with a router. Why? To avoid the excess dust that routers create. The answer is to remove as much waste as possible by drilling. Your first bit choice would likely be a Forstner. However, not being good at removing its own waste, Forstners tend to choke and burn. Instead, use a spade bit. It makes a clean hole, even in very hard wood—but it does have its foibles. The trouble comes when you stop drilling to withdraw the bit. Being rarely concentric, the emerging bit can quickly make a mess of a clean hole, along with an alarming amount of vibration and noise. The solution is to clamp the work for each new hole, drill deep enough until the point just breaks through the bottom face, switch off the machine with the bit at the bottom of the hole, and then withdraw the bit when it stops. Result: a perfect hole. By clamping the workpiece, the hand that would normally hold it is free to safely hit the off switch while the hand on the drill press handle holds the bit at full depth.

The next step is to remove the fluted walls. Use a 1-inch chisel, being careful not to cut beyond the outer edges of the holes.

The remaining waste is removed by two router bits: a pattern bit (bearing on the shank) and a trim bit (bearing on the tip). The jig is an exact rectangle cut into 1/4" MDF. Clamp the jig in place and clean up the sides of the mortise with the 1"-long pattern bit. Turn the leg over, clamp the jig from the same face, and rout again. Remove the jig, set the trim bit to depth, and clean out the waste remaining in the center.

Cutting the Ends of the Mortises

Knife the lines for the wedge openings on the outer faces of the legs. Notice that you'll wedge out the longer rail joint 5/16" and the end rail joint 1/4". By drawing both joints full-size you can determine the gradient and make guide blocks (see top *photos*, next page) to direct the chisels in cutting the slopes. Whenever paring or chopping a workpiece held in a vise, rest it on support blocks that sit on the vise guide bars. This frees you from tightening the vise to resist downward pressure from paring cuts and mallet blows, and it's easy to return the work to level and height after checking.

Making the Tenons

The bottom rail tenons are made in the same way as the "open tenons." Begin by offering the tenon piece to the

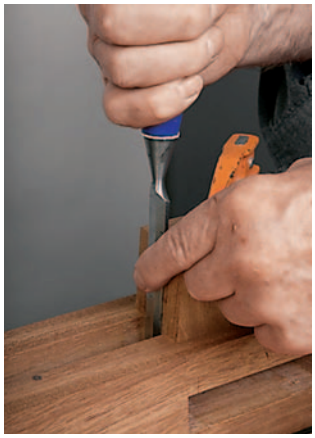
Use a 7/8" spade bit on-center to leave 1/16" of waste on each mortise wall.

Clean up the mortise with jig-guided router bits. The insert (left) lets you cut two sizes with the same jig.

QuickTip

Ideal Climate for Finishing

According to finishing specialist Jerry TerHark, there are three rules for finishing: the room should be 72°, the finish should be 72° and the wood should be 72°. Kidding aside, the main thing is to have these three components the same temperature, close to 72°.



Put the leg in the vise on a support block and chop out the bulk of the waste using a mortise chisel (above left). Then complete the cut (above right) by pressing a sharp bench chisel tight against the face of the angled guide block.

newly cut mortise and decide how close you should cut to the mortise gauge line. Make a 1/2" or so depth of cut, saw some temporary shoulders, and test this stub tenon in the mortise. Adjust the cut as necessary and cut the finish tenons: faces, shoulders, and cosmetic shoulders. Next, saw the kerfs for the wedges. Use a 3/32" blade set 1/4" from the edge and ending 1/4" short of the shoulder line. (The wedge kerfs are made using the same jig setup that was used for the cosmetic shoulders.) The long rail tenon is too heavy and too tall to stand upright in the tenoning jig. Use a 3/4" dado head and make multiple passes across each face. Clamp the work to your miter fence and make a trial cut from both sides about 5/8" from the end. Check this stub tenon in a mortise, adjust the blade height as necessary, and complete the cut. The cosmetic shoulders and the wedge kerfs are made by sawing down the tenon as in ripping, then cleaning up the curved-out bottom with a back saw or narrow chisel.

Completing the Final Details

Sawing the Leg Ends: Form four standing pads so the leg ends won't break out at the bottom edges when the bench is dragged across the shop floor.

Holes for the Lag Screws: Use 4½" lag screws to hold the top to the underframe. Drill 1⅛" counterbore holes in the top end rail to recess the heads. The two center clearance holes are 3/8" and the four outside clearances holes are 5/8" to allow the top to shrink and expand.

MAKING THE WEDGES

Place a wide maple board, 4" long, on support blocks in the vise and plane across the grain to dimension.

The next step is to check the fit of the wedge blank in your mortise.

When testing the wedge for fit, don't drive it home! You should be able to see that the length and slope will correctly fit the kerf and opening.

Clamp the blank to the miter gauge fence set at the correct angle and saw a wedge with a 3/32" blunt end. You need a second miter fence set to 90° to saw a second wedge.

A successful mortise and tenon glue-up requires thorough wetting of all surfaces. Use a small paint roller for the tenons and a piece of scrap for spreading glue in the mortises. Dry-clamp every assembly (left) to confirm joint accuracy and the presence of all necessary clamps and protection blocks.

Assembling the End Frames

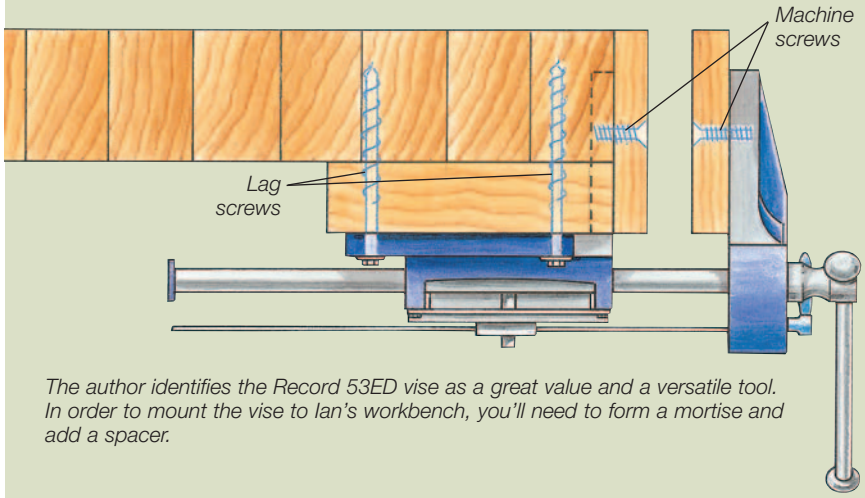
Once the end frame parts are made and ready to assemble, wipe an oil finish on the rails and the inside faces of the legs. Finishing at this early stage allows glue squeeze-out to dry on the shoulder line. Clear it away with a sharp chisel and the result is a clean, clear surface and joint line. Begin by clamping the end frame dry. This obliges you to get all the necessary clamps and protection blocks in place. No matter how long-winded the dry clamp-up seems, it's a vital step toward a successful glue-up. Put the parts together dry and check for square, twist and alignment. Then glue, clamp and drive in the wedges. Now that the end frames are complete, use the same steps to complete the underframe.

You'll need to mount the vise to the top, as described on the next page, before your work is done. Attach the bench stop to its leg and engage it as you mount the top to the underframe.

Clean up and oil all the unfinished areas. Now you are ready to put this essential tool to work in your shop—and to show off your handiwork too.

Close the shoulders using two bar clamps. Check that the top ends of the legs are as far apart as the distance between shoulders. Drive the two wedges, alternating the hammer blows. The hammer will bounce and the note changes when the wedge is firmly home. When the glue has cured, saw off the excess wedge and then clean the joint up with a plane.

INSTALLING THE VISE



The author identifies the Record 53ED vise as a great value and a versatile tool. In order to mount the vise to Ian's workbench, you'll need to form a mortise and add a spacer.

Begin the vise installation by clamping the pattern jig against the benchtop for routing the vise mortise.

Hang the vise with the top turned upside-down. (The mounting bolts are on an older bench, before Ian used lag screws.)

Make the fixed cheek square with the benchtop (left). A clamped workpiece should be square (center) with the top and vise cheeks parallel (right).

Value for price, the Record 53ED is the best woodworking tool investment there is. The jaws of Model 53ED are 10½" wide and open to 13". Remove the metal dog, which is intended for use when the vise is mounted at the end of a benchtop with a series of lengthwise dog holes. English hand tool woodworkers did not clamp work this way. Using the vise dog on a side-mounted vise against an opposing dog could split the benchtop in two. The metal jaws each have two 1/4" holes so that wood cheeks can be bolted in place. Later models no longer come with threaded holes, so you will need to thread your own with a 5/16" x 20 tap. Then drill and countersink the wood cheeks to accept 5/16" x 1¼" flathead machine screws. A quick-release trigger disengages the screw so that work can be held in one hand while the vise is quickly adjusted. The trigger turns a bar that lifts a half nut in the fixed jaw casting. The half nut is held in place by a metal plate that is fixed to the casting with two 1/4" bolts. Lock them down tight when you get the vise, and that is about all you'll ever have to do other than keeping the bars and buttress thread clean and lightly oiled.

Because the jaw is deeper than the bench is thick, you must fill the gap with a spacer block. The block must be thick enough to leave a gap of up to 1/8" between the top edge of the fixed jaw and the mortise it sits in. If you make the top edge tight, the spacer block could compress enough when you tighten the lag screws to break out the strip of benchtop above the fixed jaw. The side edges of the jaw should fit tightly in the mortise.

Hang the vise 9" to 10" from the working end of the top and clear of the underframe. You can mark out and cut the jaw mortise by hand or use a router, 1/2"-diameter pattern bit and a pattern jig. Clamp the jig into position, locating the opening with a batten screwed to the back of the jig that puts it 5/8" from the top edge of the bench. Stand the top on edge. Prepare eight spacer strips 1/4" x 1/4" x 20" and stand them all on edge against the fence at the top of the jig. Set the router bit to full depth and ride the router base against the strips to make a cut 1/4" wide. Remove a strip each time you make a cut. On the final pass the pattern bit bearing rides against the jig.

Hold the vise in place with clamps and blocks. The jaws are thinner at the top edge than the bottom. You want the metal face flush with the bench or a whisker below. To compensate for the casting variance, plane the spacer block at an angle so the vise tilts toward the back lag screws. Once the vise is hung, make and attach the wood cheeks, preferably of quartersawn maple or cherry. The lower edges sit 1/2" above the guide bars. Note that the jaws toe in at the top to compensate for the flex in the casting when the vise is under load. As the jaws are tightened, the clamping force is evenly distributed from top to bottom rather than being concentrated where the screw is. The jaws should also come together parallel so the clamping force is evenly distributed side to side. Again, you may have to plane the cheeks to adjust for any distortion in the casting. The toe-in need only be a maximum of 1/8".

— Ian Kirby