COOL TOOLS! — TABLE SAW BLADES FOR PERFECT CUTS

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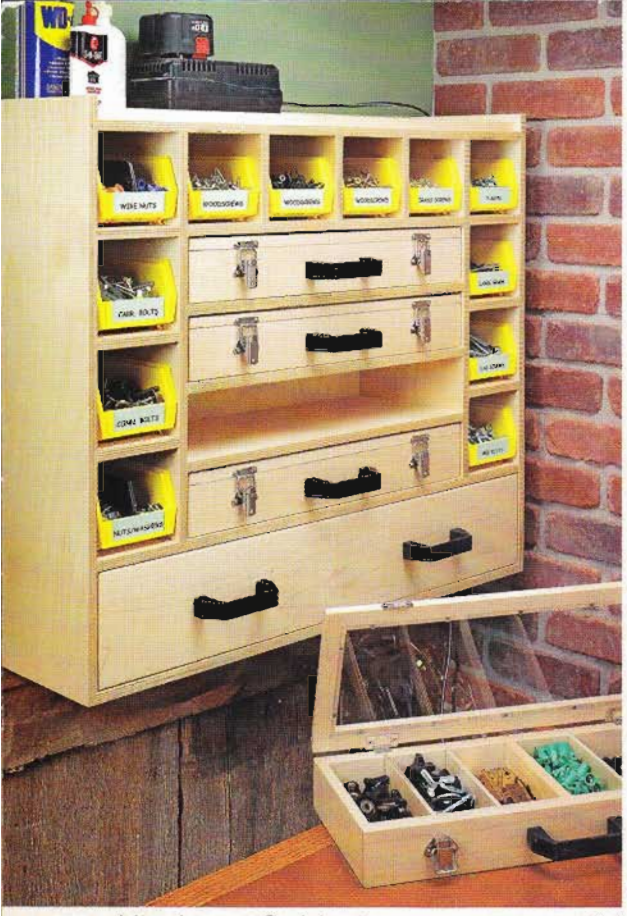

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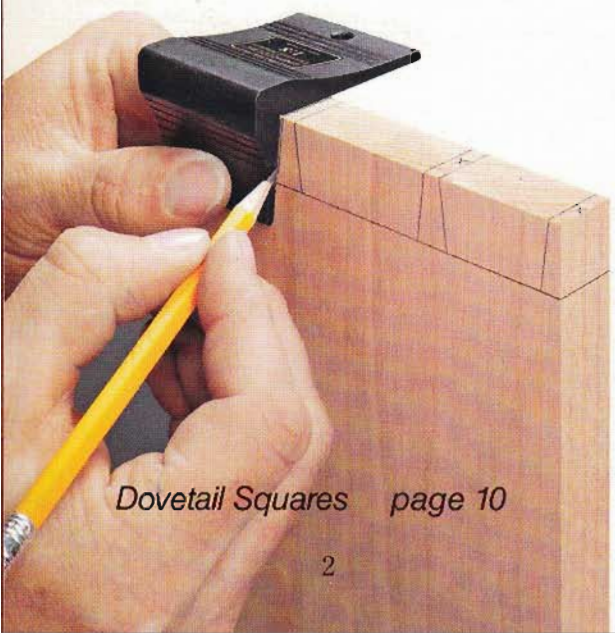

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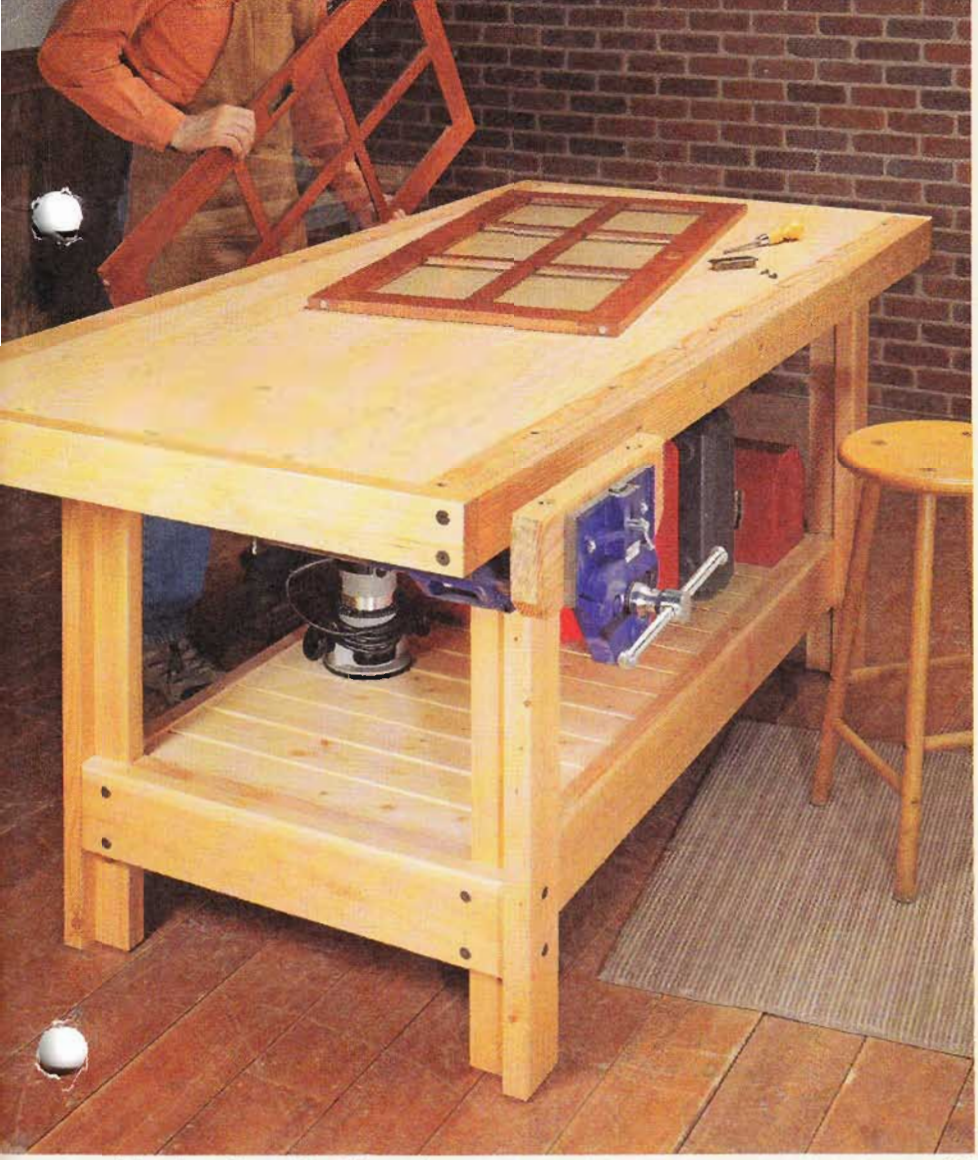

Torsion-Box Workbench *page 12*

Cutoffs

My first workbench was nothing more than a single sheet of plywood screwed to a frame made of 2x4s. It worked fine as a basic workbench and an assembly table. But it wasn't easy to hold a workpiece securely. And honestly, the top sagged a bit over the years. I finally saved up the money and found the time to build a workbench with all the features I was looking for. Unfortunately, it wasn't cheap and it took quite a bit of time.

Well, if time and the cost of materials has caused you to put off building a full-featured "dream" bench, take a look at the workbench at left. This heavy-duty bench really doesn't take all that long to build. Plus, it won't cost you a lot. And, it has everything you need in a bench — a rock-solid base, a large, dead-flat worksurface, and multiple time-tested ways to securely hold a workpiece.

You'll find other projects in this issue that are handy problem solvers, like a hardware storage cabinet (page 24). It's a compact design that organizes and stores an amazing amount of hardware for easy access.

Another project to consider is the mortising jig on page 40. This router jig makes quick work of cutting mortises. You'll find the setup is fast and simple — and the clean, crisp results can't be beat.

So take some time to thumb through the pages of this issue. You're sure to find something that will help you get more out of the time you spend in your shop.

Terry

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This symbol lets you know there's more information available online at ShopNotes.com

from our Readers

Tips for Your Shop

Table Saw Auxiliary Table

As with many small shops, finding adequate worksurface can be a problem. And in my case, I didn't even have room for a router table.

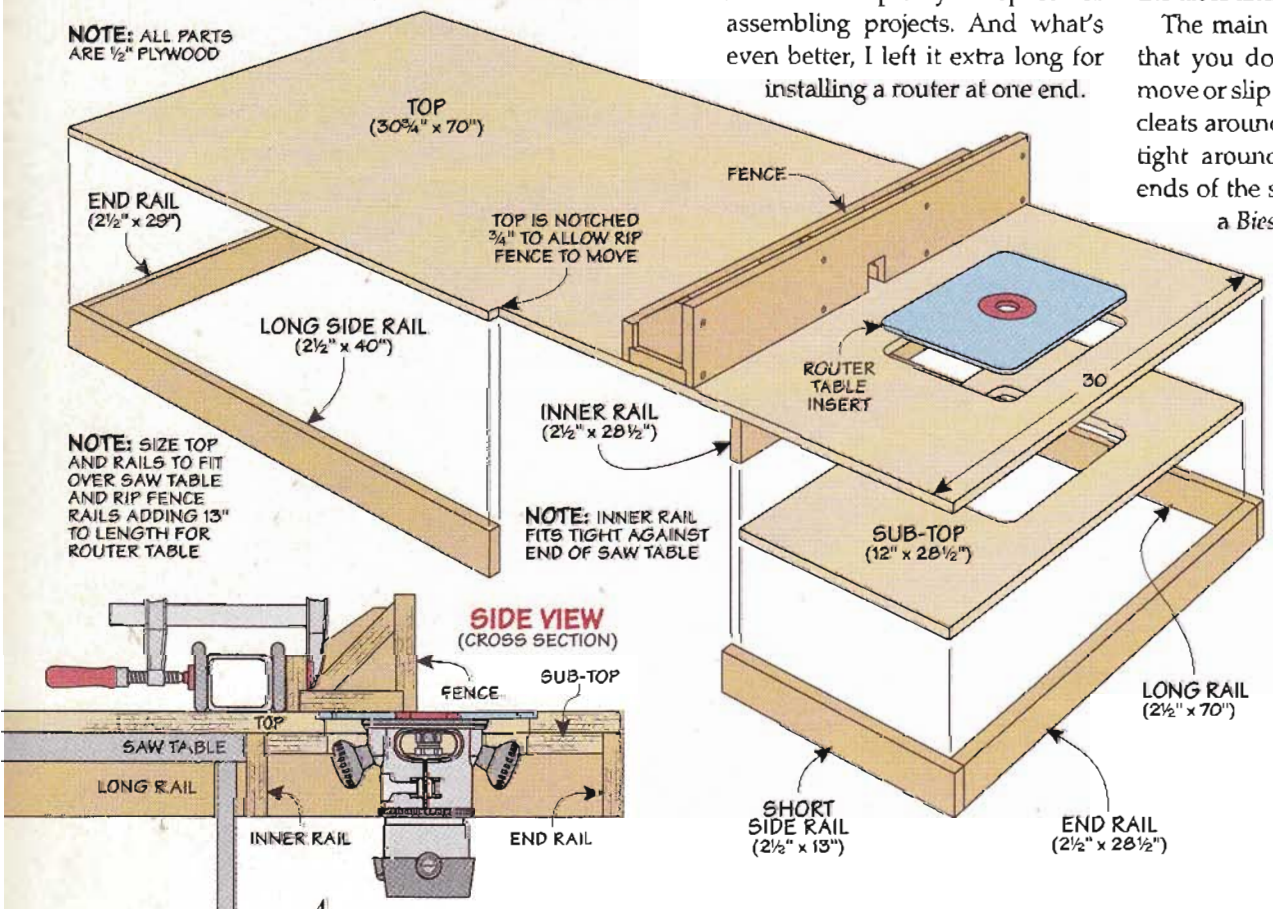
The idea I came up with was to use my table saw. By slipping on the auxiliary table you see above, I now have plenty of space for assembling projects. And what's even better, I left it extra long for installing a router at one end.

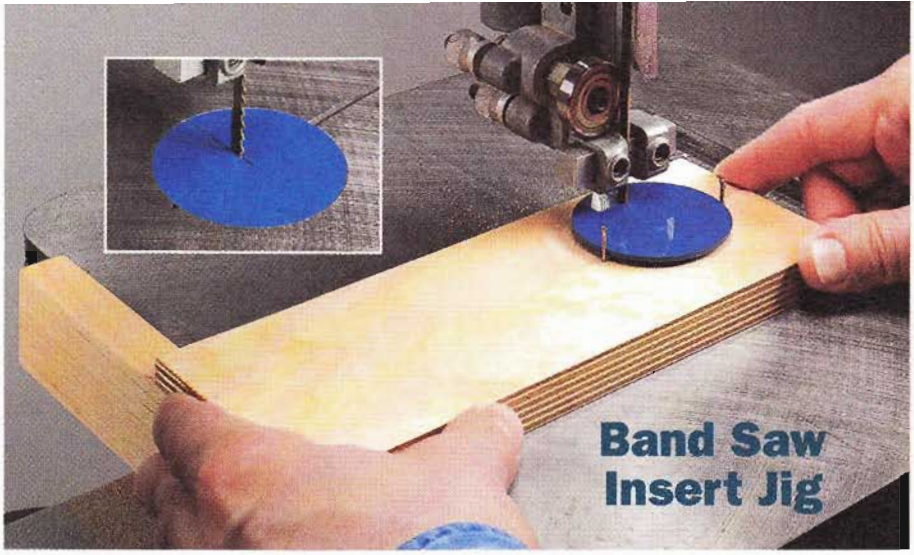
The drawings below show you how it goes together, but you'll probably have to modify the size of the table and rails to fit your saw.

The main point to remember is that you don't want the table to move or slip once it's installed. The cleats around the outside edges fit tight around the fence rails and ends of the saw table. If you have a *Biesemeyer*-style rip fence, make sure the cleats don't interfere with its operation. This way, you can also use the rip fence for attaching and using a simple fence made for the router table.

I created a cutout on the end of the table for a router insert plate. A blank plate covers the cutout to create a smooth worksurface when I'm not using the router.

Raymond Gawlas
Scotia, New York





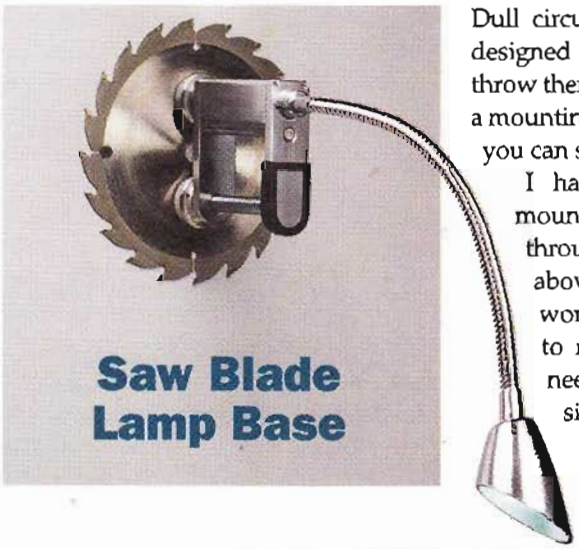
A zero-clearance insert on your band saw provides the same benefits as the one on your table saw. It keeps small pieces from falling through the opening and helps reduce tearout.

The problem is you need to cut a kerf in a new insert before you can install it. The jig you see above is a simple one that does the job accurately.

The jig consists of a plywood base with a cleat at one end. The cleat rides along the edge of the band saw table. (You could also make a version with a miter bar that rides in the miter slot.)

With the cleat against the table, cut a short kerf to use as a guide for aligning the insert. I used a couple of small finish nails to position and hold the insert on the base. Then just cut a kerf about halfway through the diameter of the insert.

Bill Huber
Haslet, Texas



Dull circular saw blades aren't really designed to be sharpened, but I hate to throw them away. Instead, I use them as a mounting base for a magnetic lamp, as you can see on the left.

I have a few of these blades mounted at strategic locations throughout my shop. There's one above the router table, sander, workbench, and on the wall next to my drill press. Now when I need more light on the subject, I simply move the lamp.

Jack Vreeland
Portland, Maine

Submit Your Tips Online!

If you have an original shop tip, we would like to consider publishing it. Go to

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SUBMIT A TIP

There, you'll be able to describe your tip in detail and upload photos or drawings. Or you can mail your tip to the editorial address shown in the right margin. We will pay up to $200 if we publish your tip. And if your tip is selected as the top tip, you'll also receive the *Bosch Impactor* shown on the right.

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Mobile Clamp Rack

During a glueup, the last thing I need is to go hunting for clamps. The clamp cart you see here keeps my clamps organized and nearby. And it couldn't be easier to make with construction-grade lumber, plywood, and some simple hardware. The best part is, it can be customized to store a variety of styles and lengths of clamps.

The drawings below show you all the details. I started by building the base that also serves as a tray to provide additional storage. I used a dado blade to cut a groove in the 2x4s to house the tongue of the plywood bottom (detail 'd'). To complete the base and make the cart mobile, I attached four casters to the underside.

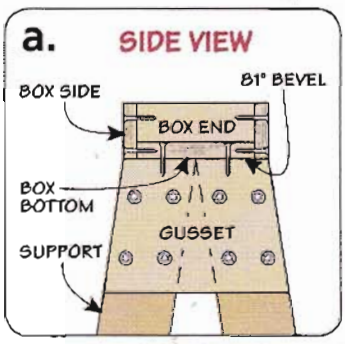
Now you're ready to get started on the A-frame rack that forms the main supporting structure for the clamp cart. I beveled each end of four 2x4s to fit into the tray and form the uprights of the A-frame. A trip to the drill press takes care of the holes that support the metal conduit I used as clamp hangers.

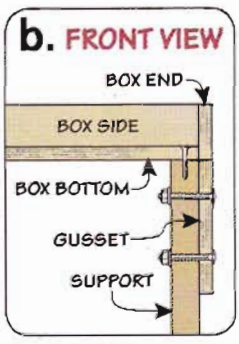
Carriage bolts, washers, and hex nuts secure the uprights into the base tray. I cut plywood to create gussets that reinforce the top of the frame and secured them with carriage bolts, as well.

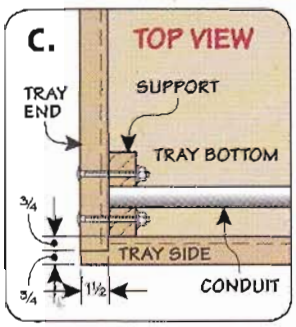
Finally, you can make a handy storage tray at the top of the rack by building a shallow box. (I used 1x3s and plywood.) Then, simply screw the box to the top of the frame.

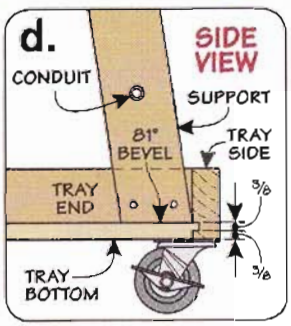
Now all you need to do is cut several lengths of conduit to fit through the uprights and arrange them to suit your clamp collection.

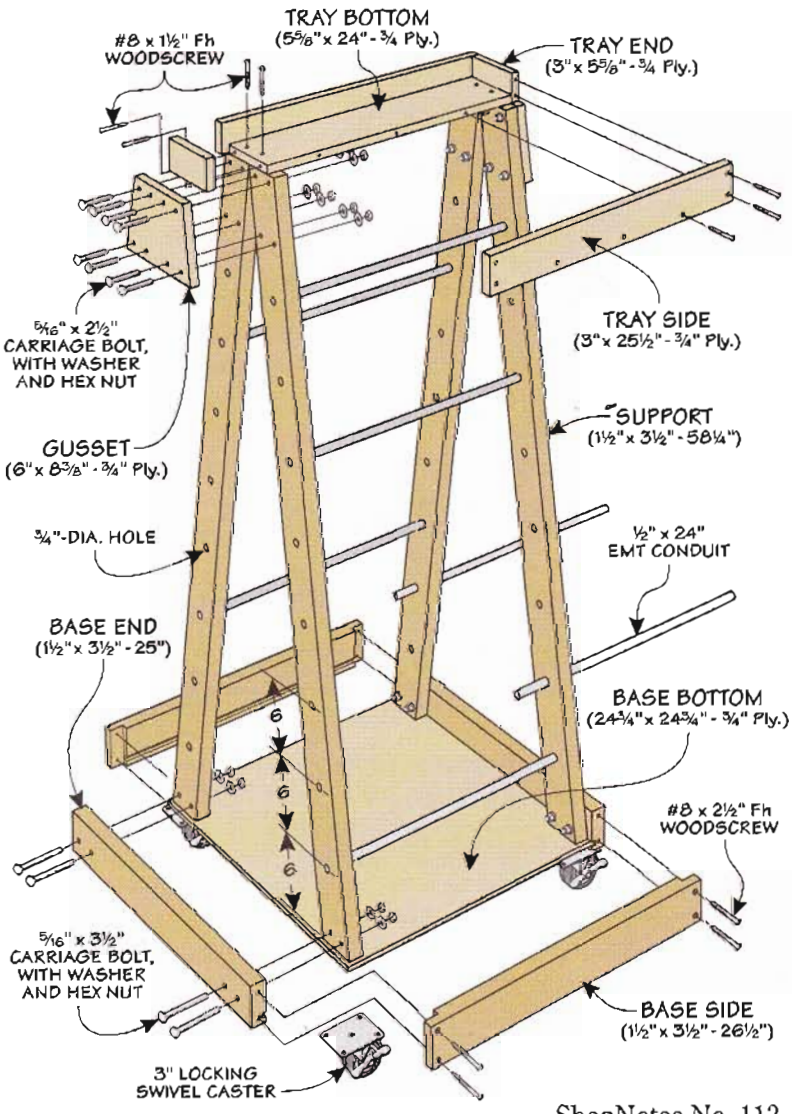
Robert Hoover
Athens, Texas











Tool Tote

The molded plastic boxes that come with portable power tools are great for retail packaging. But I can never get the tool and the accessories back in the box as originally packaged.

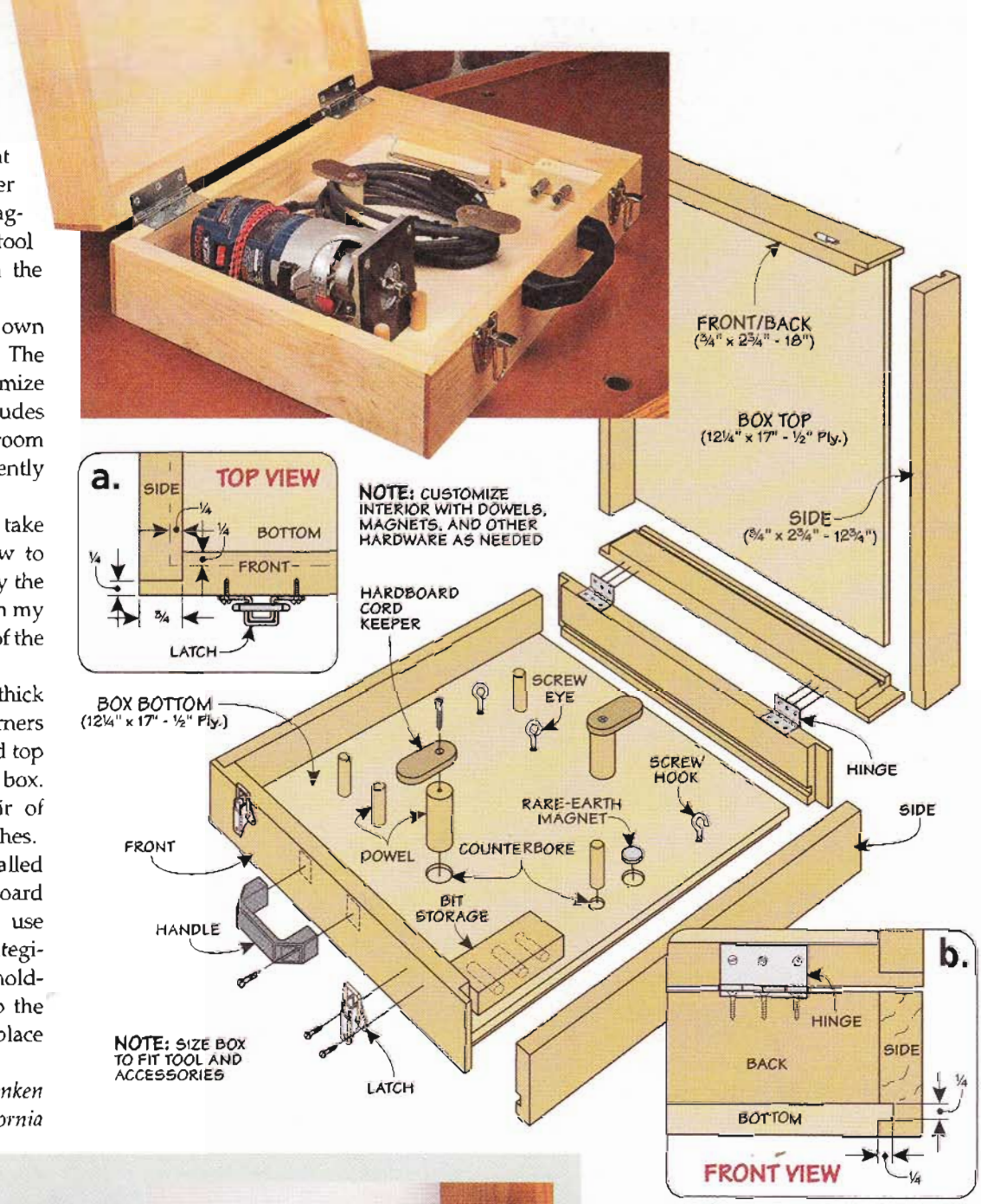
I resorted to building my own storage boxes for each tool. The benefit is that I can customize the box for the tool. This includes organized cord storage and room for any accessories I frequently use with the tool.

Before you build the box, take the time to think about how to organize it on the inside. I lay the tool and its accessories out on my benchtop to give me an idea of the size of box I need.

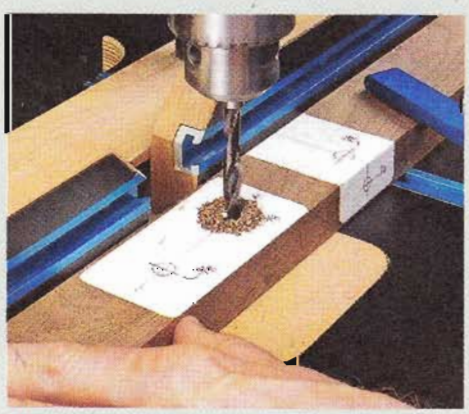
The box starts out with ¾"-thick sides. I used rabbets at the corners for easy assembly. A plywood top and bottom completes the box. Then you can install a pair of hinges, a handle, and the latches.

For cord storage, I installed dowels capped with hardboard "keepers." (You can also use fender washers.) Other strategically placed dowels, custom holders, and a bungee cord keep the tool and the accessories in place while transporting the tool.

Gerald Renken
Carlsbad, California



Quick Tips

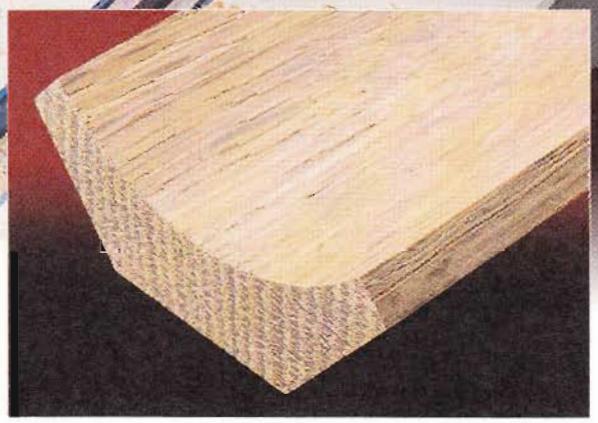


▲ *When working with dark wood, **Len Urban** of Rancho Mirage, California, discovered that printer labels are ideal for layout work. You can buy them in a variety of sizes to suit the task at hand.*

▲ ***Don Ferron** of Spanaway, Washington, found that the rectangular shape of some food containers is perfect for storing shop supplies. They take up less space and make it easy to see the contents.*

fast & easy Crown Molding

Add a distinctive look to your projects with classic trim molding created at the router table.



One way to add a distinctive look to your projects is to use crown molding. It's a great way to dress up your project without a lot of extra work. The style of crown I use most often is just a basic cove molding, like the one shown in the inset photo above.

Router Table. Making this large profile at the router table is a little different than routing other traditional profiles. Most profiles are routed on the edge of a workpiece using bearing-guided bits. Here, the wide, hollowed-out curve of the cove is removed from the face of wide stock with the help of a special bit (main photo).

Later, the outside edges of the stock are beveled on the table saw. This is done so that the molding can be fit and attached between the case and top.

Cove Bits. The router bit I use to make crown molding is a horizontal cove crown molding bit. These bits can be purchased separately or as a set, as shown in the margin photos at left. Each one creates a perfectly shaped cove profile that requires very little clean up afterwards.

The three-piece set includes bits in 1¾", 2½", and 2¾" diameters. The two-flute carbide cutters of these bits do all the heavy work, but there's one important thing to remember. These are large-diameter bits, so be sure to run the router at a relatively slow speed (about 10,000 to 12,000 RPM). The slower speed not only provides a safer cut, it also reduces the chance of the router bit burning the workpiece.

Classic Cove. Another option for routing crown molding is a classic cove bit, like the one shown at far right in the margin. It features a slightly smaller cove profile (as well as a fillet and a small roundover) and comes in a wide variety of diameters.

I find the smaller diameter of these classic bits look best for a lot of the furniture I build. I use just the upper, radius portion of the bit to rout shallow profiles. You'll find sources for all the bits on page 51.

Horizontal Routing. Once you decide on a bit, it's time to take a look at the setup and routing process. As I said earlier, this technique

Woodline USA
Horizontal Cove Crown Molding Bits

Magnate
Large Classic Cove Bit

involves routing the workpiece face down on a router table. And since there's no bearing to guide the bit, you'll need to use a fence. I also like to use a featherboard to keep the molding properly positioned against the fence.

Router Table Setup. Getting the bit set up is pretty simple. The goal is to rout a cove that's centered on the workpiece with a flat area left on each side. Later, you'll complete the shaping of the crown molding at the table saw.

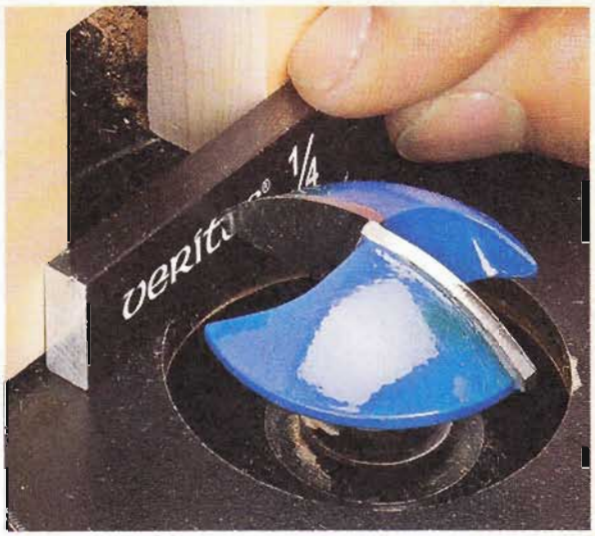
The look you end up with depends on the bit shape, the length of the cutters, and the amount of the profile you use. I often use the full depth of a bit to obtain the widest cove profile possible. But you can get an entirely different look by using more or less of the profile as you see fit.

Just remember, you need a minimum of ¼" flat area on each side for cutting the bevels later. For this, I use a spacer to position the fence on my router table, as you can see in the photo and detail drawings above. (My blank is 2¼" wide.)

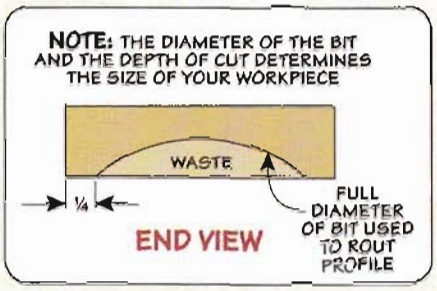
Featherboard. Now all that's left is to use the workpiece to position the featherboard, as shown in the main photo on the previous page. Once that's completed, you're ready to start routing.

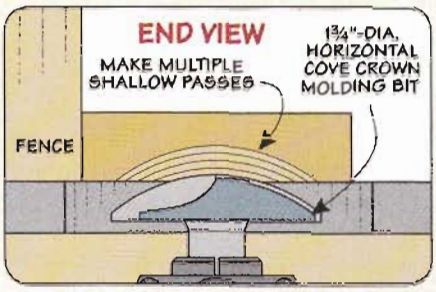
ROUTING TECHNIQUE

The secret to getting clean cuts is to rout the cove using multiple shallow passes. This also puts less strain on your router.



▲ **Setup.** *A setup block makes it easy to position the fence. The goal is to leave at least a ¼"-wide shoulder along each edge after routing the profile.*





For the first pass, raise the bit about 1/16" above the tabletop. Then use a push block to feed the blank over the router bit, while applying downward pressure just in front of the bit (main photo).

There's no need to adjust the fence after each pass. Simply raise the bit slightly and repeat the process, as shown in the lower detail drawing above. On the last pass, take just 1/32" off. This last skim pass lessens the chance of swirls and burn marks, so very little sanding will be necessary.

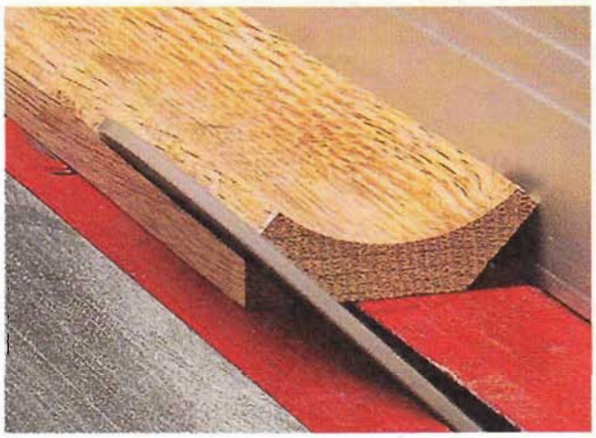
Now that the cove has been routed, you can head to the table saw to complete the profile.

CUT THE BEVELS

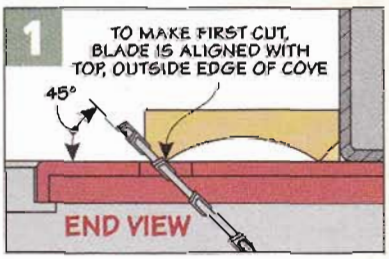
There's a simple, four-step process used to finish up the profile. In the photo and drawings below, you can see the sequence I used.

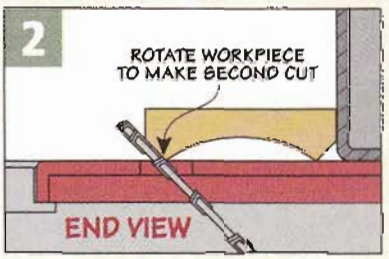
Four Steps. With the saw blade tilted to 45°, place the blank face down. Then set the rip fence so the blade aligns with the edge of the cove (Figure 1). Now you can make the first two bevel cuts, as shown in Figures 1 and 2. Next, flip the workpiece over so the cove is facing up. A couple more passes are all you need to complete the cuts (Figures 3 and 4).

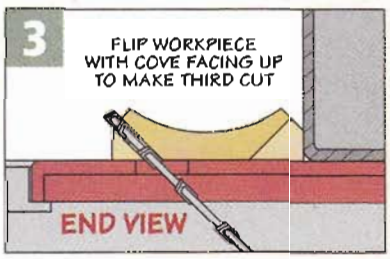
There's no need to settle for plain-looking moldings. Instead, use a horizontal crown molding bit to dress up your next project.

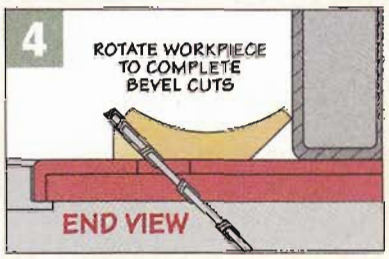


▲ **Elevels.** *Switch to the table saw to complete the crown molding profile. After adjusting the blade to 45° and setting the fence, all it takes are four simple cuts.*



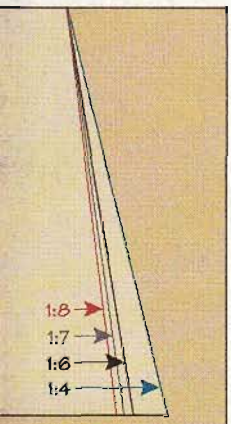






saddle-style Dovetail Squares

Improve the ease and accuracy of your dovetail layouts with one of these dedicated markers.



TYPICAL DOVETAIL RATIOS

Creating handcut dovetails boils down to three steps: layout, cutting to a line, and finally, fine-tuning the fit. Since it all starts with the layout, the more accurately you complete this step, the better your dovetails will be in the end.

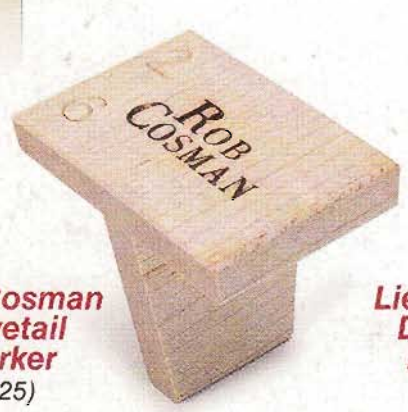
To improve the ease and accuracy of laying out your dovetails, you may want to consider using a dedicated dovetail "square," or marker. The saddle-style dovetail markers you see here allow you to lay out both the end and face lines in one quick and easy step. Since these markers are small, they're less cumbersome than switching back and forth between a large square and a bevel gauge. So it's a better way to more accurate layouts.

The nice thing is they aren't very expensive. They range in price from $13 to $35. There's even a pivoting, solid brass model ($60) you can read more about in the box on the opposite page.

Dovetail Angles. There's one thing I want to mention here. You'll need to decide what dovetail angle you plan to use for projects. The angles for the dovetail squares featured here are most often expressed as a ratio or slope.

These ratios are typically 1:7 or 1:8 for dovetails in hardwoods and a 1:6 ratio for softwoods. There's even one dovetail square available with a 1:4 ratio (14°). This steeper ratio helps provide a stronger mechanical lock and a more pleasing look in thin stock. To see a comparison of the difference in dovetail angles, check out the drawing at left.

Now keep in mind, there's really no right answer when it comes to dovetail angles. You need to select one that looks right to your eye and the projects you build.



Rob Cosman Dovetail Marker ($25)

Lie-Nielsen Dovetail Marker ($35)

Traditional Squares. If you take a look at the two dovetail squares at the bottom of the opposite page, you'll see what I would call traditional dovetail saddle squares.

The *Rob Cosman Dovetail Marker* is as basic as it comes. Made from solid maple, the two dovetail angles (1:6 and 1:7) are hand planed for accuracy. It's comfortable to use and the warm feel of the material can't be beat.

Like the *Cosman* marker, the dovetail marker from *Lie-Nielsen* is set up for both 1:6 and 1:7 layout ratios. But instead of a single piece of hardwood, *Lie-Nielsen* uses a piece of brass screwed to a cocobolo support. It actually looks so nice I was almost afraid to use it.

To use the *Cosman* or *Lie-Nielsen*, you mark the end and one side of a workpiece for the tails (or pins). You then flip the marker around, check the position, and mark the second side of the joint.

There is a downside to these markers. You run the risk of cutting into the wood part of the marker if you like to use a marking knife for layout tasks.

Precision Dovetail Template. The dovetail marker from *Woodjoy* you see at the lower left is quite similar to the *Cosman* and *Lie-Nielsen* markers. But there aren't any wood components. It's an all-metal design, so it's sure to last. The template screwed to the brass base is designed with both 1:6 and 1:8 dovetail ratios.

Unlike the first two markers, after you lay out one side of the dovetail, you simply slide the square over and lay out the other side. Plus, this marker has a low profile, which makes it handy to carry around in your apron.

Designed for One. Although laying out dovetails with one of the *Veritas* dovetail markers shown above is similar to the *Woodjoy*, the design is quite a bit different. Instead of a T-shape with two different dovetail angles available for layout, each marker is dedicated to a single angle.

Veritas Dovetail Markers
($13 each)

You can buy the squares individually in a 1:6 ratio for softwoods, 1:8 for hardwoods, and a 14° dovetail angle (1:4 ratio) for use in thinner material. (The 1:6 and 1:8 dovetail markers can be purchased as a set.) These right-angle designs are made from anodized aluminum, so they're light and durable.

Any one (or two) of these dovetail squares would be a great addition to your collection of layout tools. They're accurate and easy to use. And a dedicated dovetail square makes the process of creating hand-cut dovetails less of a hassle by simplifying the layout task.

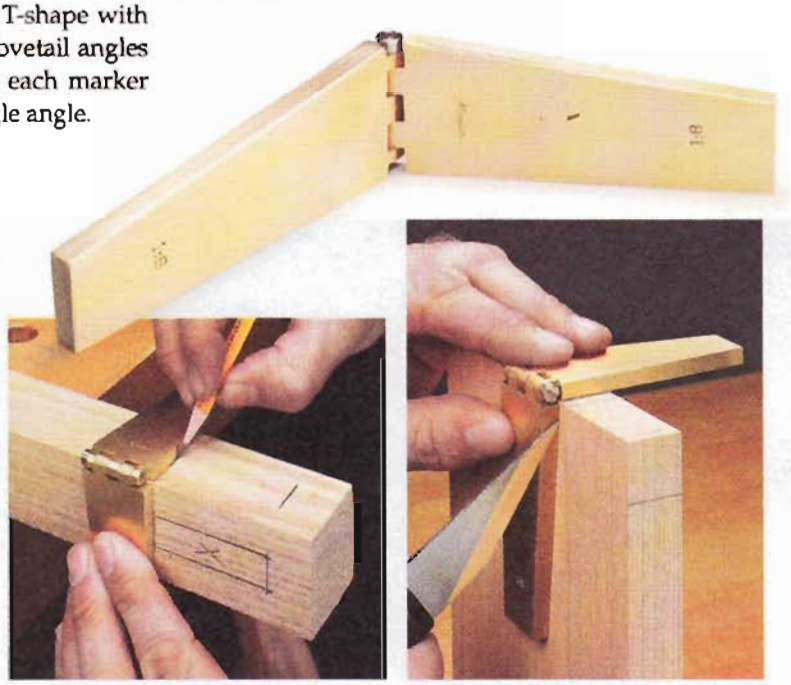
Woodjoy Dovetail Template
($25)

woodjoy's Saddle Square

The *Woodjoy* dovetail marker you see at the upper right is designed a little differently than the others. Instead of being, the legs are hinged together.

One side of each leg is tapered to match either a 1:6 or 1:8 ratio for laying out dovetails. The other two edges of the legs are square, making it easy to mark straight lines around adjacent sides of a workpiece (photo at right).

Unfortunately, this setup doesn't allow you to "wrap around" the edge of a workpiece to lay out one side of the dovetail at once. To solve this problem, I reassembled the square, mating one straight side with one of the tapered sides. I found the machining accurate enough that I could lay out dovetails in one step (far right photo.)



▲ ***90° Transfers.*** *Marking adjacent sides of a workpiece is a snap using the straight edges.*

▲ ***One Step.*** *You can reassemble the square to work like a typical dovetail saddle square.*

torsion box Workbench

Flat, stable, and strong — you get it all with this unique bench that stands up to any task.

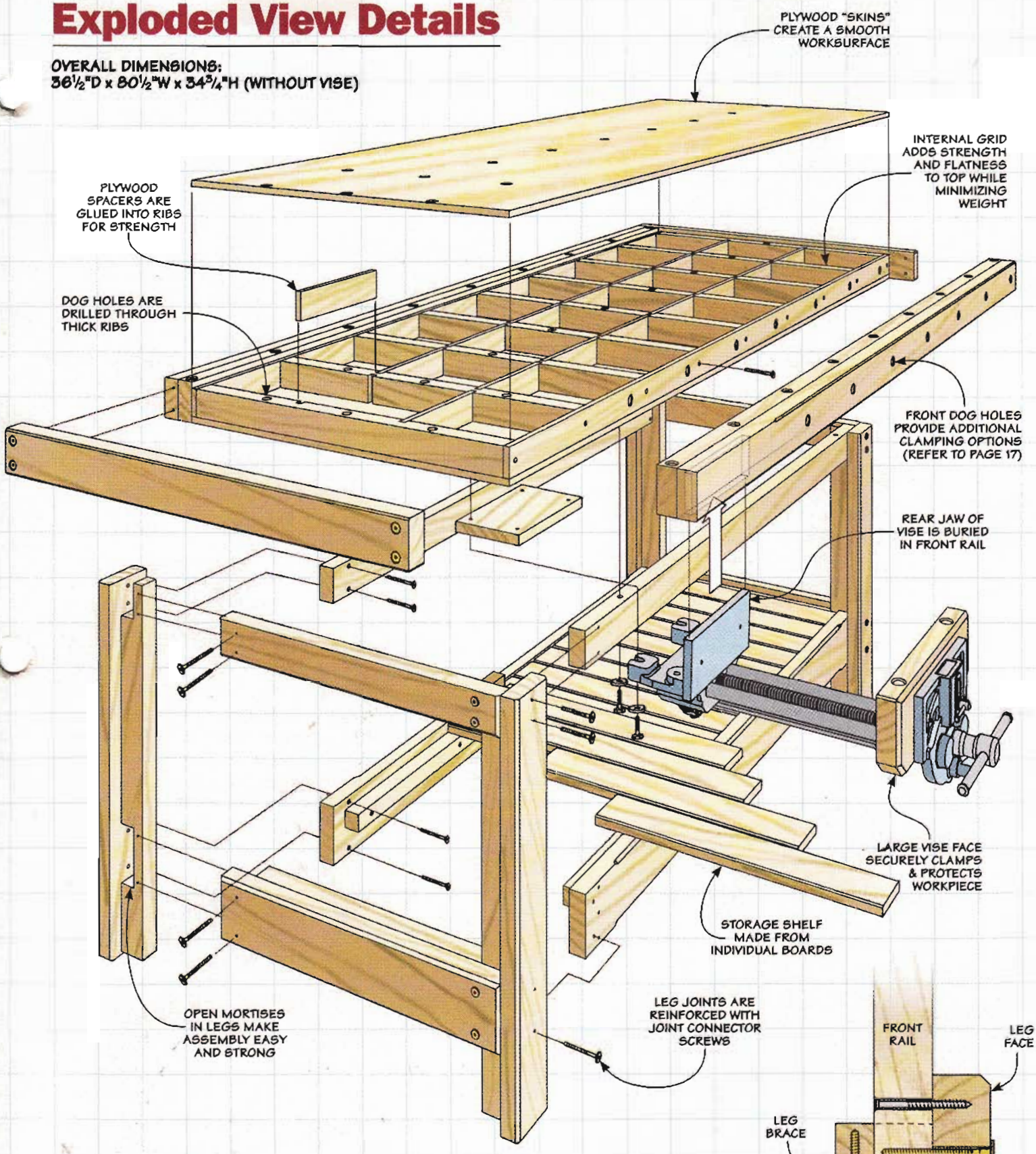
A good bench really has some pretty stiff requirements if you think about it. For starters, it has to be stable so it doesn't wobble or scoot across the floor. And it needs to be flat so a workpiece — and your project — ends up straight and square.

This workbench has all that and more. But it departs a little from traditional design. Instead of having a conventional, solid top, this benchtop is a torsion box.

You can see what I mean in the drawing on the next page. It consists of grid sandwiched between a plywood top and bottom. It's a proven construction method that's strong, yet easy and inexpensive to build. (You can learn more about torsion boxes on page 19.) But the best thing is, this project brings with it all of the characteristics you want in a good workbench — low cost, strength, and stability.

Exploded View Details

OVERALL DIMENSIONS:
36½"D x 80½"W x 34¾"H (WITHOUT VISE)



BASE CORNER
(TOP VIEW)

ShopNotes GO ONLINE EXTRAS

To download a cutting diagram and 3-D model, go to: ShopNotes.com

strong & sturdy

Base

What makes this workbench different from others is its torsion box top. But as you can see in the drawings here, even the base is a departure from conventional design. Instead of large, solid legs, these legs are T-shaped. The front face joins a notched brace piece. This makes it easy to form the open mortises that lock the rails in place to form the base of the bench.

LEGS

The first thing to get started on is the legs. The face of each leg is cut to size and chamfered on all but the top and back edges. Next, you'll need to drill a few holes for screws. Joint connector screws add a decorative touch and their deep threads and large heads make for a strong connection (Figure 1b).

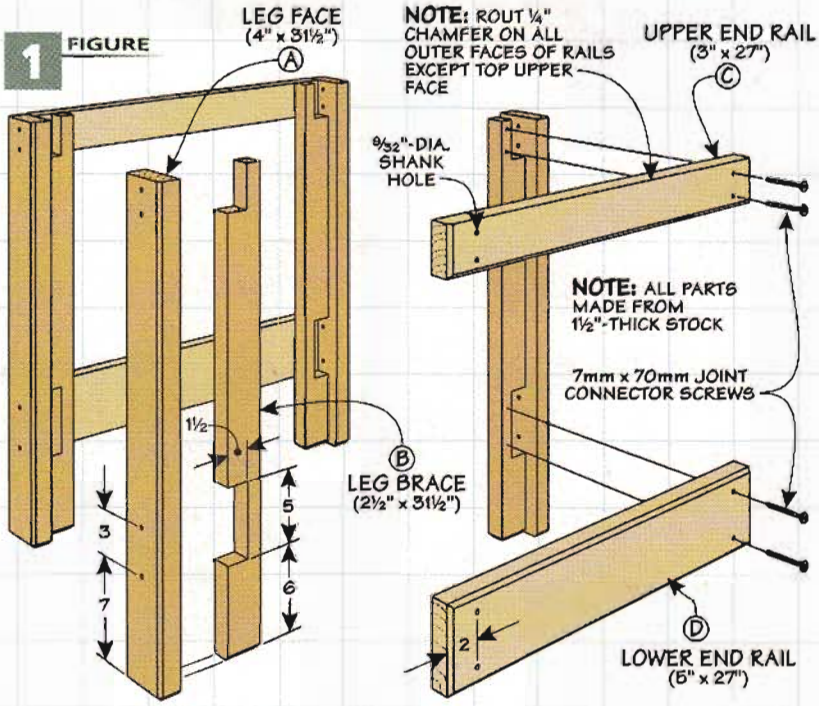
Braces. The braces complete the "T" shape and require just a little more work at the table saw. There are two notches cut to accept the rails, as Figure 1 shows. A dado blade on the table saw makes quick work of cutting these notches. But before you glue the braces to the backs of the leg faces, you'll need to chamfer the bottom edges.

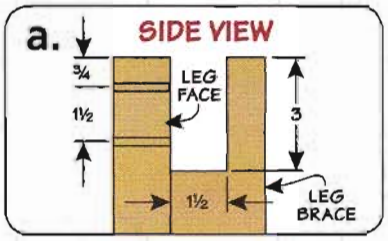
Leg Assembly. Now it's time to pair up each leg face with a brace. But there's one tip I want to pass along first. In Figure 1b, you'll see that the inside edge of the chamfer on the end rails is aligned with the edge of the leg face. The chamfer sits proud of the leg face.

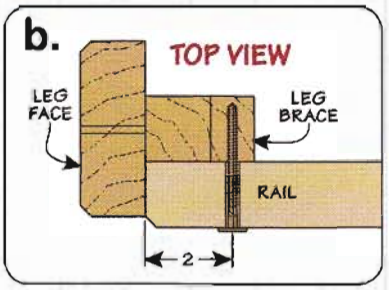
To make sure this reveal is consistent on all four legs, I cut a temporary spacer to help align and position the brace. Refer to Shop Short Cuts on page 23.

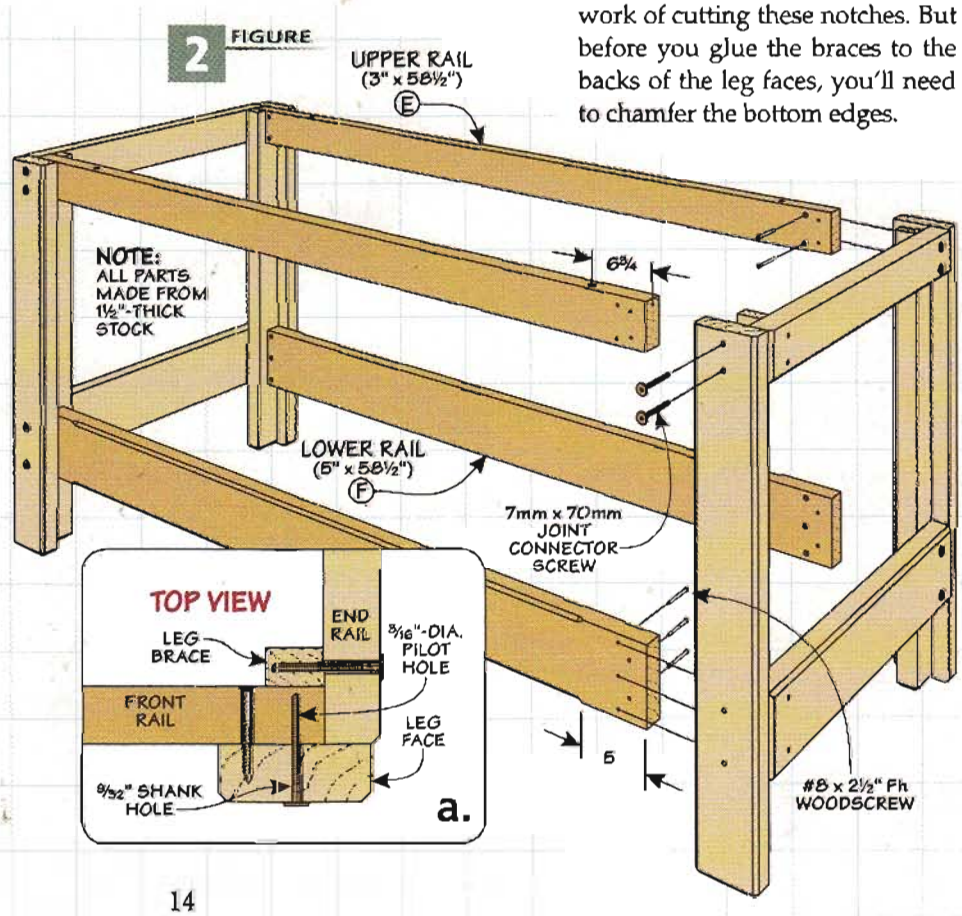
BASE ASSEMBLY

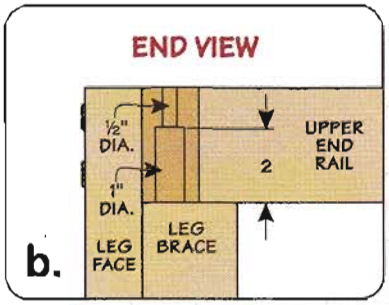
You can set the legs aside for now and get started on the rails that









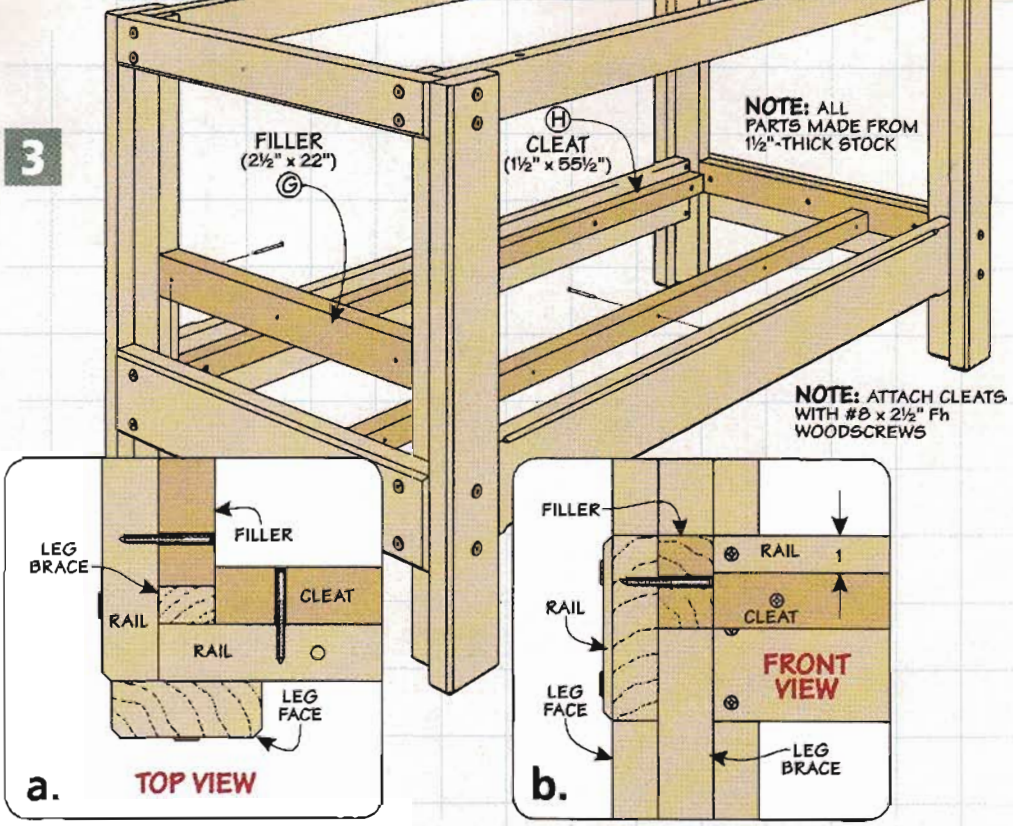


connect them to create a stable frame. You'll start with the end rails to create the two end assemblies. Later, you'll make the long rails to connect the end assemblies, as shown in Figure 2.

Chamfered Blanks. There's nothing too special about the end rails. After cutting them to size, rout a chamfer along all four outside edges (Figure 1). After drilling a pair of holes at each end, you're ready to fasten them to a pair of legs with joint connector screws. You can use the holes as a drill guide for drilling pilot holes into the legs for the screws.

Connect the Leg Assemblies. Figure 2 shows you all you need to know about the long rails. There are a couple of things to be aware of here. The first is the stopped chamfer at the top and bottom front edges of the lower rails. There's nothing critical about creating the chamfer — you can simply mark where the chamfer starts and ends then rout to the lines.

The upper rails are drilled with a pair of counterbored bolt holes. These accommodate the bolts and washers that thread into inserts in the benchtop. The hole details are shown in Figure 2b.



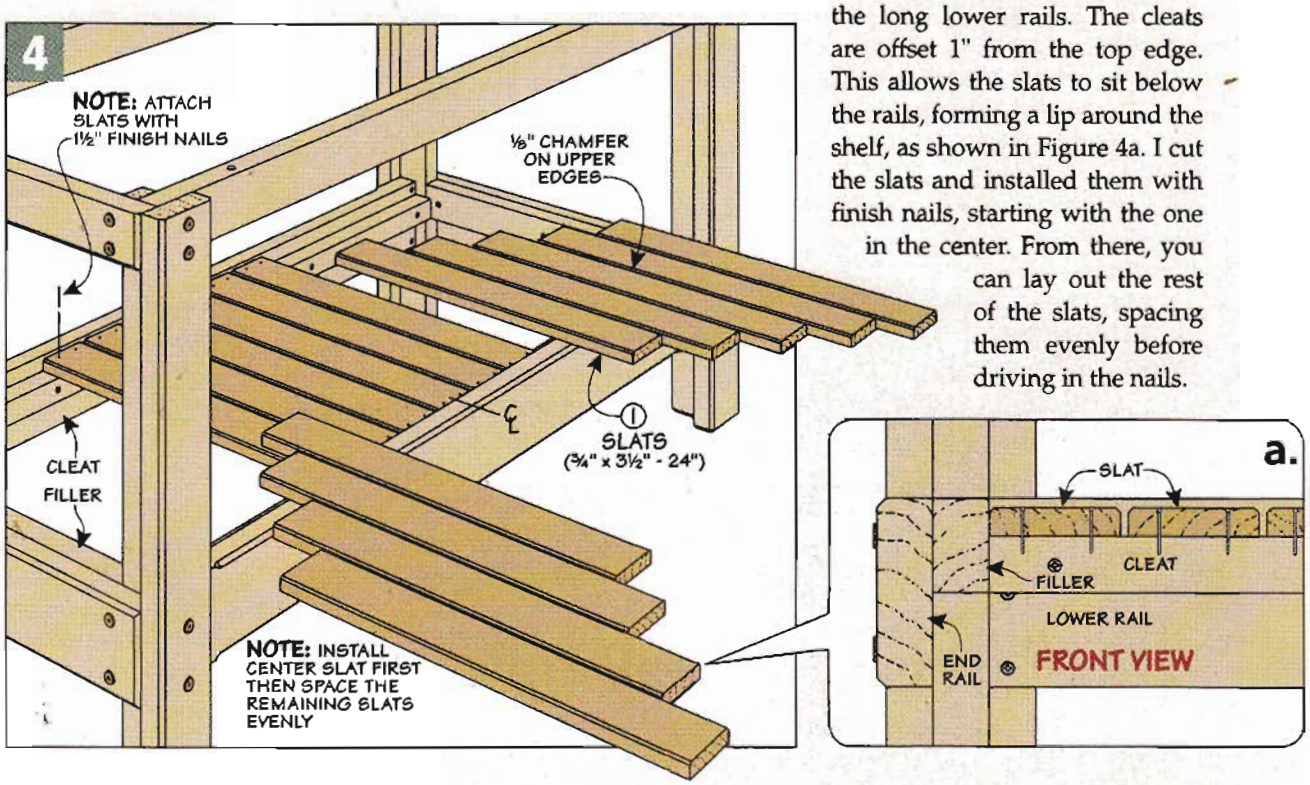
Like the end rails, the long rails are attached with decorative joint connector screws. For additional reinforcement, woodscrews at each end connect these pieces to the backs of the legs, as shown in Figure 2a. To make assembly easier, I predrilled these screw holes. After slipping the rails into the mortises, make sure they fit tight against the end rails before installing all the screws.

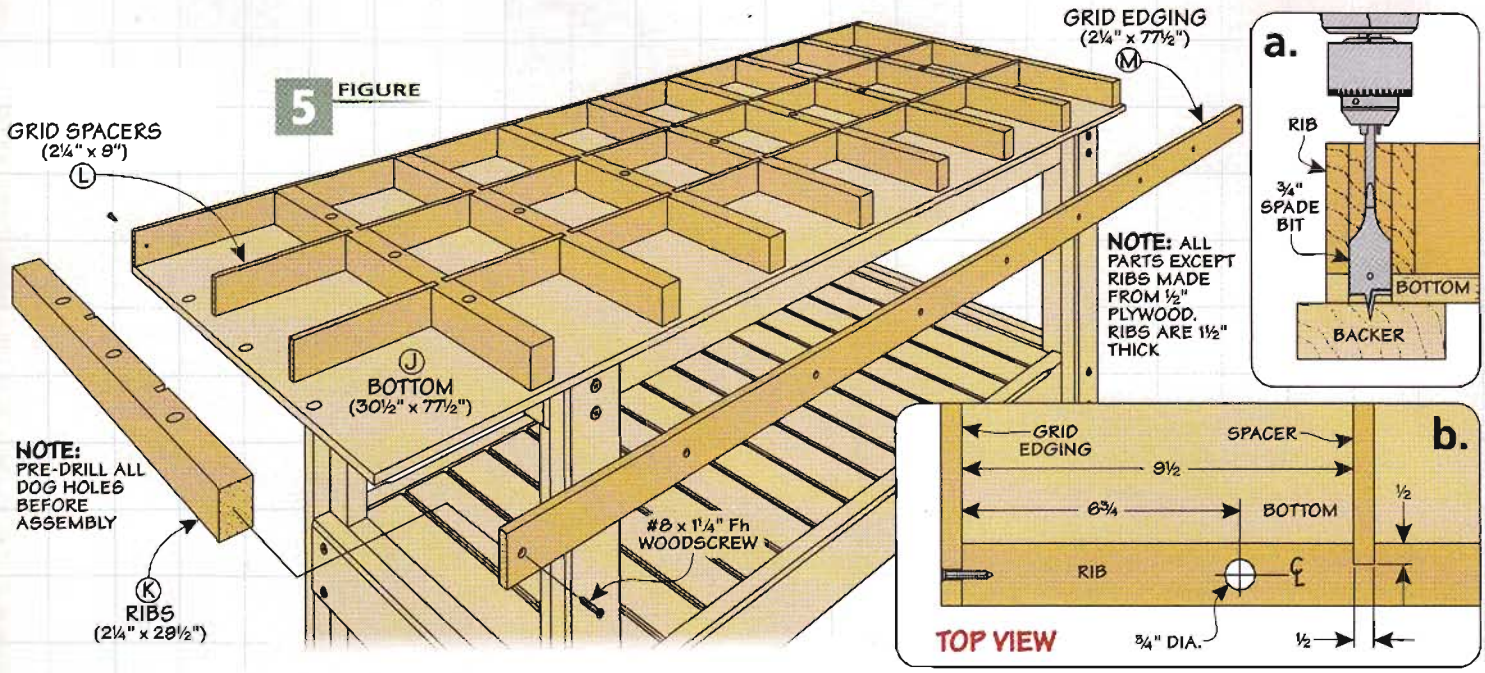
OPTIONAL STORAGE

With the base complete, adding the shelf shown below is easy to do and provides bonus storage.

Slat Shelf. To form the shelf, I used solid-wood slats sitting on cleats. A filler strip at each end is positioned flush with the top of the rail and eliminates the need to notch the end slats to fit around the legs (Figure 3b).

The slats rest on cleats inside the long lower rails. The cleats are offset 1" from the top edge. This allows the slats to sit below the rails, forming a lip around the shelf, as shown in Figure 4a. I cut the slats and installed them with finish nails, starting with the one in the center. From there, you can lay out the rest of the slats, spacing them evenly before driving in the nails.





torsion box
Benchtop

At this point, you're ready to start building the top that makes this bench stand out from the crowd. You'll start with a plywood "skin," add the internal grid structure, then cap it off with another plywood skin. Since the benchtop is built in layers, it's important that the surface you use to glue it up is flat. For this, I used the base, making sure it was sitting flat and level.

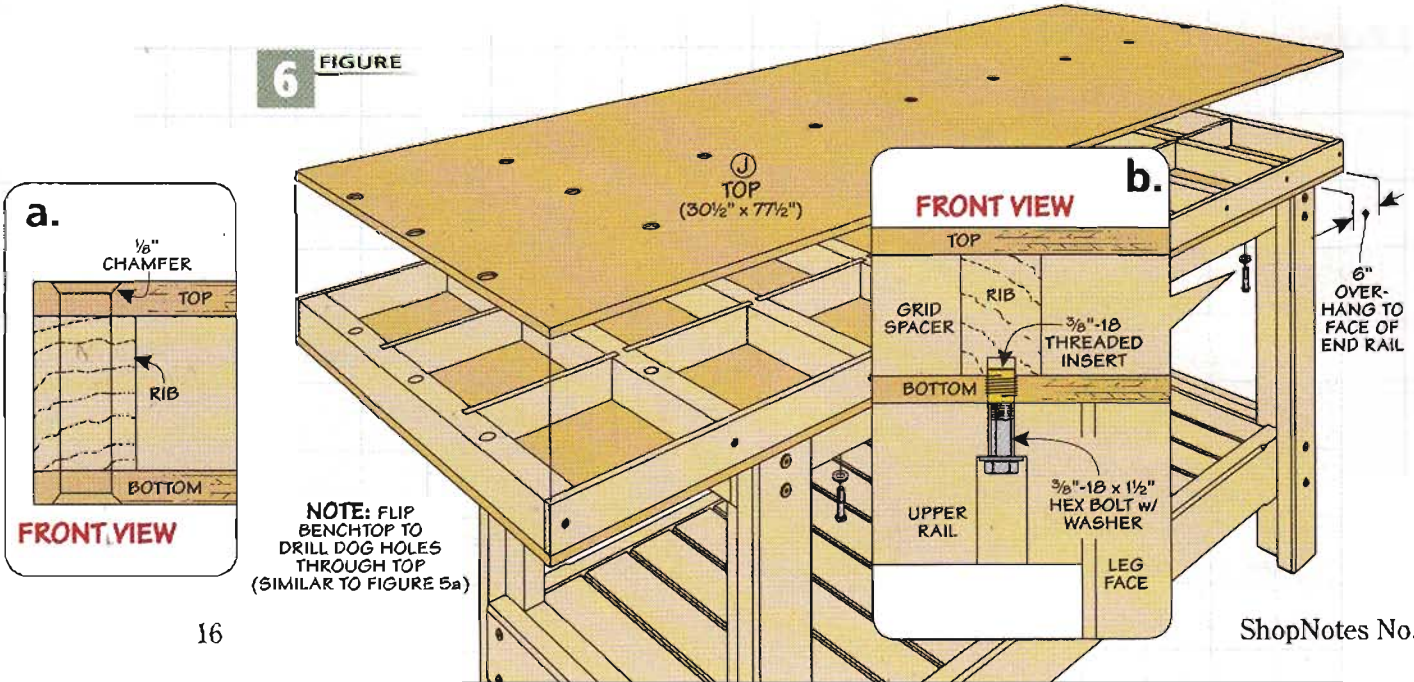
First Layer. Figure 5 shows the basic makeup of the top. Before you get started on the assembly it's a good idea to cut all of the ribs and plywood spacers.

The ribs are 1½" thick to provide enough "meat" for drilling the dog holes. The dadoes in the sides of the ribs are for locating the plywood spacers between the ribs.

I started the assembling the torsion box top by placing an oversized piece of plywood facedown on the base. (You can trim it to size after the assembly is complete.) It helps to clamp a straight cleat along one edge to align all of the ribs. Then, it's a matter of starting at one end and gluing a rib near the end of the plywood and square to the edges. Clamping cauls come in handy when gluing the ribs. After each rib is in place, add two plywood spacers and repeat the process, working to the other end.

Edging & Dog Holes. To tie the ends of the ribs together, I attached plywood edging with glue and screws. Before you cap off the top with another layer of plywood, you need to drill the dog holes through the first layer. You'll be drilling from the back side using the holes in the ribs as drill guides, so back up the plywood with a scrap piece to avoid tearout on the visible face (Figure 5a).

A Plywood Cap. Now you can apply a generous layer of glue to the ribs, spacers, and edging for the plywood skin. As before, it's slightly oversized to allow for trimming it flush. Once again, clamping cauls help apply pressure in the middle of the assembly.



Flush Trim. The next step involves using a flush-trim bit in your router. Routing in a counterclockwise direction, trim both plywood layers flush with the edging and end ribs.

Flip & Drill. Just like before, you'll need to drill dog holes through the top layer of plywood. I like to soften the top and bottom edges of the dog holes by routing a slight chamfer (Figure 6a).

To make the benchtop easy to install and remove if needed, I used threaded inserts and bolts to attach it to the base. You can mark the location of the inserts by positioning the benchtop on the base and tapping a drill bit through the counterbored holes in the aprons.

Hiding the Box. In Figure 7, you can see all the parts that wrap the torsion box and provide additional dog holes for more clamping options (box below). First, I cut the end caps, leaving them a little long. I temporarily clamped these to the top to help with fitting and aligning the front and rear dog rails and edging. Then the dog rails are simply cut to size, drilled, and then glued in place.

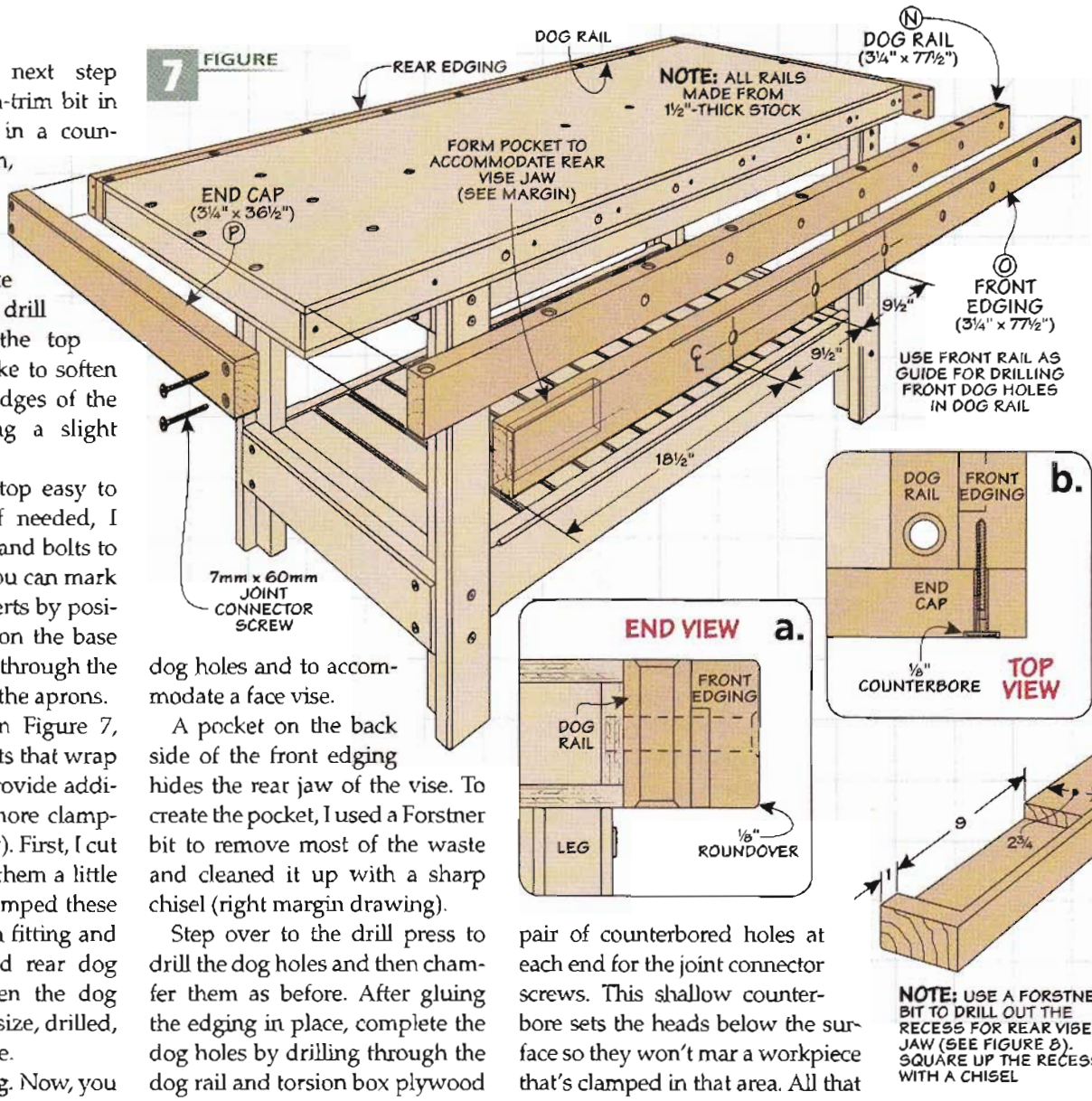
Front & Rear Edging. Now, you can attach the rear edging. The front edging requires just a little more work to add the front-facing dog holes and to accommodate a face vise.

A pocket on the back side of the front edging hides the rear jaw of the vise. To create the pocket, I used a Forstner bit to remove most of the waste and cleaned it up with a sharp chisel (right margin drawing).

Step over to the drill press to drill the dog holes and then chamfer them as before. After gluing the edging in place, complete the dog holes by drilling through the dog rail and torsion box plywood edging (Figure 7a).

End Rails. After cutting the two end rails to final size, I drilled a pair of counterbored holes at each end for the joint connector screws. This shallow counterbore sets the heads below the surface so they won't mar a workpiece that's clamped in that area. All that remains is to glue and clamp the end caps and install the screws. Then you're ready to add the vise.

FIGURE 7



Useful Bench Accessories

Clamping Options. *This handy Surface Clamp fits into any dog hole to solve a wide range of clamping problems.*

Tail Vise Substitute. *With its long reach and quick-release knob, the Surface Vise makes a great addition to any workbench.* *Turn to page 51 for sources.*

attaching the face

Vise

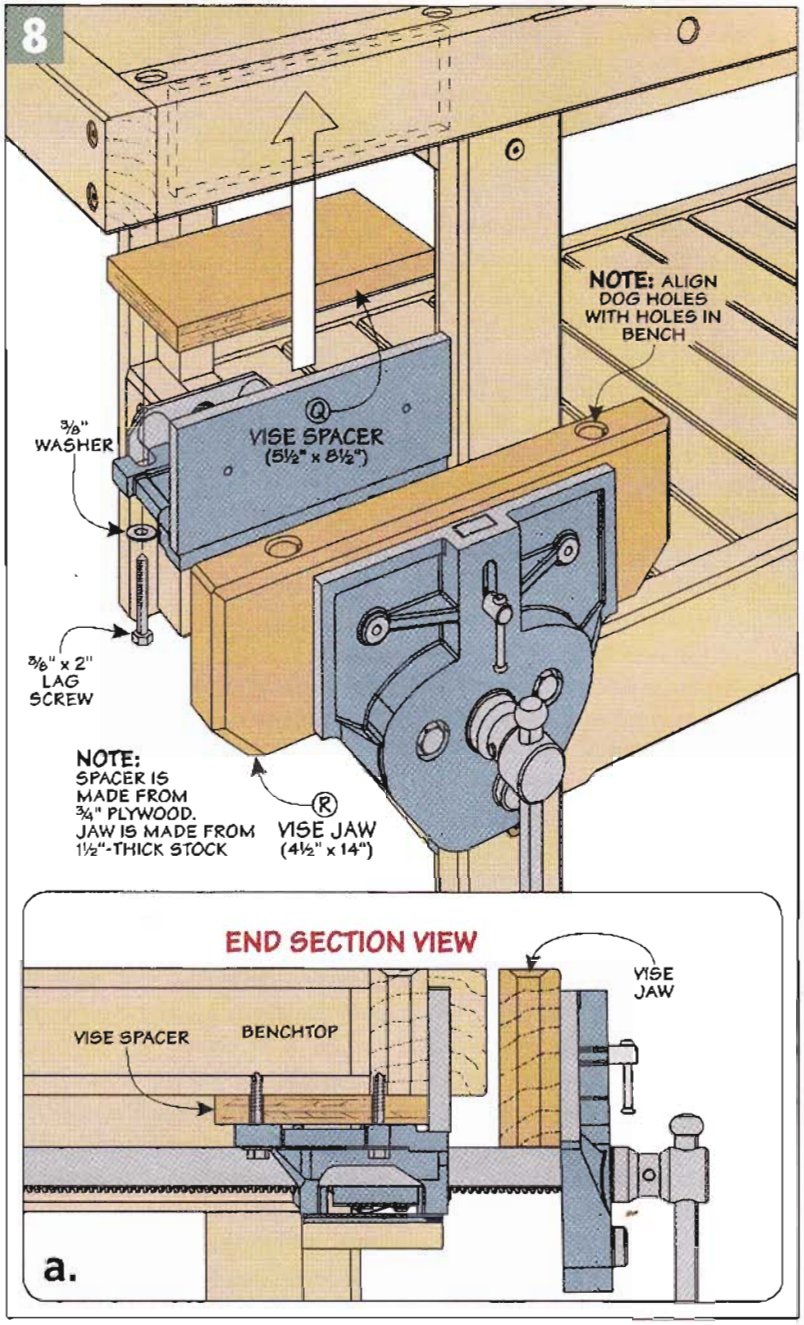
There are only a couple things left to do on the benchtop — install the vise and add an auxiliary jaw. You might find the process of mounting your vise easier if you turn the benchtop upside down.

Spacer. In Figure 8, you'll notice a spacer between the vise carriage and the underside of the bench. Its purpose is to position the top of the metal jaws slightly below the surface of the benchtop.

After gluing the spacer to the bottom of the bench, you're ready to install the vise. For this, I used lag screws and washers. With the vise in place, you can attach the benchtop on the base.

Auxiliary Jaw. The last step is to make the auxiliary jaw. It protects the workpiece from the metal vise jaw and provides more bearing surface for secure clamping.

I started with a rectangular blank and drilled a pair of dog holes to align with those on the benchtop. After knocking off the corners and routing a chamfer along the outside edges, you can attach it to your vise. All that's left to do is ease the edges of the benchtop with a roundover. With a little sanding and a finish, you're ready to put your workbench to use for a lifetime of service.



▼ ***Increased Versatility.*** *Adding an auxiliary jaw opens up more clamping options.*

Materials & Hardware

BASE		
A	Leg Faces (4)	1½ x 4 - 31½
B	Leg Braces (4)	1½ x 2½ - 31½
C	Upper End Rails (2)	1½ x 3 - 27
D	Lower End Rails (2)	1½ x 5 - 27
E	Upper Rails (2)	1½ x 3 - 58½
F	Lower Rails (2)	1½ x 5 - 58½
G	Fillers (2)	1½ x 2½ - 22
H	Cleats (2)	1½ x 1½ - 55½
I	Slats (15)	¾ x 3½ - 24
BENCHTOP		
J	Top/Bottom (2)	30½ x 77½ - ½ Ply.
K	Ribs (9)	1½ x 2¼ - 29½
L	Grid Spacers (16)	2¼ x 9 - ½ Ply.
M	Grid Edging (2)	2¼ x 77½ - ½ Ply.
N	Dog Rails (2)	1½ x 3¼ - 77½
O	Front/Rear Edging (2)	1½ x 3¼ - 77½
P	End Caps (2)	1½ x 3¼ - 36½
Q	Vise Spacer (1)	5½ x 8½ - ¾ Ply.
R	Vise Jaw (1)	1½ x 4½ - 14

- (38) 7mm x 70mm Joint Connector Screws
- (2) 7mm x 60mm Joint Connector Screws
- (20) #8 x 2½" Fh Woodscrews
- (18) #8 x 1¼" Fh Woodscrews
- (4) ⅜"-18 x 1½" Hex Bolts
- (8) ⅜" Flat Washers
- (4) ⅜"-18 Threaded Inserts
- (1) 9" Quick-Release Face Vise
- (4) ⅜" x 2" Lag Screws

ShopNotes

torsion box Workbench

Materials List

BASE		
A	Leg Faces (4)	1½ x 4 - 31½
B	Leg Braces (4)	1½ x 2½ - 31½
C	Upper End Rails (2)	1½ x 3 - 27
D	Lower End Rails (2)	1½ x 5 - 27
E	Upper Rails (2)	1½ x 3 - 58½
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G	Fillers (2)	1½ x 2½ - 22
H	Cleats (2)	1½ x 1½ - 55½
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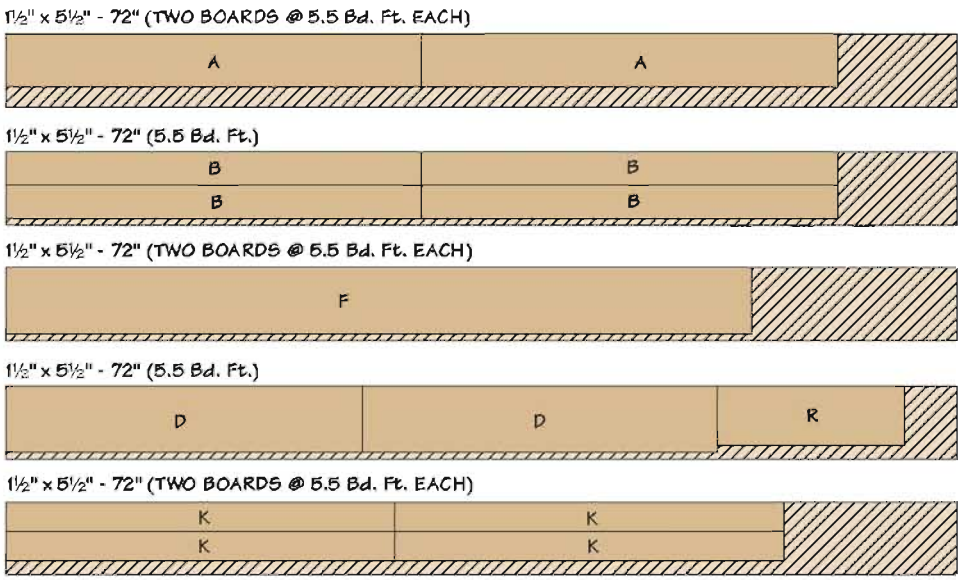
M	Grid Edging (2)	2¼ x 77½ - ½ Ply.
N	Dog Rails (2)	1½ x 3¼ - 77½
O	Front/Rear Edging (2)	1½ x 3¼ - 77½
P	End Caps (2)	1½ x 3¼ - 36½
Q	Vise Spacer (1)	5½ x 8½ - ¾ Ply.
R	Vise Jaw (1)	1½ x 4½ - 14

- (38) 7mm x 70mm Joint Connector Screws
- (2) 7mm x 60mm Joint Connector Screws
- (20) #8 x 2½" Fh Woodscrews
- (18) #8 x 1¼" Fh Woodscrews
- (4) ⅜"-18 x 1½" Hex Bolts
- (8) ⅜" Flat Washers
- (4) ⅜"-18 Threaded Inserts
- (1) 9" Quick-Release Face Vise
- (4) ⅜" x 2" Lag Screws

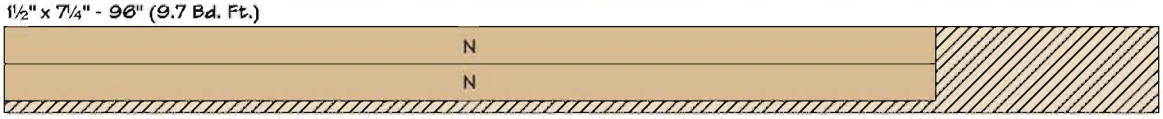
Cutting Diagram



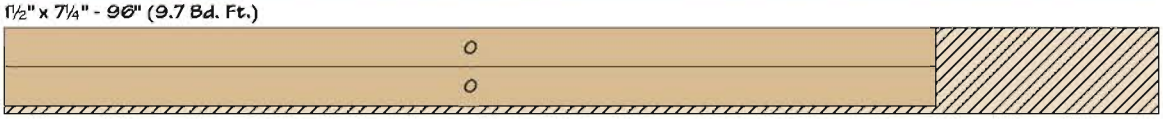
Cutting Diagram

1½" x 7¼" - 96" (9.7 Bd. Ft.)

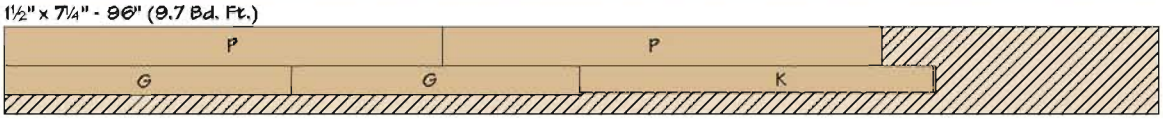
1½" x 7¼" - 96" (9.7 Bd. Ft.)



1½" x 7¼" - 96" (9.7 Bd. Ft.)



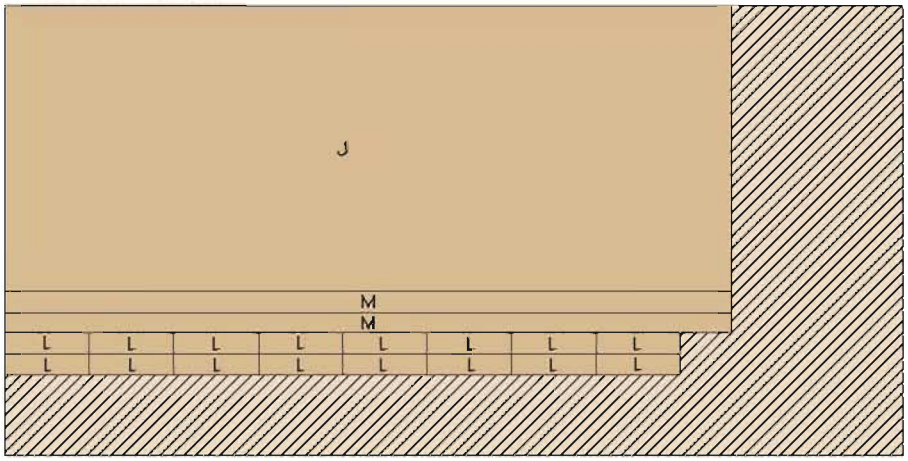
1½" x 7¼" - 96" (9.7 Bd. Ft.)



1½" x 3½" - 72" (3.5 Bd. Ft.)

¾" x 3½" - 96" (FIVE BOARDS @ 2.3 Bd. Ft. EACH)

½" x 48" - 96" PLYWOOD



½" x 48" - 96" PLYWOOD

NOTE: ALSO NEED ONE 12" x 12" PIECE OF ¾" PLYWOOD FOR VISE SPACER (Q)

constructing a Torsion Box

Learn how this low-cost, lightweight design for a flat, stable assembly can be put to use in the shop.

A torsion box design has a lot of applications in woodworking. We used it for the benchtop on page 12. But what exactly is a torsion box and what makes it special?

Stressed-Skin Panel. For most typical woodworking projects, the basic design of a torsion box usually means a framework or grid sandwiched between two thin, outer "skins." Engineers call this a stressed-skin panel. It's more commonly called a torsion box because of its ability to resist twisting and flexing under a load.

You may already be familiar with this design. A hollow-core door is often made up of two thin plywood skins glued to a cardboard grid. It's the glue and the internal grid that makes the entire assembly stiff and stable. Any load applied to it is distributed across and throughout the assembly.

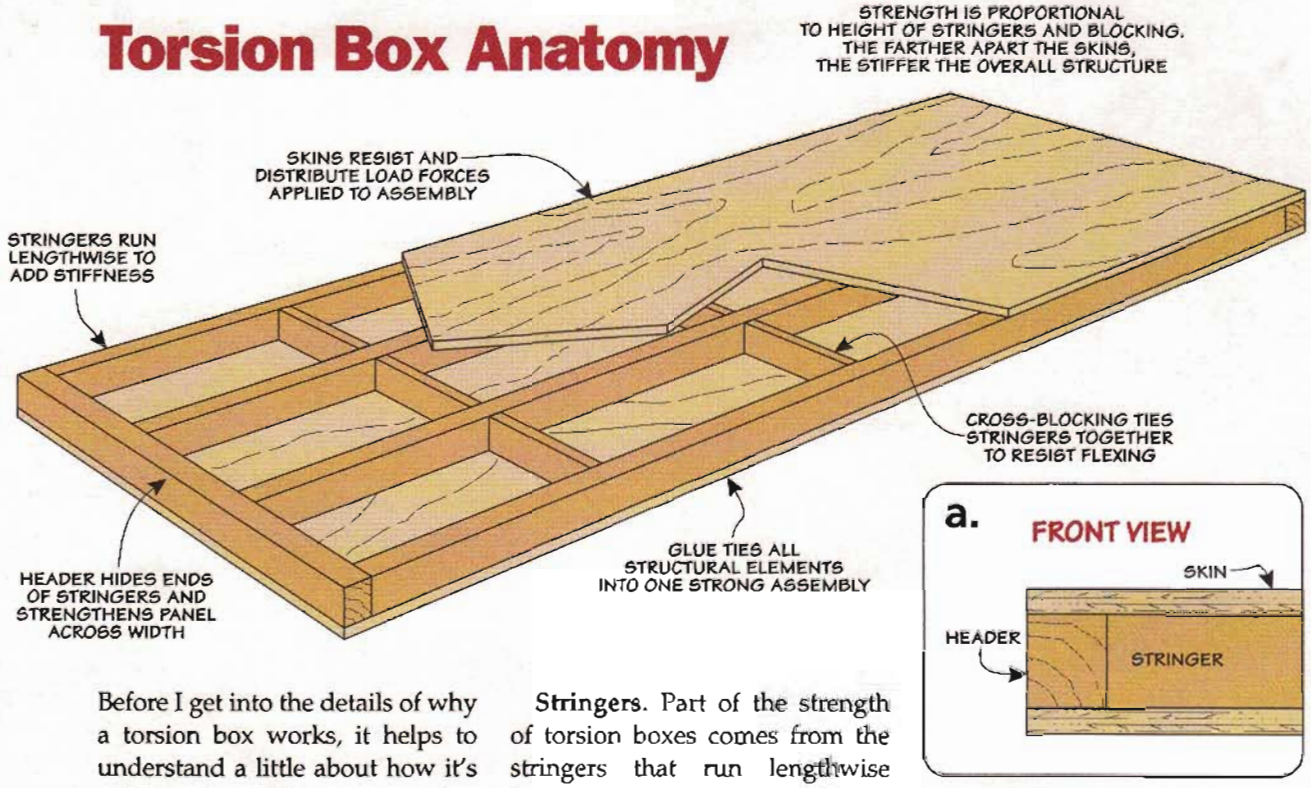
So why would you want to use this design for a shop project? There are several benefits you'll want to consider.

Stable & Strong. Most importantly, a torsion box structure is an easy way to create a flat surface that resists warping and twisting. And the bonus is, the process of building one isn't difficult.

Inexpensive. The most obvious benefit to this design is lower cost. Instead of using solid wood, you can get by with thin sheet goods like plywood for the external skins. For building the internal structure, plywood or secondary woods are often used and work great.

Lightweight. It's this type of assembly that brings about another benefit — torsion boxes are lighter in weight compared to their solid wood counterparts of the same size. This means that using a torsion box design for a shelf or benchtop doesn't require a heavy-duty support structure.

Torsion Box Anatomy



Before I get into the details of why a torsion box works, it helps to understand a little about how it's put together. Once you understand what makes them so strong, you'll find a lot of applications for them in the shop. It's all about load (weight) distribution. The engineering and physics might seem complicated, but the application couldn't be simpler. I'll lay out the basics of a good design for you.

But if you're curious about the engineering behind torsion boxes, specifically stressed-skin panels, see the margin tip on the left.

Grid. A torsion box starts on the inside with a grid or framework. You can see what I mean in the drawing above. The grid is made of longitudinal stringers and cross-blocking.

Stringers. Part of the strength of torsion boxes comes from the stringers that run lengthwise between the two outer skins. In conventional torsion box designs, these stringers are continuous members running along the long edges and oftentimes, with others spaced evenly between them.

The number, spacing, and width of stringers depends a lot on the thickness of the skins. The thinner the skin, the more stringers you'll need to support any load placed on the torsion box. For the benchtop (page 12), where there's a potential for a heavy load and a lot of pounding, I used ½" plywood skins with stringers spaced 8" apart.

Blocking. To provide even more rigidity, cross-blocking is often added between the stringers. These cross-blocks tie everything together into a strong, rigid frame.

I modified this structure slightly for my workbench. In this case, the "ribs" run across the width of the assembly and act as blocking (refer to photo on page 19). The plywood spacers between the ribs in effect become the stringers. Because of the joinery used, the end result is the same — a rigid grid structure to support the two outer skins.

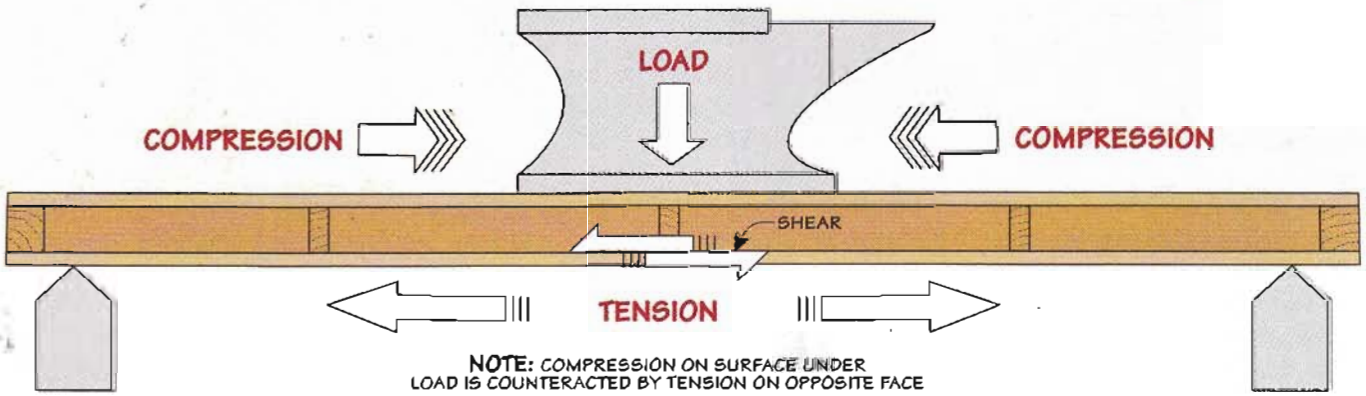
Note: For lighter-duty, smaller applications (like shelves), you can sometimes eliminate the blocking.

Skins. To complete the torsion box assembly, the two outer skins sandwich the internal grid and tie

TIP

To download the free document "*Design and Fabrication of Plywood Stressed-Skin Panels*," from *APA-The Engineered Wood Assoc.*, go to: **apawood.com**

Forces On A Torsion Box Assembly



everything together. The skins can be made out of sheet goods from hardboard to plywood.

The choice of material comes down to strength and appearance. For woodworking applications, I find it helps to start by deciding what type of skin to use.

Besides appearance, you'll need to decide on the thickness of the skin. To avoid bending under a load, thinner skins require a beefier grid using more stringers than would be required if you were using thicker skins. You can use ⅛" plywood for a light-duty shelf, for example. But for heavy-duty use, your design will benefit from a thicker skin.

Glue. Finally, you can't discuss torsion box anatomy without mentioning the glue that holds everything together. It's a key element to a strong, stable assembly. My choice is a PVA glue with a long working time.

Cohesive Assembly. If you take a look at the drawing at the bottom of the opposite page, you can see how all of these components work together. As a load is applied on one side, the forces are distributed throughout the assembly.

Edging. There's one more thing you may want to do. While not required for strength, chances are you'll want to add edging to cover the torsion box assembly. It's a nice, added touch that provides a finished look to your project.

ASSEMBLY

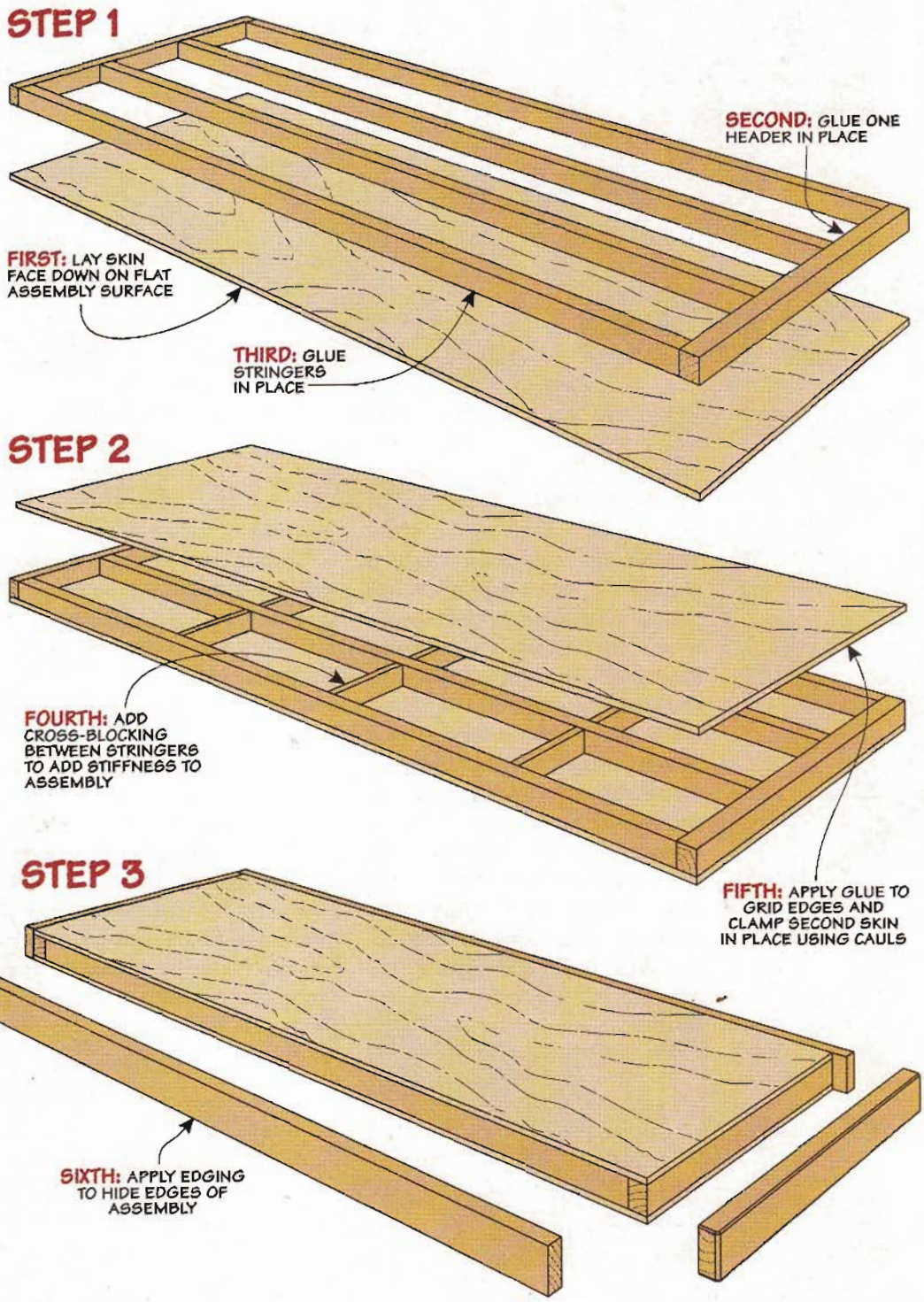
The drawings at right show you how I assemble a torsion box. The first requirement is that your assembly area be flat and free of twist. Any bumps or dips will be telegraphed into your torsion box as you glue it up. So use a level or winding sticks to make sure your assembly area is flat.

Skin First. I like to start by placing the first skin face down on the assembly surface. Then you can get to work on the internal grid. When gluing the stringers and blocking, it helps to use clamping cauls across the assembly.

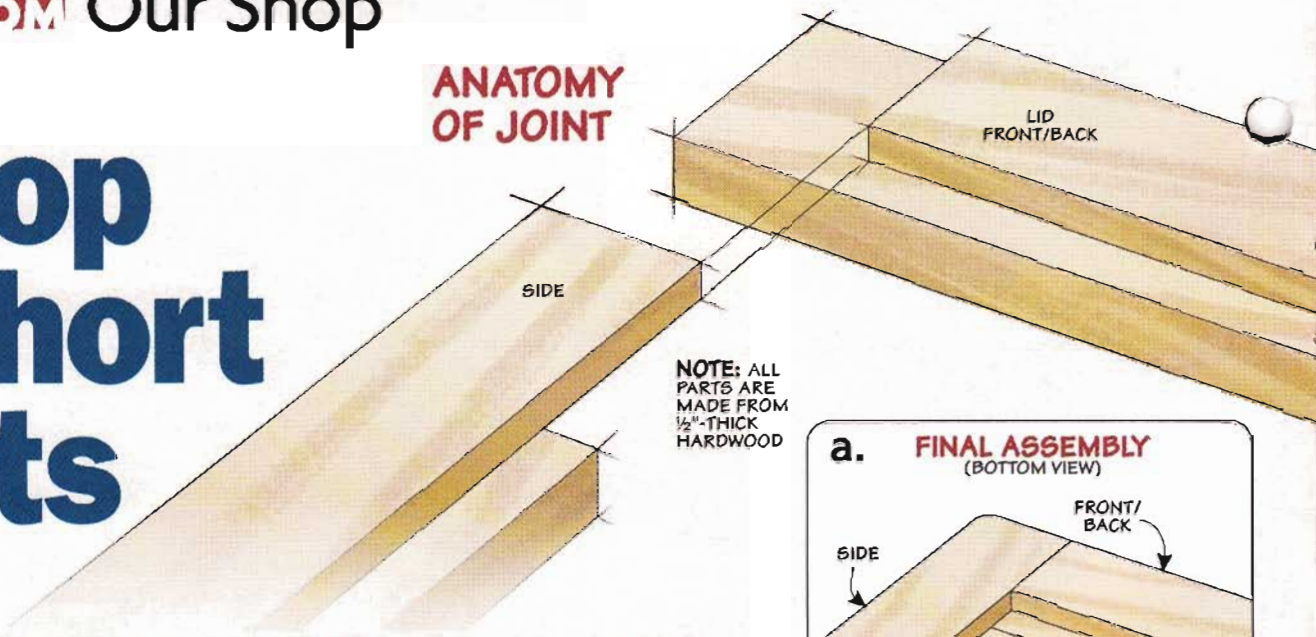
Don't Skimp on the Glue. There's one other thing — don't be afraid of using too much glue. You'll want enough to cover all the edges of the joints. All mating surfaces should fit tight without gaps. This is an important step for a strong assembly.

Second Skin. With the grid glued up, apply glue to the grid and then clamp the second skin in place. As before, clamping cauls help with this task. Finally, if the skins overhang anywhere, trim them flush and add edging (if you wish). In the end, you're left with a strong and stable assembly.

Constructing a Torsion Box



Shop Short Cuts



Cutting An Offset Lap Joint

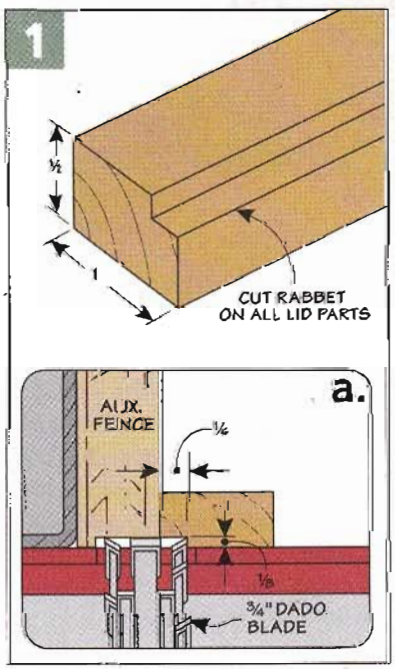
The lids on the pullout trays of the hardware cabinet (page 24) have a clear, acrylic panel so you can see what's inside. The frame keeps the panel rigid and provides an anchor point for the hardware.

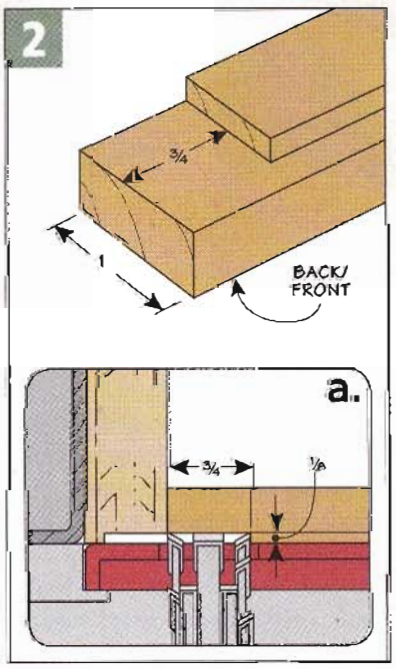
The frame is assembled with a unique, offset lap joint. Overlapping tongues at each corner create a strong joint with a lot of glue surface. Sizing the parts is a breeze. The front, back, and sides are cut to length to match the overall size of the tray. Best of all, you can do everything at the table saw.

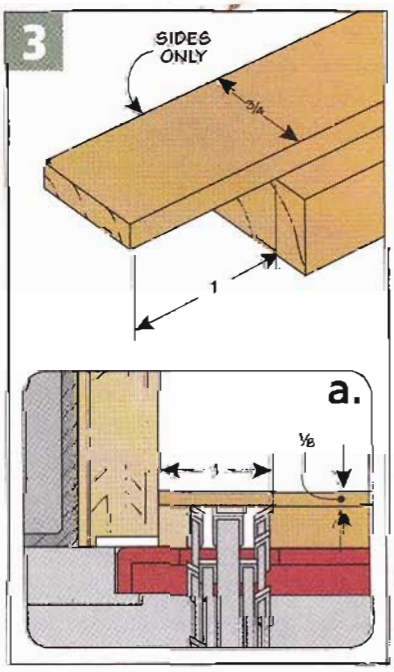
Rabbet First. The first step is to cut a rabbet in all the parts, as shown in Figure 1. The depth of the rabbet matches the thickness of the acrylic panel (Figure 1a). This way, the panel is flush with the bottom face of the lid. This keeps the contents of the tray in place.

Notches. The lap joinery can be cut at this point. The pieces are guided across the blade with the miter gauge, using the rip fence as an end stop. To cut the tongues on the front and back pieces, the blade height remains the same as when you cut the rabbets, as illustrated in Figure 2. The length of the lap matches the width of the lid sides minus the rabbet, as in Figure 2a.

The other half of the joint is cut on the lid sides. The length of this tongue matches the width of the lid front and back (Figure 3a). Raise the blade in stages to sneak up on fit so the top and bottom faces of each piece are flush (Figure 3).







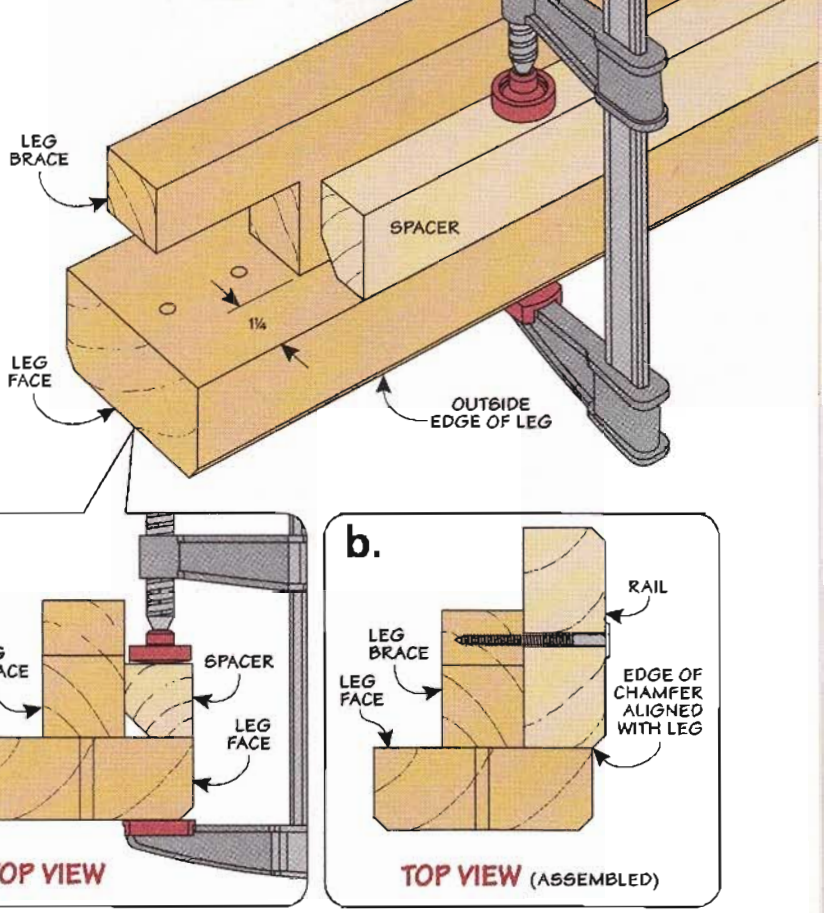
Bench Leg Spacer

Gluing up the T-shaped legs for the workbench (page 12) is a simple process. But there's one detail you need to keep in mind. The rails at the end of the leg assemblies are chamfered and sit proud of the leg face. You can see what I mean in detail 'b' at right. To make sure all of the rails have the same amount of reveal, I made temporary spacers to help locate the leg brace on the back of the leg during glueup. This way, when the rails are attached, the look is consistent between each pair of legs at the ends of the bench.

I ripped the spacers from two-by stock. The width of the spacer equals the thickness of the rails minus the depth of the chamfer, or 1¼" in my case. The thickness of the spacer really doesn't matter.

To keep the glue from adhering to the spacer, I ripped a slight bevel on one edge. You can see this illustrated in detail 'a' at right.

Simply align the face of the spacer flush with the edge of the leg face and clamp it in place. Then you can glue and clamp the leg brace, keeping it tight against the spacer, as in the main drawing.



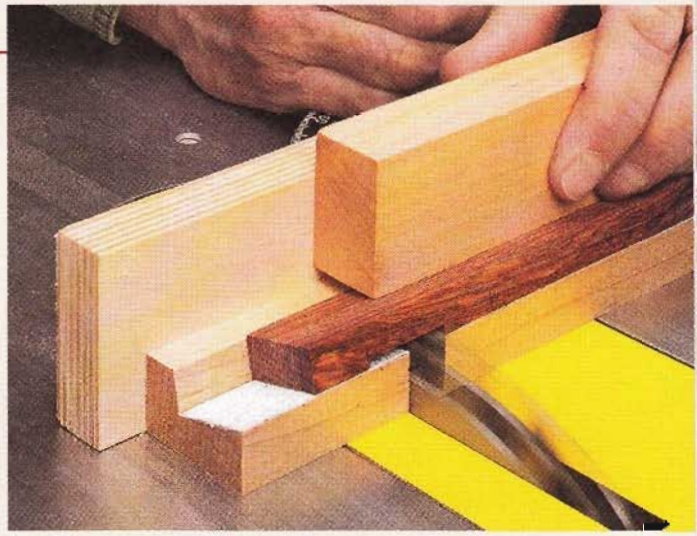
Notched Sled

The easiest way to make the beveled channel on the toe plate of the scraper shaves (page 32) is to use a sled, as shown in the photo and the left drawing below. The sled is held against an auxiliary fence on the miter gauge and positions the toe plate at a 20° angle. Then, you make multiple passes over a dado blade to cut the channel.

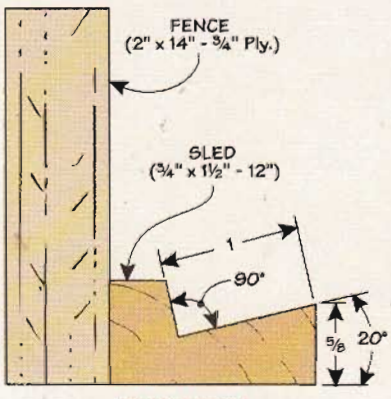
On the flat-bottom and large-radius shaves, I made a slightly deeper channel (photo at right). For the chamfer and the small-radius shaves, lower the dado blade 1/16", as shown in the center drawing.

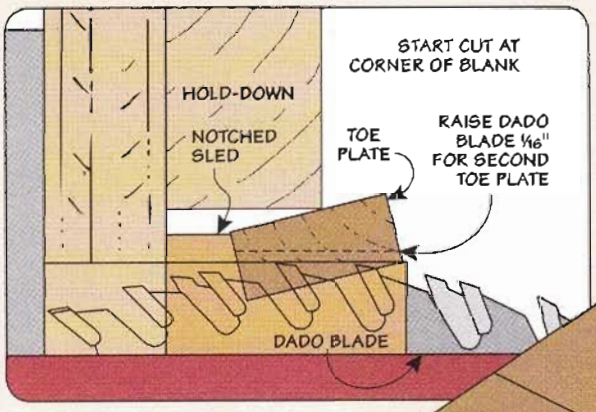
In order to cut the channels safely, I used an extra-long blank to make two toe plates. And, I held it in place with a piece of scrap.

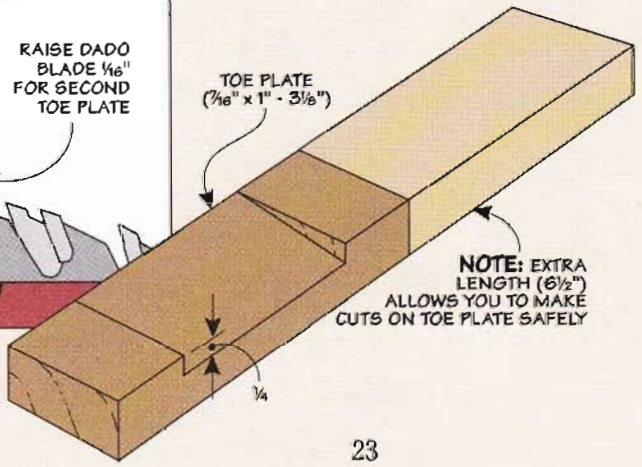
Cut Channel. To use the sled, lay out the channels on the blank. With the blank in place, raise the blade to sneak up on the final depth. After nibbling away the waste, clean the channels up with a chisel. Finally, cut the toe plates to size from the blank.

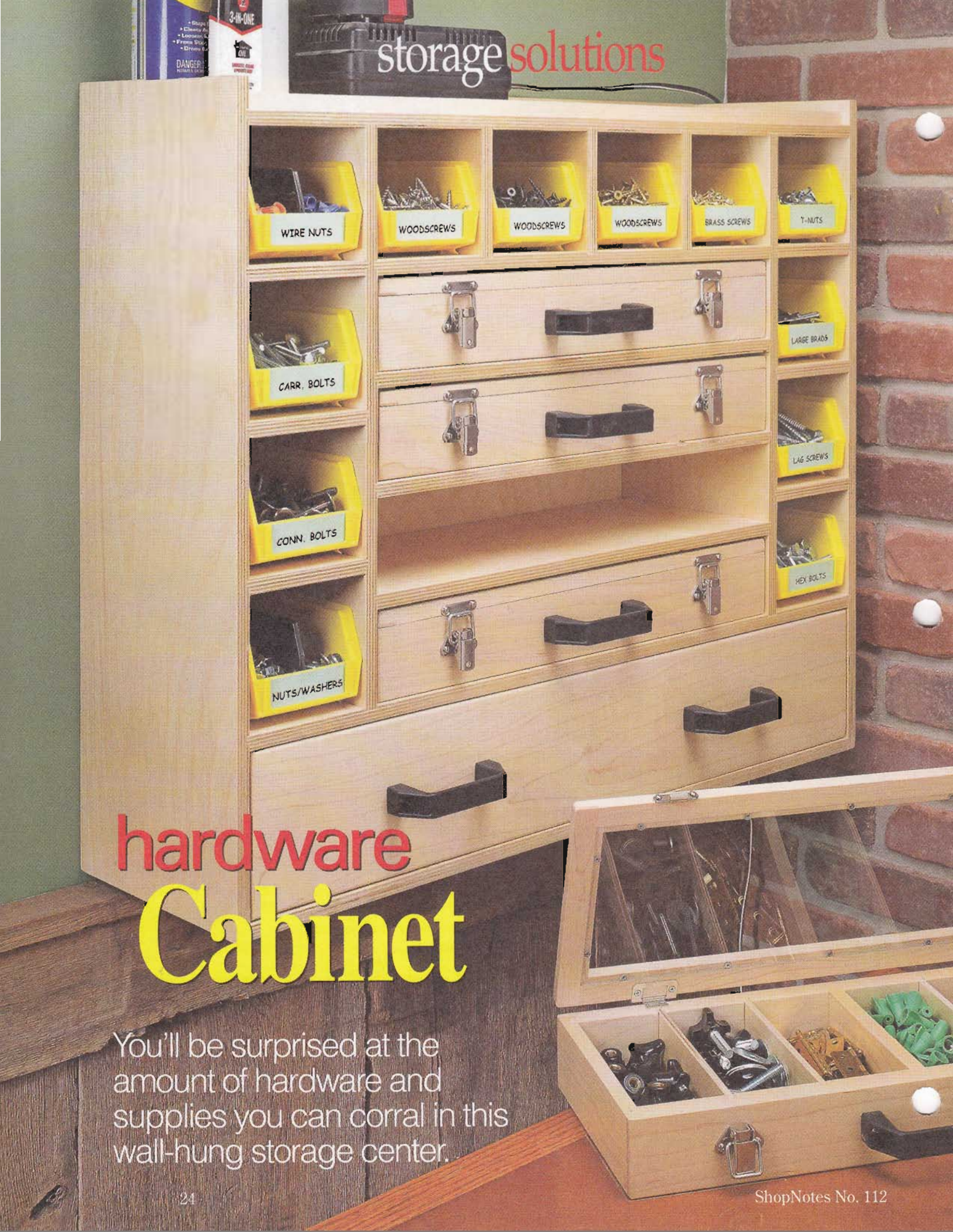


▲ ***Setup.*** *A sled is used to safely cut the channel in the toe plate blank. A scrap block holds it in place.*







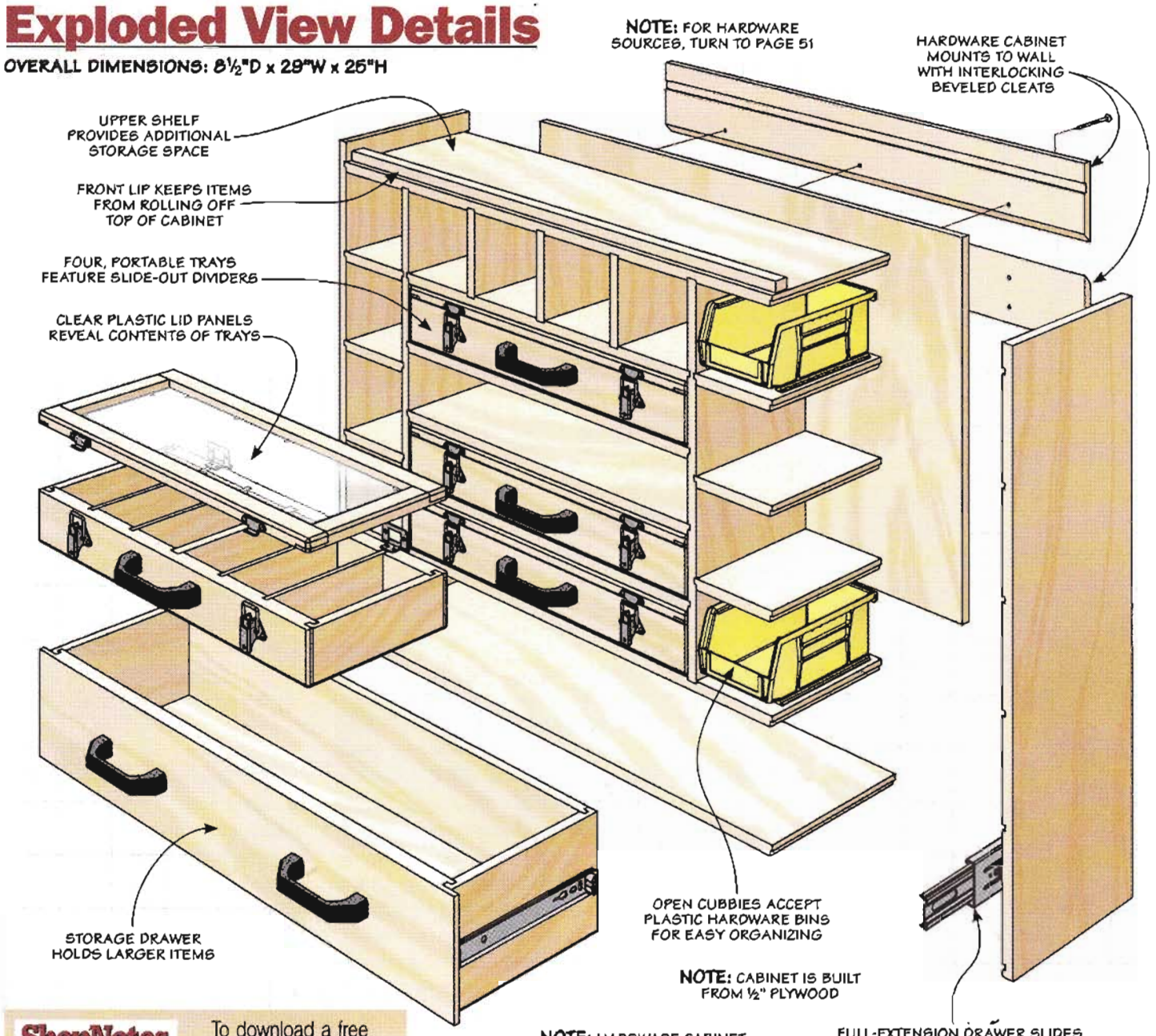


hardware Cabinet

You'll be surprised at the amount of hardware and supplies you can corral in this wall-hung storage center.

Exploded View Details

OVERALL DIMENSIONS: 8½"D x 29"W x 25"H



ShopNotes GO ONLINE EXTRAS

To download a free cutting diagram for the Hardware Cabinet, go to: www.ShopNotes.com

Materials & Hardware

CASE

A	Sides (2)	8½ x 25 - ½ Ply.
B	Top (1)	8⅛ x 28¼ - ½ Ply.
C	Drawer Divider (1)	7½ x 28¼ - ½ Ply.
D	Bottom (1)	8½ x 28¼ - ½ Ply.
E	Upper Divider (1)	7½ x 18¾ - ½ Ply.
F	Side Dividers (2)	7½ x 17¾ - ½ Ply.
G	Bin Dividers (3)	7¼ x 4¼ - ½ Ply.
H	Shelves (3)	7½ x 18¾ - ½ Ply.
I	Bin Shelves (6)	7½ x 4½ - ½ Ply.
J	Lip (1)	½ x ¾ - 28
K	Back (1)	28 x 18 - ½ Ply.
L	Back Rail/Cleat (2)	4 x 28 - ½ Ply.

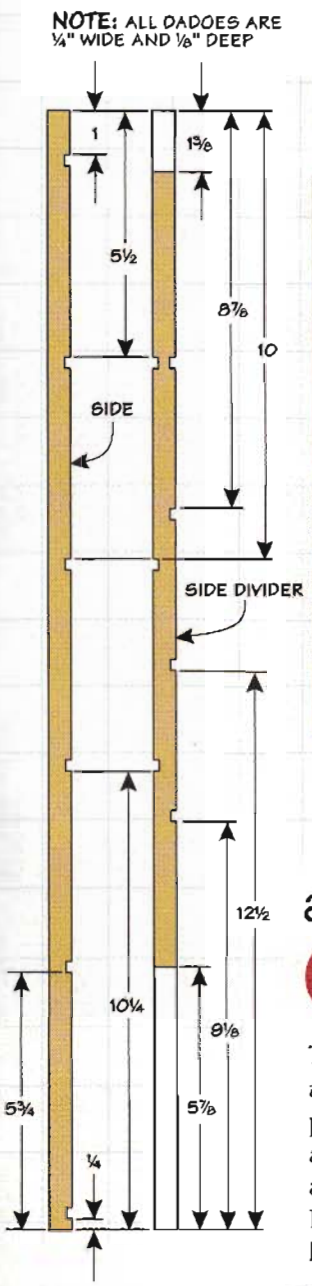
TRAYS

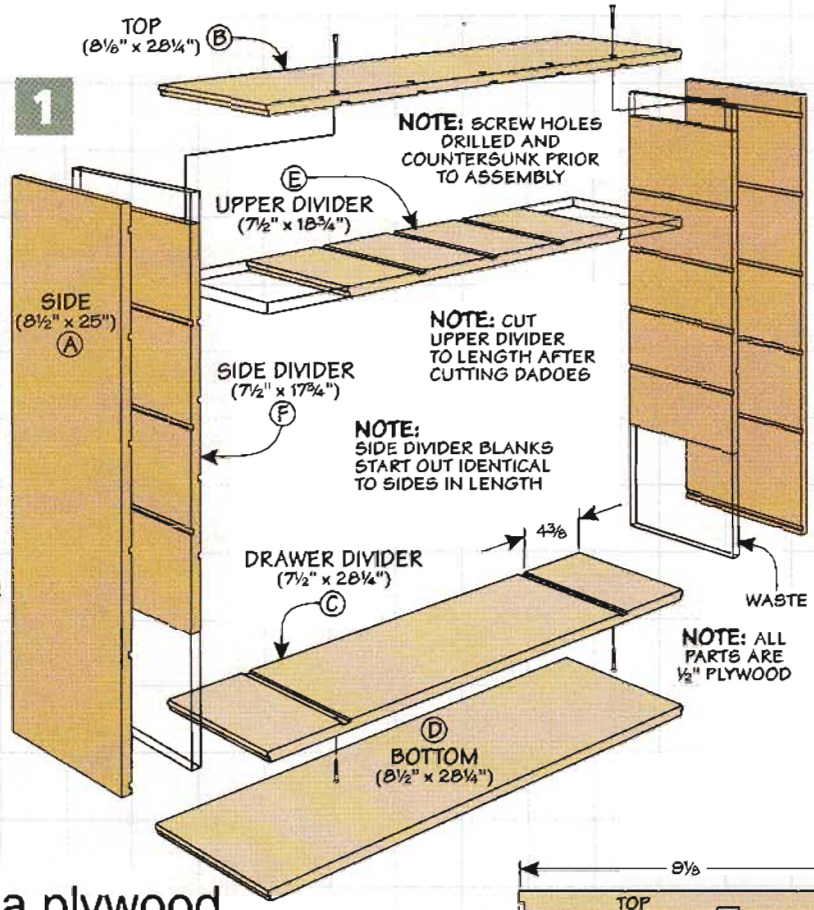
M	Tray Front/Back (8)	¾ x 2¼ - 18⅜
N	Tray Sides (8)	½ x 2¼ - 6 13/16
O	Tray Bottom (4)	17⅞ x 6 5/16 - ¼ Ply.
P	Tray Brace (4)	½ x 1¾ - 6 5/16
Q	Dividers (16)	1¾ x 6 5/16 - ¼ Ply.
R	Lid Front/Back (8)	½ x 1 - 18⅜
S	Lid Sides (8)	½ x 1 - 7 5/16
T	Lid Panel (4)	5⅞ x 16 13/16 - ⅛ Acrylic

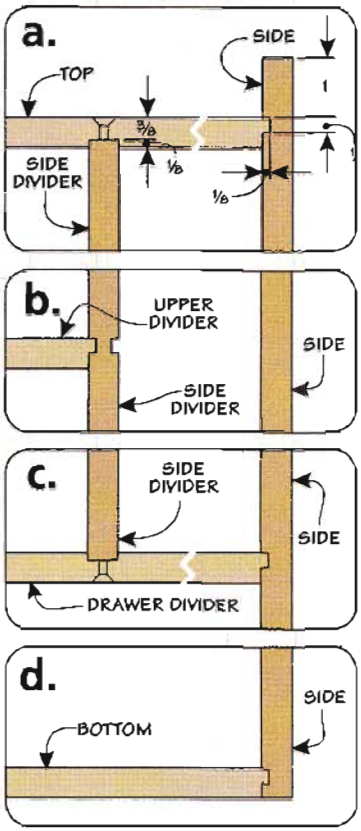
DRAWER

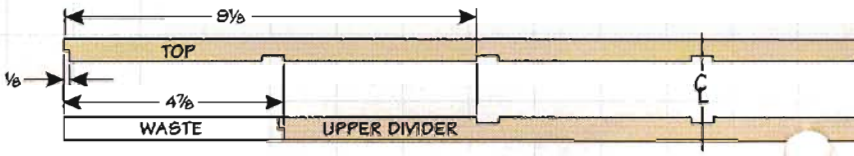
U	Drawer Front (1)	¾ x 4⅞ - 27⅞
V	Drawer Back (1)	½ x 4⅞ - 26½
W	Drawer Sides (2)	½ x 4⅞ - 8
X	Drawer Bottom (1)	26½ x 7½ - ¼ Ply.

- (10) #8 x 1¼" Fh Woodscrews
- (3) #8 x 2" Fh Woodscrews
- (12) #10 x 1" Rh Woodscrews
- (14) #4 x ⅜" Fh Woodscrews
- (6) 4¼" Plastic Handles
- (4 pr.) 1½" No-Mortise Hinges w/Screws
- (8) Draw Latches w/Screws
- (1 pr.) 8" Full-Ext. Drawer Slides w/Screws
- (12) Plastic Hardware Bins









a plywood Case

This compact cabinet can hold a lot of hardware and supplies. There are open cubbies to accept plastic bins, four removable trays, and a large drawer. Each of those storage options is housed in a matching opening.

Building a sturdy case with so many interlocking dividers may seem intimidating. But as you'll see, the solution is just a matter of doing things in the right order.

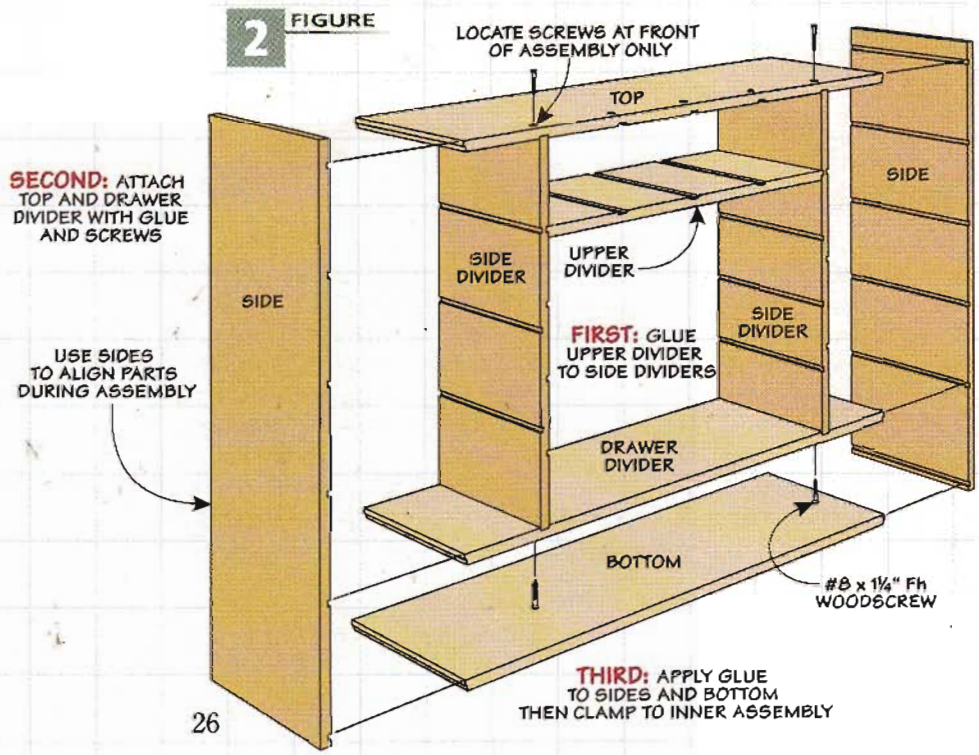
I built the case from ½" plywood. And it's assembled with simple joinery and screws. This combination keeps the weight down and yet makes for a strong assembly.

Outside First. Figure 1 shows you how to start building the case. Essentially, construction works from the outside in.

One of the challenges of this project is keeping the dadoes for the inner pieces aligned. That's because the parts are not the same size. You can see what I mean with the sides and the side dividers.

To solve this problem, I cut four pieces of plywood to the overall length of the cabinet sides. Two will become the sides. The other two will be cut down later to form the side dividers.

Matching Dadoes. These pieces have dadoes cut in them to hold small, horizontal dividers to create the bin cubbies, as well as the cabinet top and bottom, as shown in the left margin drawing. The outer side dividers get another set of dadoes cut on the opposite face to hold the tray shelves.

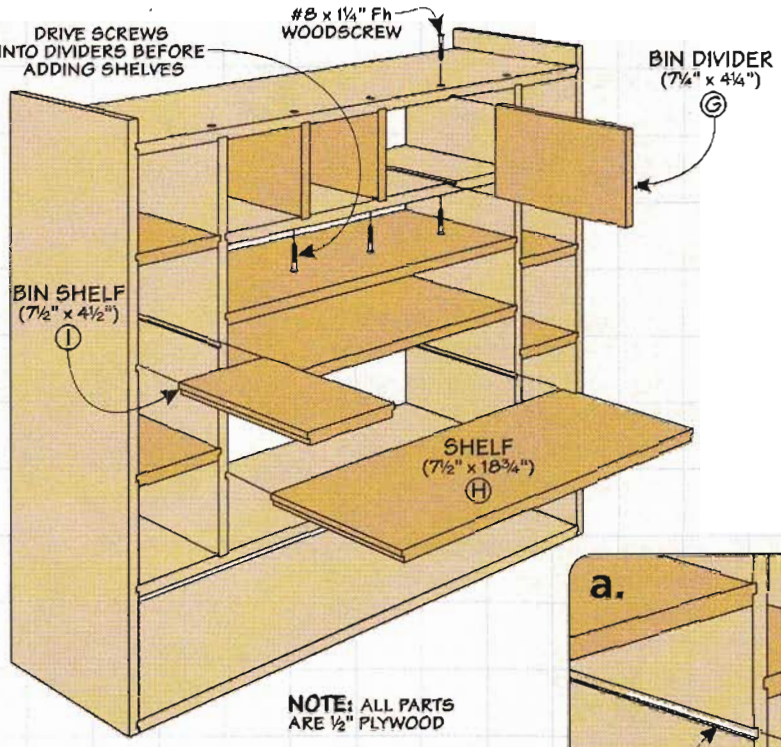


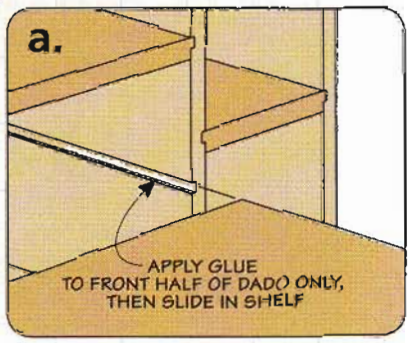
Horizontal Parts. The next pieces to make are the top, bottom, upper divider, and drawer divider. Here again, cut them all to the same length. The top and drawer divider have matching dadoes cut in them to hold the side dividers, as shown in Figures 1 and 1c.

There are a few dadoes in the top and upper divider to hold bin dividers added later, as shown in the lower portion of Figure 1. These dadoes are sized to match the thickness of the plywood. Finally, you can cut a tongue on each end of the top, the drawer divider, and the bottom to fit the dadoes in the case sides.

Cut to Fit. In order for the case to come together, some of the parts need a little trimming. To determine the final length of the side dividers, I dry assembled the sides, top, and drawer divider. I used the assembled case as a gauge to mark where I needed to trim off the ends of the side dividers. As you do this, make sure to keep the dadoes aligned with the dadoes in the case sides.

Assembly. Now, you're ready for a little assembly. And as I mentioned earlier, the order is important. You can see the order I used in Figure 2. The key is to assemble the side dividers to the drawer divider and top before adding the sides and bottom. This allows you to reinforce the joints with some screws at the front of the case. (At the rear, the joints will be strengthened by the case back.) To keep this assembly square while I installed the screws, I temporarily clamped the sides in place. Then, the remaining parts can be glued up.



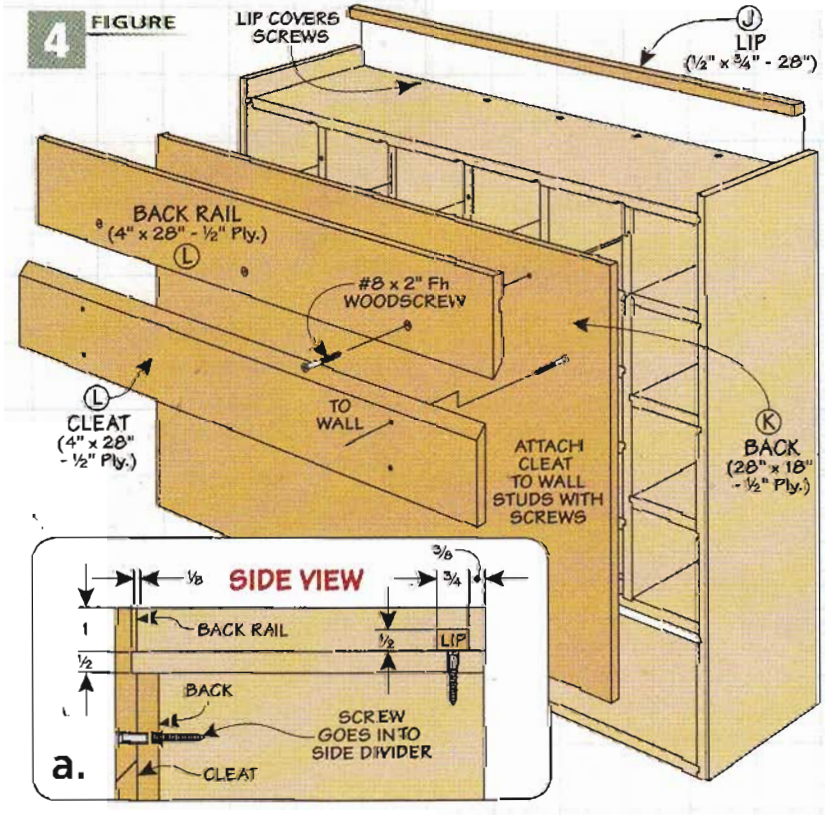


Make Dividers. Working your way in, cut the small inner dividers to fit. The small bin dividers at the top come first. They're simply cut to fit the dadoes at the top of the case. Driving screws from above and below adds mechanical strength to the joints.

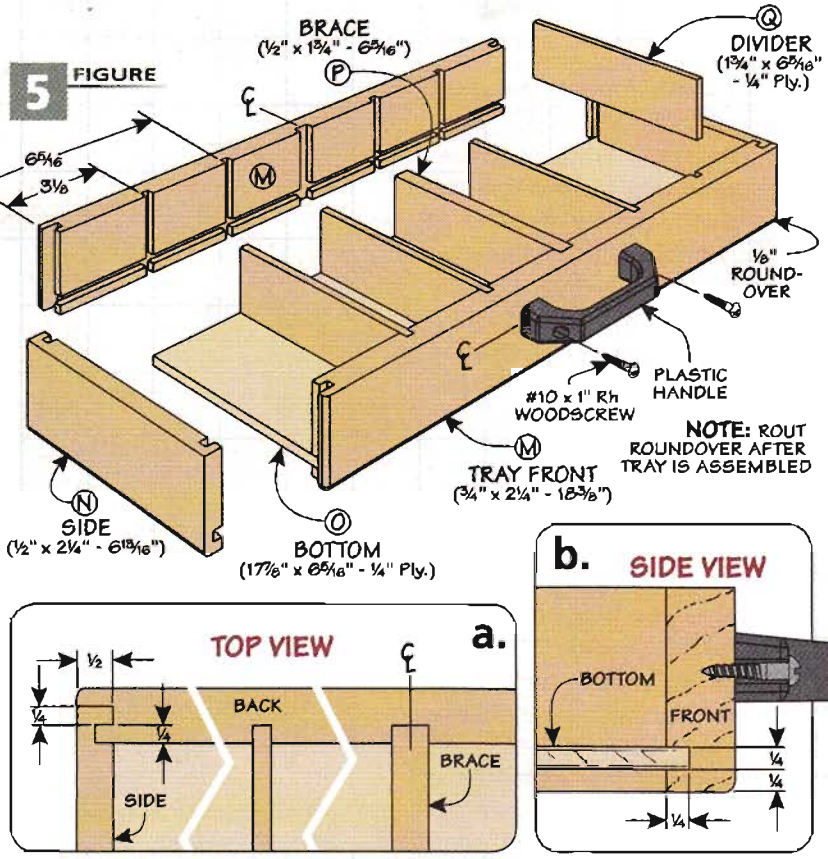
I divided the opening in the center of the case with three shelves. The shelves create slots for the portable trays you'll build later. After cutting the shelves to size, you can cut a tongue on each end to fit the dadoes in the side dividers. Gluing these dividers in place can be a challenge. You can see a trick I use in Figure 3a.

The last dividers to add are the bin shelves. These are simply shorter versions of the larger shelves, as in Figure 3.

Complete the Case. A handful of pieces completes the case. The back is sized to fit below the top and flush with the bottom of the drawer divider (Figure 4). Next, I cut a pair of beveled rails. The back rail has a groove to fit over the case top. The other piece is a cleat that's attached to the wall. The final piece is a lip glued to the top of the case (Figure 4a).



make the Tray & Drawers



The work on the case is complete. All that remains to make for the cabinet are the pull-out trays and a storage drawer.

Trays. For the center of the cabinet, I made four, removable trays. The trays are covered so you can grab one and go without worrying about the contents getting jumbled around. Another nice feature is the lid has an acrylic panel so you can easily see what's inside.

I sized the tray parts to create a 1/16" gap on either side and ¼" gap at the top. Before moving on to the joinery, there are a few dadoes to cut in the tray front and back. These dadoes hold dividers that let you customize the inside of each tray to suit your needs (Figure 5).

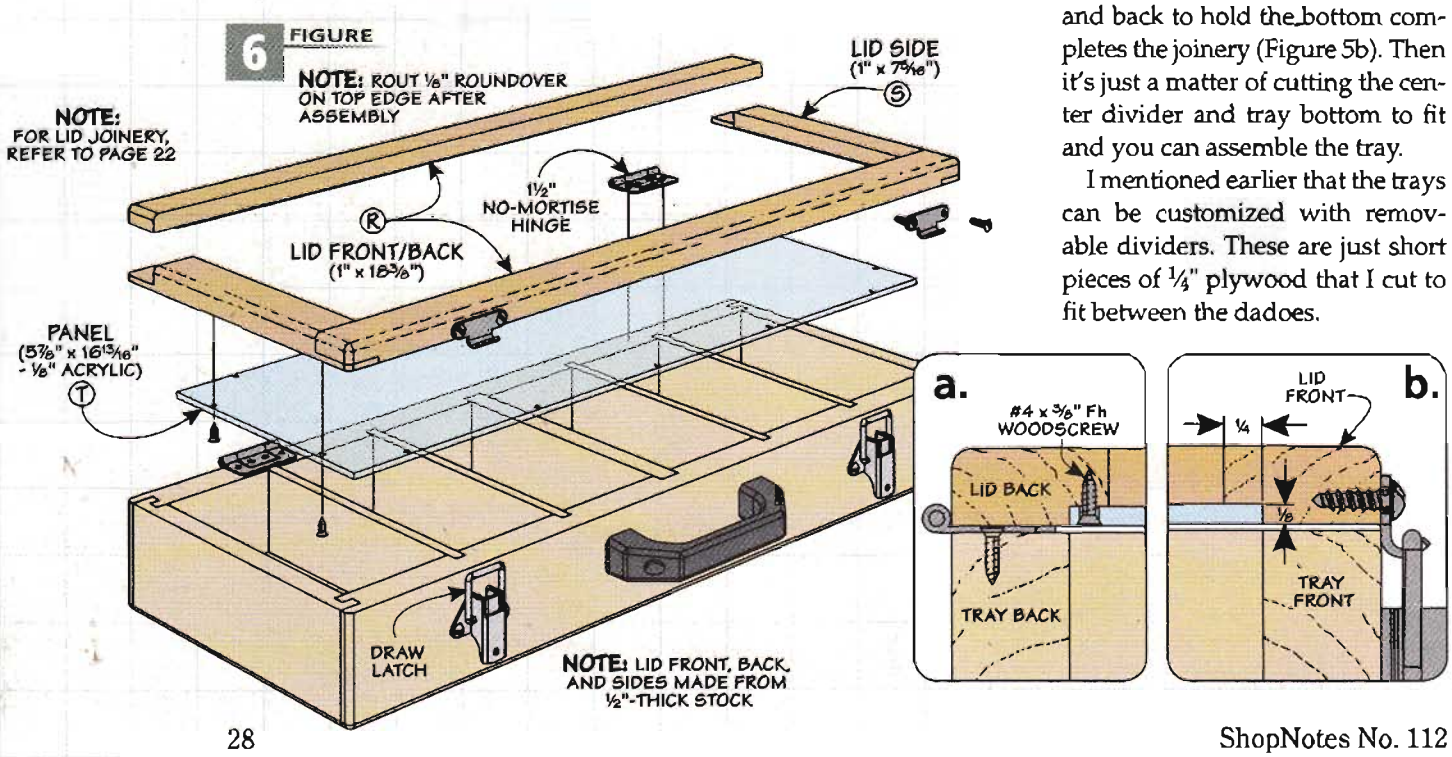
I want to point out that the center dado is sized to match a fixed, ½"-thick hardwood brace. The remaining dadoes are sized to hold removable plywood dividers.

Locking Rabbet Joinery. The trays are assembled with locking rabbet joints. You can see the steps to cut them in the box on the bottom of the opposite page. Creating the joint starts with cutting a slot in each end of the tray front and back. This slot accepts a tongue on the tray side. Then I trimmed back the inside shoulder of the slot. This creates a tongue that fits in the side.

The other half of the joint consists of a dado cut near the end of the tray side. There are two critical things about this part of the joint. First, the dado is sized to match the thickness of the short tongue on the front and back. And second, the location of the dado is determined by the location of the short tongue on the tray front and back. Aim for a nice slip fit, here. If it's too tight, the short tongue on the tray side may snap off.

A groove cut in the sides, front and back to hold the bottom completes the joinery (Figure 5b). Then it's just a matter of cutting the center divider and tray bottom to fit and you can assemble the tray.

I mentioned earlier that the trays can be customized with removable dividers. These are just short pieces of ¼" plywood that I cut to fit between the dadoes.



The Lid. A simple lid caps the trays and is built next. The lid is a frame and panel assembly. The wood frame wraps around an acrylic panel, as in Figure 6.

The panel is set flush with the bottom face of the lid frame. This keeps items in place as the tray is carried around. To do this, I used an offset lap joint to assemble the lid. To find out how to cut this joint on the table saw, turn to Shop Short Cuts on page 22.

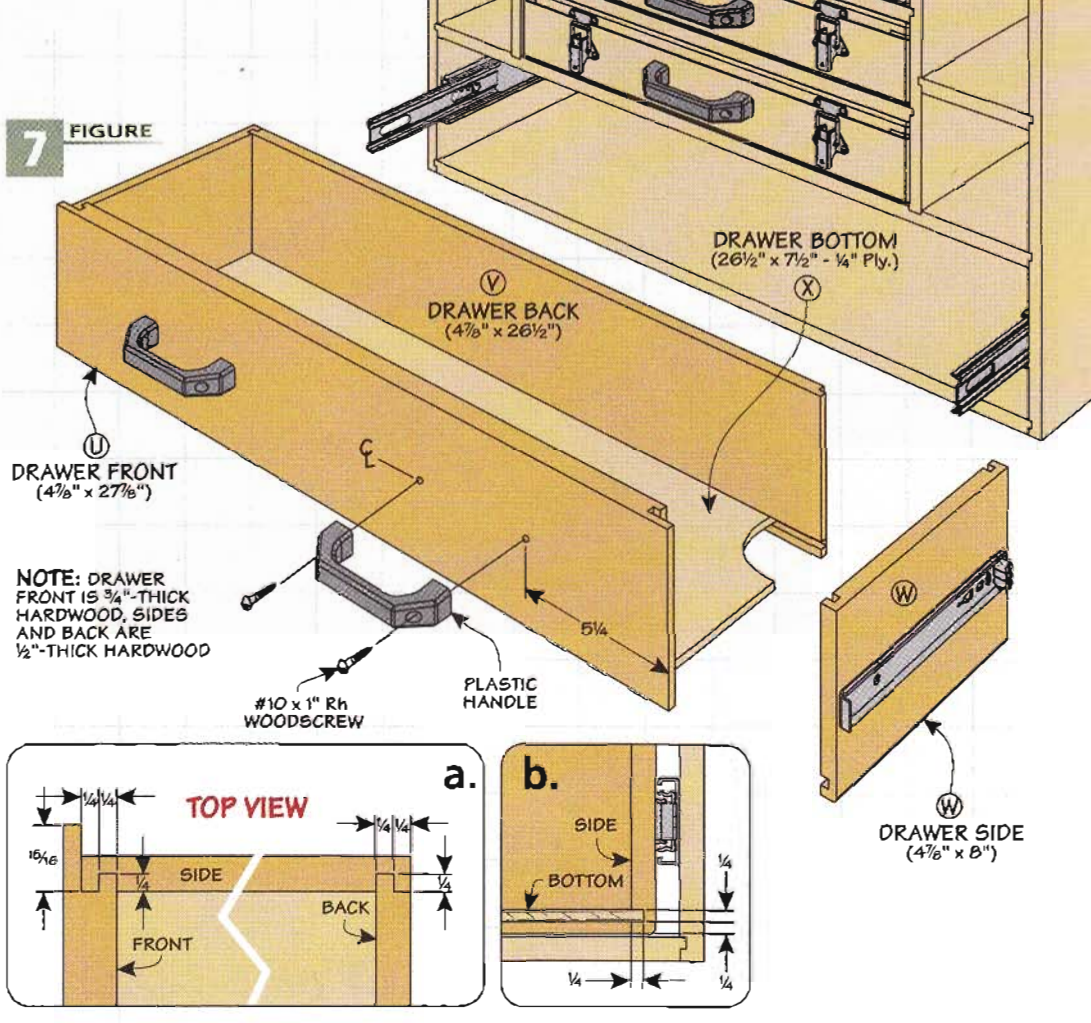
When the lid frame is complete, the acrylic panel can be cut to size. It's held in place with small screws around the edge (Figure 6a).

Drawer. At the bottom of the case, there's a drawer for storing larger supplies, as you can see in Figure 7. Like the trays, the drawer front is joined to the sides with a locking rabbet. However, there's a difference to point out. A lip on the drawer front extends past the drawer sides to cover the full-extension slides, as in Figure 7a.

I did something a little different at the back, however. The back is attached to the sides with a tongue and dado joint (Figure 7a).

All that remains is to cut a groove in all the parts to hold the drawer bottom, as in Figure 7b.

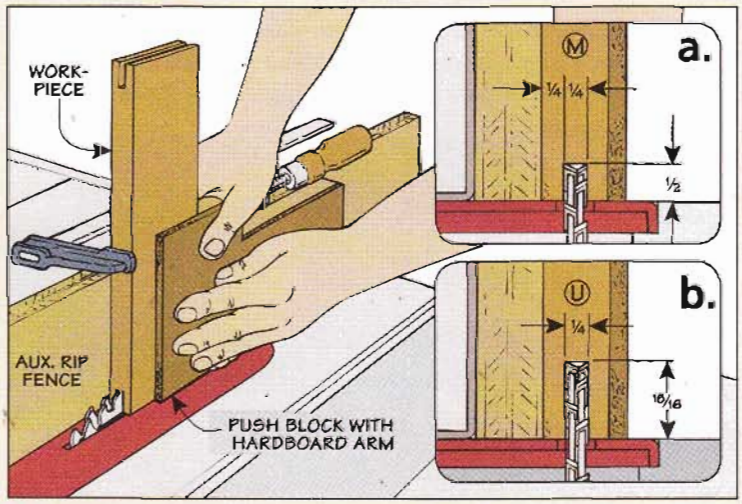
FIGURE 7



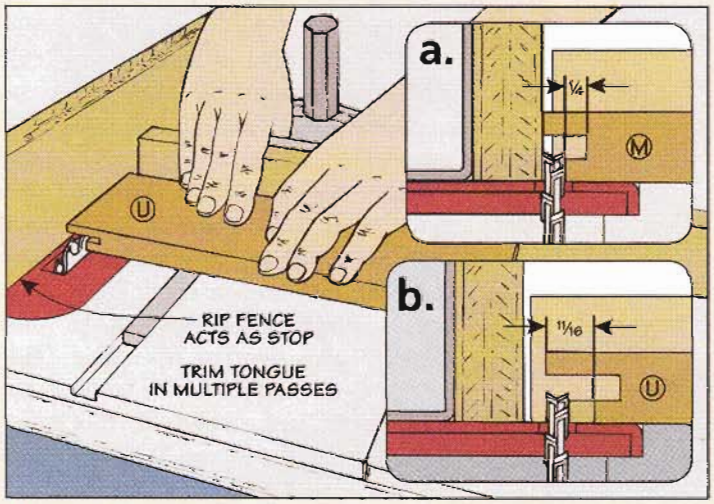
Once the drawer bottom is cut to size, you can glue up the drawer. Make sure everything remains flat and square during the assembly. Then, attach the two-part drawer slides to the case and drawer.

Finally, you can apply a few coats of finish. Once it dries, you can start rounding up all of your hardware. In no time, you'll have it organized and easy to find the next time you need something.

Locking Rabbet



▲ ***End Slots.*** *To keep narrow pieces from tipping, use a simple pushblock. I also attached a tall, auxiliary fence to the rip fence for added stability. Detail 'a' shows the depth of the slot for the trays. The slots for the drawer front are shown in detail 'b.'*



▲ ***Trim Cut.*** *Trim the inside tongue of the slot to create clearance for the tray side (detail 'a'). For the drawer, you need to account for the metal slide as well, as shown in detail 'b.' I use the rip fence as a stop to keep the cuts consistent.*

ShopNotes

hardware Cabinet

Materials List

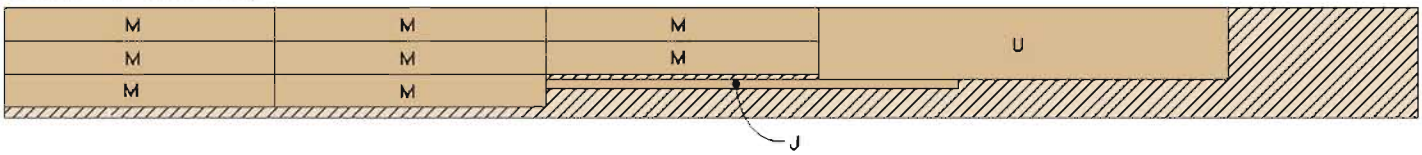
CASE		
A	Sides (2)	8½ x 25 - ½ Ply.
B	Top (1)	8⅛ x 28¼ - ½ Ply.
C	Drawer Divider (1)	7½ x 28¼ - ½ Ply.
D	Bottom (1)	8½ x 28¼ - ½ Ply.
E	Upper Divider (1)	7½ x 18¾ - ½ Ply.
F	Side Dividers (2)	7½ x 17¾ - ½ Ply.
G	Bin Dividers (3)	7¼ x 4½ - ½ Ply.
H	Shelves (3)	7½ x 18¾ - ½ Ply.
I	Bin Shelves (6)	7½ x 4½ - ½ Ply.
J	Lip (1)	½ x ¾ - 28
K	Back (1)	28 x 18 - ½ Ply.
L	Back Rail/Cleat (2)	4 x 28 - ½ Ply.

TRAYS		
M	Tray Front/Back (8)	¾ x 2¼ - 18⅜
N	Tray Sides (8)	½ x 2¼ - 6 13/16
O	Tray Bottom (4)	17⅞ x 6 5/16 - ¼ Ply.
P	Tray Brace (4)	½ x 1¾ - 6 5/16
Q	Dividers (16)	1¾ x 6 5/16 - ¼ Ply.
R	Lid Front/Back (8)	½ x 1 - 18⅜
S	Lid Sides (8)	½ x 1 - 7 5/16
T	Lid Panel (4)	5⅞ x 16 13/16 - ⅛ Acrylic
DRAWER		
U	Drawer Front (1)	¾ x 4⅞ - 27⅞
V	Drawer Back (1)	½ x 4⅞ - 26½
W	Drawer Sides (2)	½ x 4⅞ - 8
X	Drawer Bottom (1)	26½ x 7½ - ¼ Ply.

- (10) #8 x 1¼" Fh Woodscrews
- (3) #8 x 2" Fh Woodscrews
- (12) #10 x 1" Rh Woodscrews
- (14) #4 x ⅜" Fh Woodscrews
- (6) 4¼" Plastic Handles
- (4 pr.) 1½" No-Mortise Hinges w/Screws
- (8) Draw Latches w/Screws
- (1 pr.) 8" Full-Ext. Drawer Slides w/Screws
- (12) Plastic Hardware Bins

Cutting Diagram

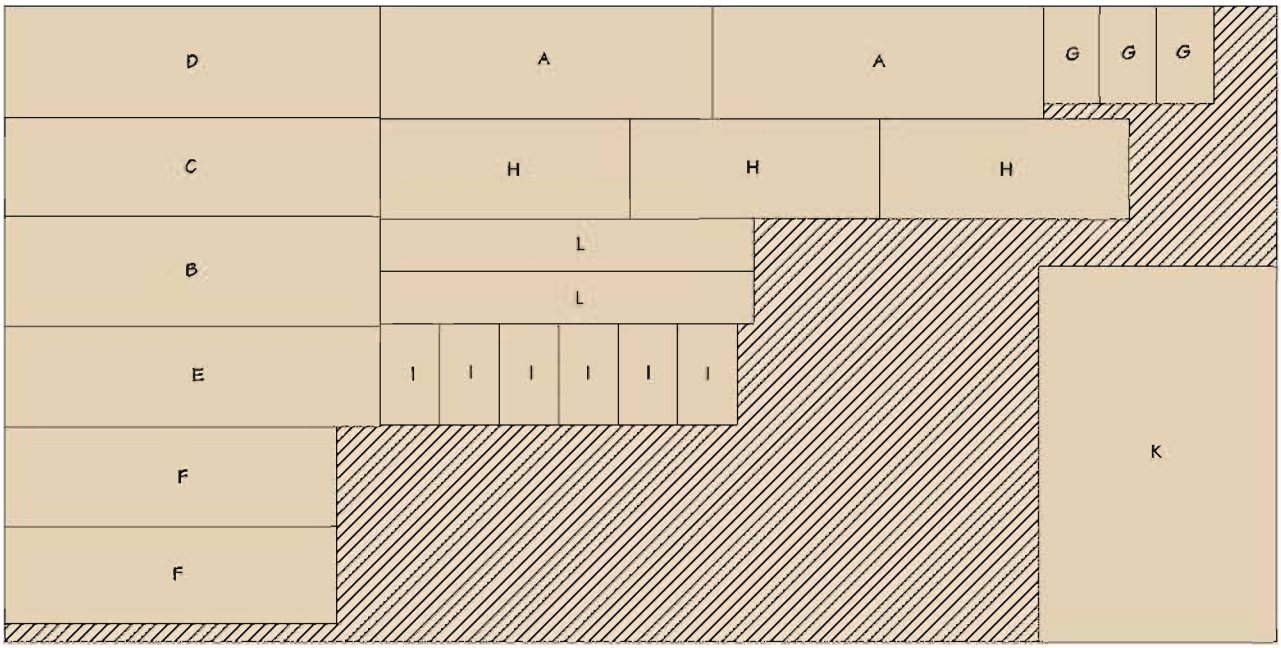
¾" x 7½" - 96" (5.0 Bd. Ft.)



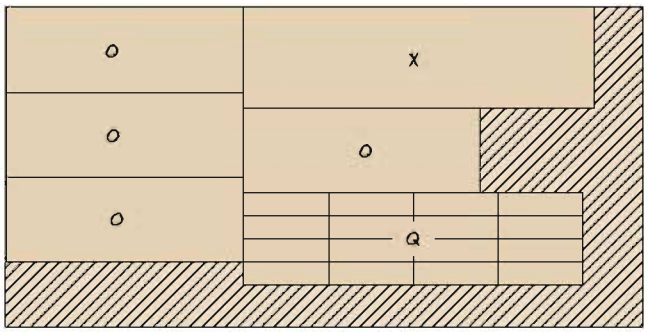
½" x 7½" - 96" (5.0 Sq. Ft.)

Cutting Diagram

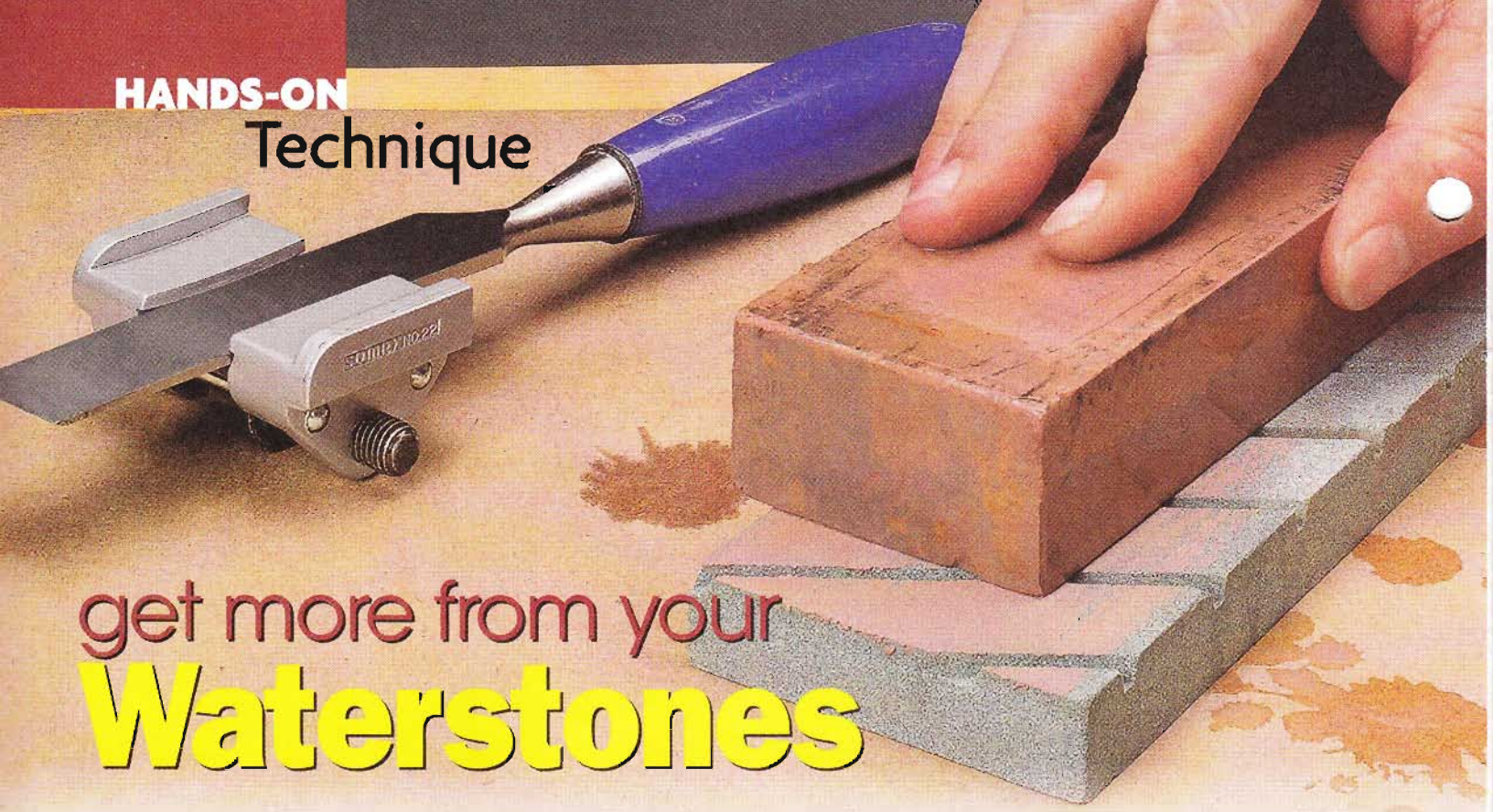
½" x 48" - 96" PLYWOOD



¼" x 24" - 48" PLYWOOD



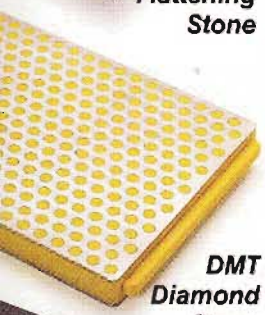
ALSO NEEDED: 24" x 24" PIECE OF ⅛" CLEAR ACRYLIC



get more from your Waterstones

To create a perfect edge, it pays to spend a little time getting your waterstones in tip-top shape.

Norton Flattening Stone



DMT Diamond Stone

220-grit Sandpaper on MDF

Waterstones are a great way to keep most edge tools sharp and ready for use. The main reason I like them so much is that they cut quickly. This means it only takes a few minutes to sharpen my tools and get back to woodworking.

But just like a tool needs to be taken care of, a waterstone needs to be properly cared for and "tuned up." I've found that by making a few important maintenance tasks part of my sharpening routine, I get better results on edge tools and more life out of the stone.

How A Waterstone Works. What makes sharpening tools with a waterstone so efficient is the way the surface continually breaks away to expose fresh, sharp abrasive particles. The downside to this is the surface of the stone wears down only where the tool is contacting the stone. This can create a hollow spot in a relatively short time. The result is a tool with a rounded bevel and curved cutting edge that keeps you from getting flat, square cuts.

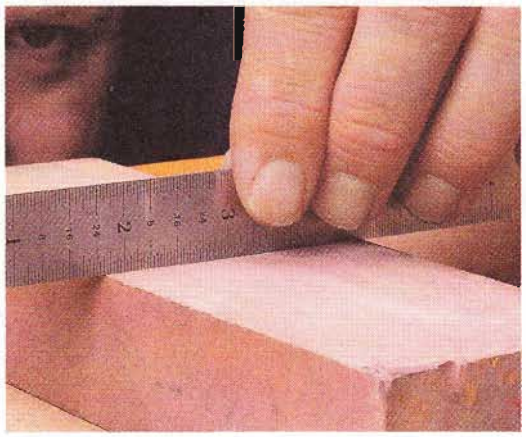
Simple Solutions. Thankfully, the solution to uneven wear on a waterstone is easy. It all starts with developing habits that keep your waterstones flat. And there are two steps you can take to accomplish this: make better use of the stone's surface and flatten it regularly.

The first step is to use the stone in a way that helps it stay flat longer. The natural tendency is to center the tool on the stone as you sharpen, which confines the cutting action to the middle of the stone. This is even more likely if you use a honing guide to sharpen a tool.

Not only does this create a hollow quicker, but it also "wastes" the remaining surface of the stone. That's because in flattening the stone to remove the hollow, you end up grinding away a large "unused" portion of the stone.

Instead, it's a good idea to make an effort to use as much of the surface of the waterstone as you can during sharpening. One way I do this is to flip the stone end for end periodically. This way, I use parts of the stone that have been under the wheel of the honing guide.

This simple step is surprisingly effective in keeping your waterstones flat and wearing evenly longer. But at some point you'll still have to flatten the surface.



▲ ***Straightedge.*** *A small ruler can show you when it's time to flatten your waterstone.*

Flattening. One question I'm asked regularly is how often to flatten a waterstone. For stones up to 2000-grit, I like to flatten them at the end of each sharpening session. These stones wear faster, and the process doesn't take much time.

Higher grit stones, on the other hand, are harder so they don't dish out as quickly. Plus, I also don't take as many strokes on them when sharpening a tool. So I usually flatten them every other time.

It's also a good idea to periodically check a stone for wear during use. You can do that with a 6" ruler, as shown in the lower photo on the previous page. Visible light under the ruler indicates a low spot.

Tools For Flattening. The process of flattening a waterstone is really a simple task using the abrasives shown the left margin on the opposite page. These products are harder than the waterstone.

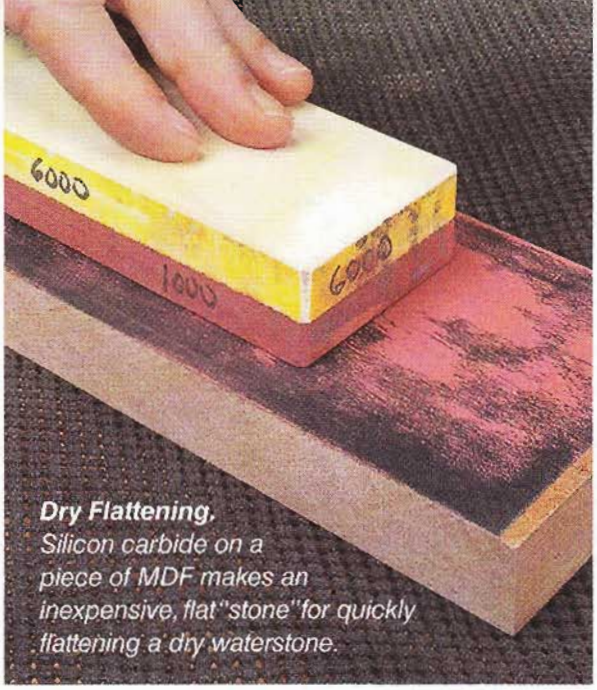
One manufacturer, *Norton*, sells a flattening stone (top). It has grooves in it to carry away the slurry created by flattening a stone. Another good choice is a diamond "stone" (middle). This super-tough abrasive will last for a long time. You can find sources for these stones on page 51.

A more economical choice is shown at the bottom of the photo. It's simply a piece of 220-grit silicon carbide sandpaper glued to a piece of MDF. It works best when flattening dry waterstones.

To flatten the stone, just rub the waterstone back and forth across the flattening stone, as you can see in the main photo on the previous page and the photo above.

Wet. If the stone is wet, you can gauge your progress by watching the color of the stone. Hollows appear as dark patches. Stop once the stone is a uniform color.

Or Dry. For dry stones, I find it best to draw a pattern of pencil lines across the face, as you can see in the top photo in upper right margin. Use the lines to gauge your progress, as in the lower photo in the upper right margin. Then, just work until all the lines have been removed.



Dry Flattening. *Silicon carbide on a piece of MDF makes an inexpensive, flat "stone" for quickly flattening a dry waterstone.*

▲ **Progress.** *A pattern of pencil lines (top) reveals low spots as you flatten the stone (bottom).*

One last thing I like to do is create a slight chamfer on all the edges of the stone (right margin photo). This helps prevent the edges from chipping or crumbling.

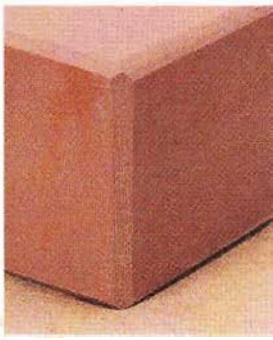
Storing A Waterstones. One aspect of waterstone care that's often overlooked is proper storage. I prefer to let the stone dry out between uses. Keep the stone in a covered box to protect it from damage and keep it clean. And you should protect a waterstone from freezing. Even a "dry" stone may contain enough water to cause a crack as the temperature drops.

Then all it takes to get a stone ready for use is to soak it for 10 to 20 minutes, as you can see in the lower left photo.

Use with Care. There are a few other tips I want to mention. I like to keep a spray bottle close at hand to add water. A light film of water helps float away debris and prevents the stone from clogging (lower right photo).

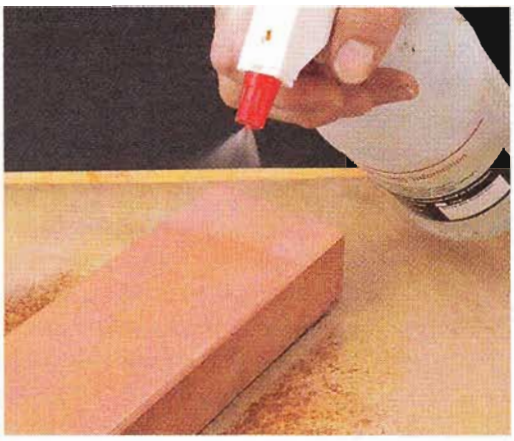
Second, when you finish with one stone, rinse off the tool and honing guide before moving to the next grit. Doing this prevents contaminating the next stone with grit that can leave scratches on the tool's edge. Finally, I always rinse and brush the stone under running water to flush away any debris.

Waterstones save you time when sharpening. And with a little care, they're easy to keep in top shape. This way, you can always rely on them to create razor-sharp edges on your hand tools.



▲ **Chamfers.** *Soften the edges of the waterstone to prevent them from chipping.*

▲ **Soak First.** *Use a small plastic tub to soak the waterstone for a few minutes before you start sharpening.*



▲ **Keep it Wet.** *Use a spray bottle to keep a film of water on the stone before and during use to help float away debris.*

custom, shop-made Scraper Shaves

A few pieces of scrap, some hardware, and a card scraper are all it takes to build a set of fine hand tools.

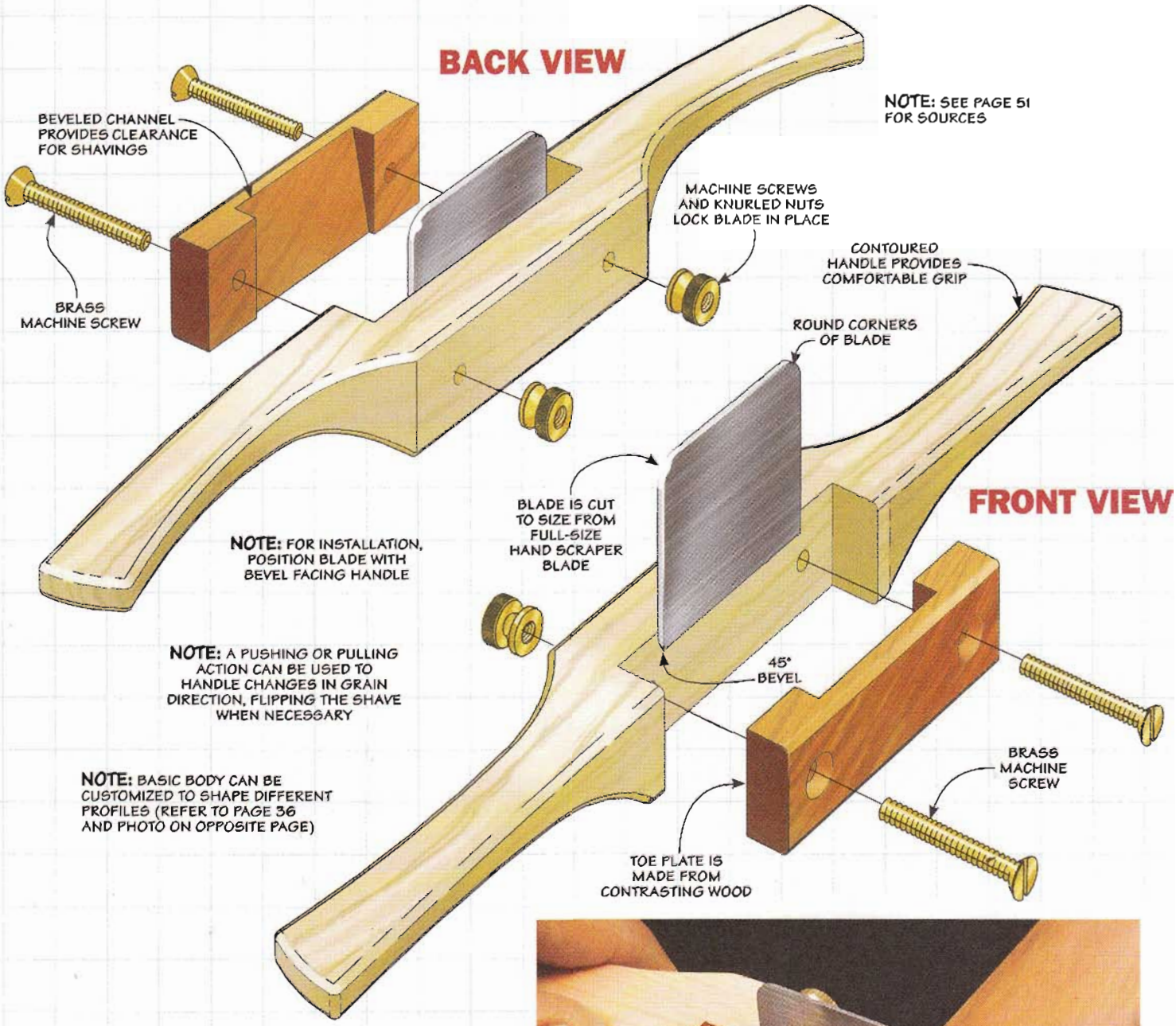
Removing marks and ridges left over from machining and hand tool shaping can be a challenge. For many of these types of tasks, I turn to a scraper shave. This unique hand tool makes cleaning up and smoothing oddly shaped workpieces a pleasure.

The gently curved handles are cut on a band saw and shaped to fit your hand. To sharpen and adjust the blade, all you do is loosen the two screws that hold the toe in place. Using the shaves produces a smooth, clean workpiece, even when working with figured wood.

Scraper Shaves. The four versions shown above include a flat-bottomed shave, as well as two radius shaves designed especially for shaping round or curved pieces. You'll also find plans for a notched shave that's great for adding and smoothing chamfers.

Exploded View Details

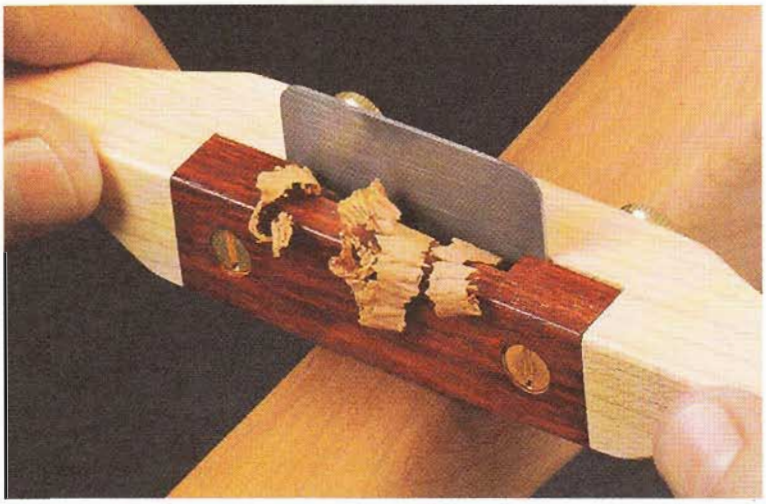
OVERALL DIMENSIONS: 1⅛"D x 11½"W x 1"H



Materials & Hardware

A	Handle (1)	1 x 1⅛ - 11 ½
B	Toe Plate (1)	½ x 1 - 3⅛

- (1) 0.8 mm Cabinet Scraper
- (2) #10-32 x 1½" Fh Brass Machine Screws
- (2) #10-32 Brass Knurled Nuts



▲ ***Wispy Shavings.*** *The comfortable handles of this shave allow you to maintain firm control of the scraper. This makes it easy to smooth and shape the surface on a wide range of workpieces.*

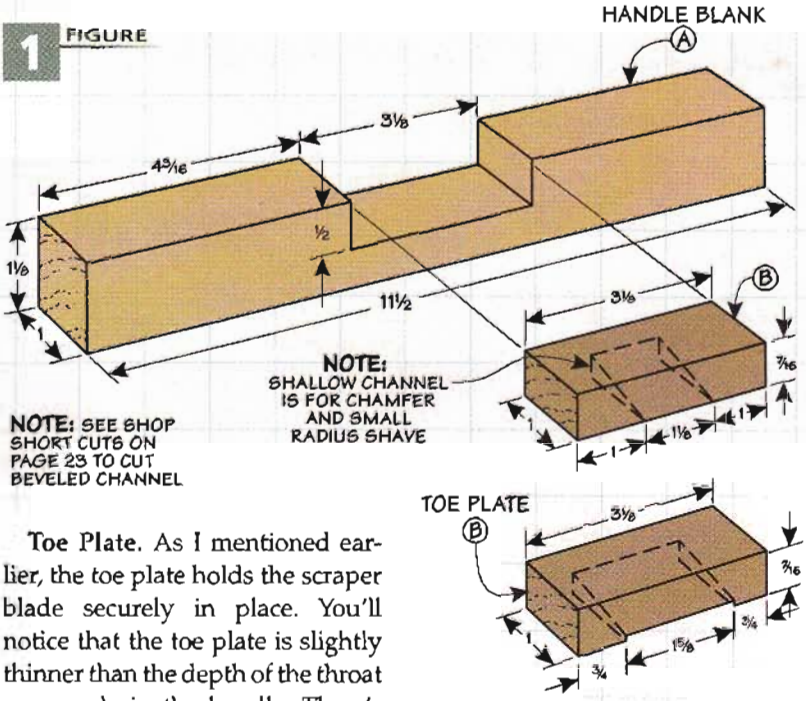
making the Handle & Toe

Building a scraper shave is a fairly straightforward process. The handle of the shave is a single piece of hardwood notched in the center to create an opening for the blade and toe plate. The ends of the handle are shaped to form a comfortable grip on each side of the blade.

The toe plate holds the scraper blade securely in place. It's just a short piece of contrasting hardwood that fits inside the opening. Sandwiched between the handle and toe is the scraper blade. My blade is 2" wide, but the opening that it rests in is a little over 3".

This leaves room to spare on each side of the blade for a pair of brass screws and knurled nuts that lock the blade in place. To position the scraper blade for use, or simply sharpen it, all you need to do is loosen the knurled nuts.

Before you can shape the handle and cut the notch for the opening, you first need to cut the blank to size, as shown in Figure 1. Then, use a dado blade in the table saw to make the throat. To establish the throat shoulders and guarantee it's centered on the handle, I used the rip fence as a stop, rotating the workpiece between passes.

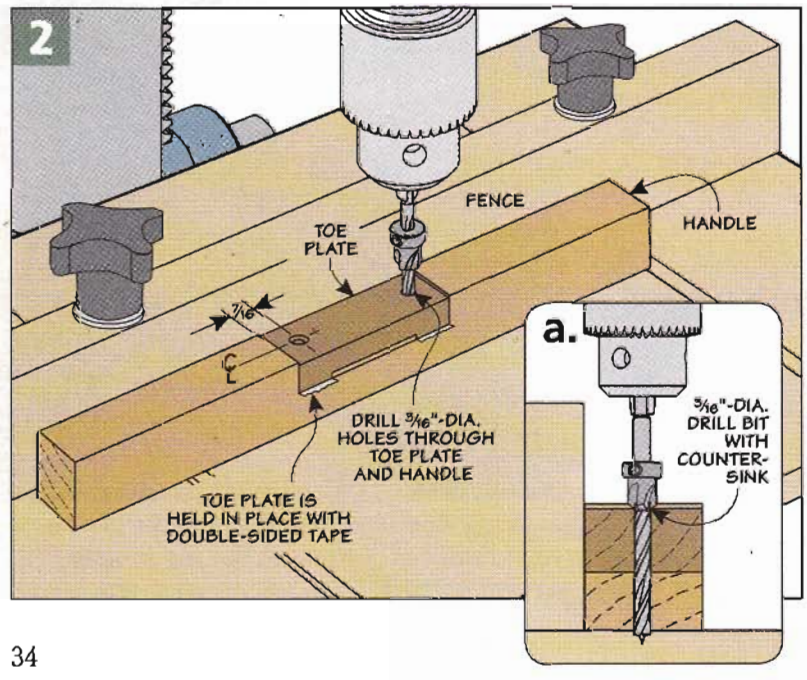


Toe Plate. As I mentioned earlier, the toe plate holds the scraper blade securely in place. You'll notice that the toe plate is slightly thinner than the depth of the throat you made in the handle. There's a good reason for this. Later on, when the blade is installed, it ensures that the outside face of the toe plate ends up flush with the outside face of the handle.

Chip Clearance. On one face of the toe you'll notice a shallow, beveled channel. This channel provides clearance for chips and shavings (Figure 1). Shop Short Cuts on page 23 shows an easy way to get the job done on the table saw.

One other thing. You'll notice that there are two different width channels. That's because only a narrow portion of the scraper blade is exposed on two of the shaves — the small radius curve and the chamfer versions.

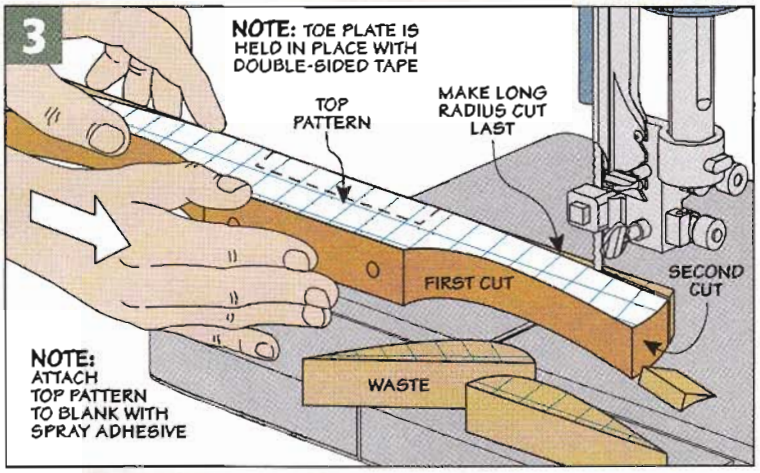
Drill Holes. Now you're ready to shape the handle and toe, but before you do that you'll want to drill the holes and countersinks for the brass screws, as illustrated in Figures 2 and 2a. You could drill the pieces separately, but drilling the holes together ensures they'll line up. It's easiest to do this while the handle is still square. I used the drill press and a fence to keep things aligned, plus a piece of double-sided tape to help hold the toe in place.

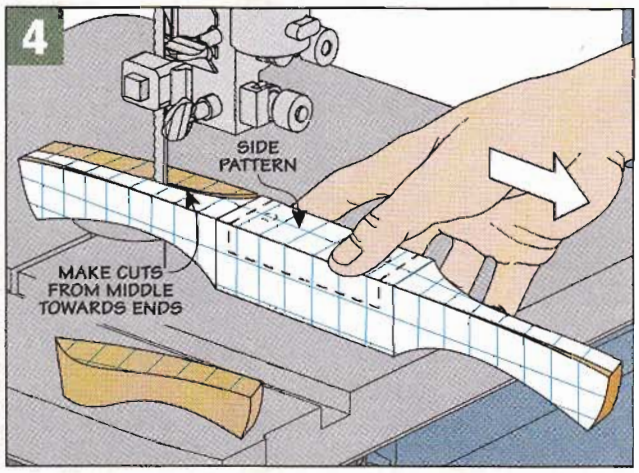


SHAPING THE HANDLE

After completing the handle and toe plate that hold the blade in the shave, the next step is to shape the handle to make it a little more "user-friendly." Beyond the basic comfort of the sculpted ends, it's easy to see that their shape also helps you to control the scraper, allowing you to easily get into tight spaces.

Shape the Shave. The two patterns at the bottom of the next page show the profile that I used for all four of the shaves. As you can see, the handle is contoured on all four sides for a comfortable grip. And a slight roundover on all the edges refines the fit and finish.





Go ahead and make full-size copies of the two patterns now. Then, set the side pattern aside and attach the top pattern to the handle with spray adhesive. Just be sure you get it attached in the correct orientation, as shown in Figure 3 and the pattern drawings below.

You'll also note that I used a couple of pieces of double-sided tape to hold the toe in place. Leave the toe plate in place during this step to help support the pattern while you're making the cuts.

Top Pattern. A band saw makes quick work of cutting the handle to shape. It's simply a matter of following the layout lines. And, to make things even easier, I've also included the order of the cuts in each of the patterns.

You'll make the first three pairs of cuts with the top pattern facing up and the bottom of the handle flat on the saw table — starting with the two deep curves of the back, followed by the two ends. Once those cuts are complete, you'll create the long, wide curve along the front of the shave (Figure 3).

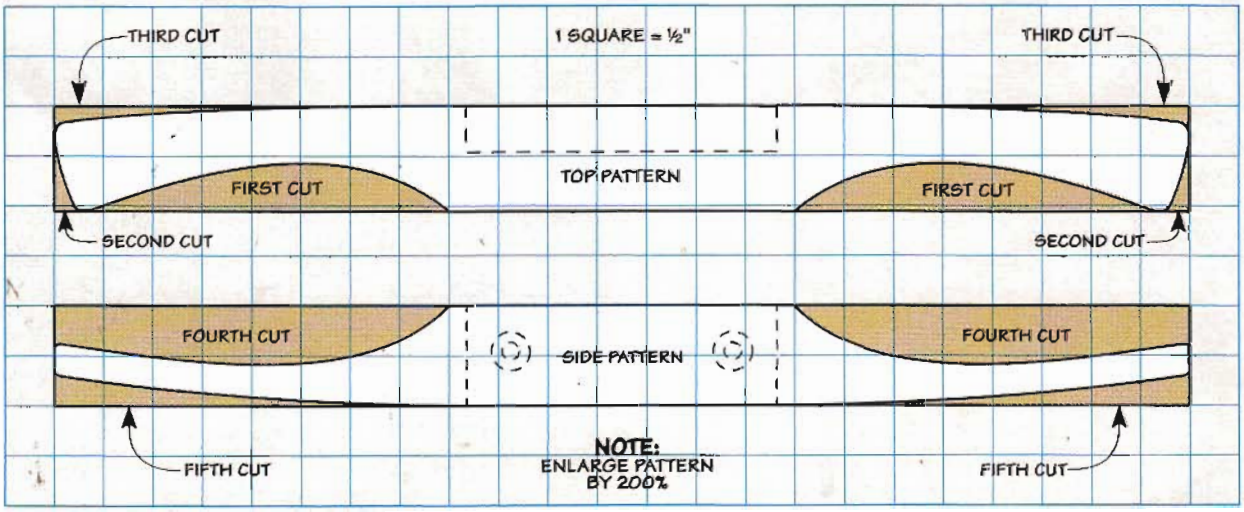
Side Pattern. With the cuts on the top face completed, you can finish up shaping the handle by cutting the side contours. Start by attaching the side pattern to the long, curved back face of the blank. In this case, the toe is facing up. You may notice, the band saw blade leaves ridges on your workpiece. If it helps make it easier to attach the pattern, go ahead and do a little sanding at this time.

If you look at Figure 4, you'll see that when the handle is set on the table, the curved ends touch the tabletop. This helps provide a little extra stability while making the last few cuts. I made the deep, curved cuts starting near the middle and working my way out to the ends, since some of the end may have already been cut away. Then, finish up by making the long radius cut (see pattern).

Finish Shaping. Now it's off to the workbench to refine the finished shape of the handle with files and sandpaper. And, to make the handle a comfortable fit, I sanded off all the sharp edges.

If you've decided to make just the flat-bottomed shave, the next step is to prepare the scraper blade. But you can also build a custom set of shaves, including the small and large radius and a chamfer shave, plus the blades to fit them. For information on building these shaves, turn to the next page.

Handle Pattern



customizing the

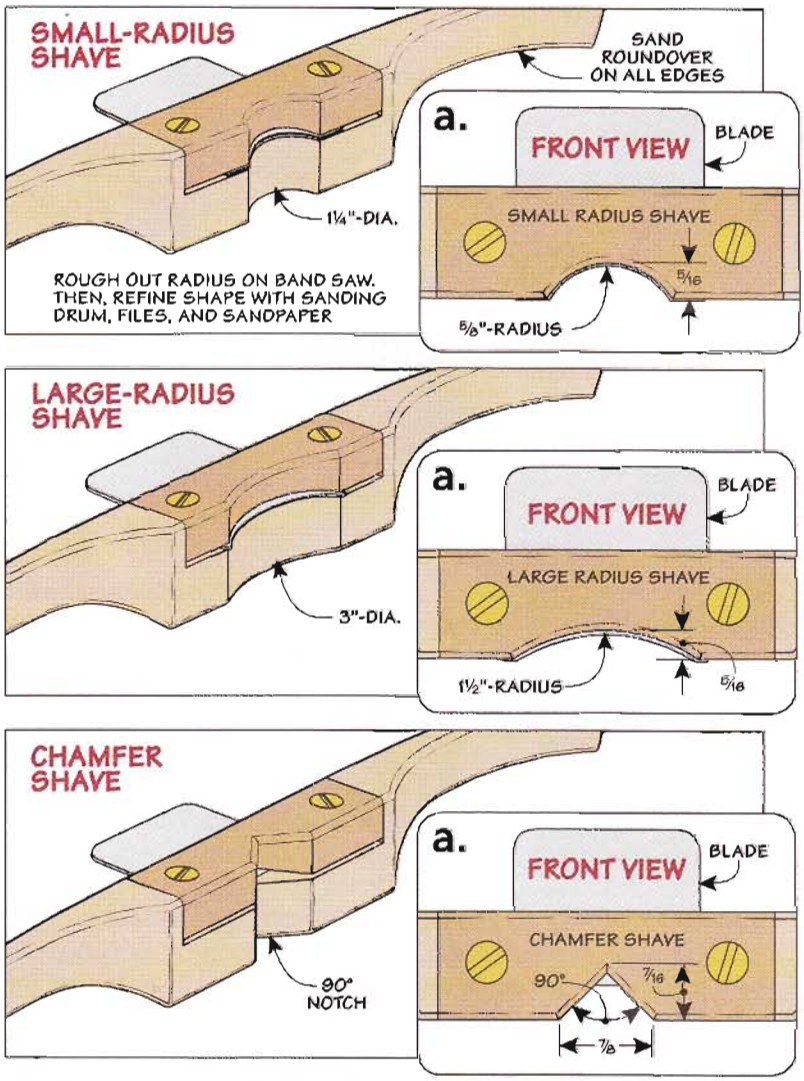
Shave Profiles

A basic scraper shave works well for smoothing flat surfaces and convex curves, but it's easy to customize one to make it even more versatile. The basic handles start out the same for the three custom shaves shown at right. Making all three completes a set of shaves that can tackle all kinds of tasks.

Radius Shaves. As you can see in the top drawing, the narrow radius of the small-radius shave works great for doing final smoothing of round shapes. I use the large-radius shave in the center drawing to make light passes when I'm cleaning up irregular-shaped pieces like cabriole legs.

Forming the radius for each shave is simple. First, I used the band saw to rough things out. Then, I refined the profile using a sanding drum at the drill press. All it takes is a little filing and finish sanding to complete the profiles.

Chamfer Shave. This shave is a great little tool for quickly easing the edge of a workpiece. Again, use the band saw to form a 90° notch on the base (lower drawing). Then, finish up with a file and some sandpaper. Once that's complete, you can make the scraper blades to fit the shaves and prepare them for scraping.

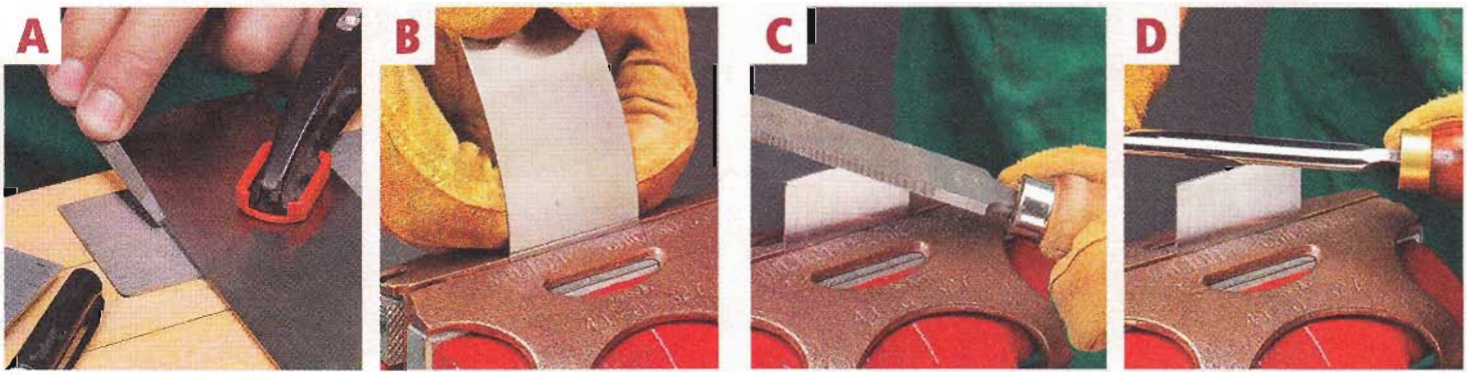


THE BLADE

The key to making a shave work is the blade. Forming a 45° bevel and creating a burr is the secret, and it's easy to do with a few basic hand tools. But first, you'll have to "cut" an inexpensive scraper blade down to size to fit the shave body.

Shave Blade. All you need is a piece that's 1½" x 2". After it's cut down to size, I'll explain how to make the bevel and add the burr on the flat-bottomed and chamfer versions. To learn more on how to prepare a scraper blade for the two radius-profile shapes, see the box on the next page.

The simplest way to cut a full-size scraper down into four smaller versions is to first clamp



▲ **Score & Snap.** *Clamp the full-size scraper blade to the workbench and score a groove with a file. Then, place the blade in a vise and gently pull on the blade until it snaps at the groove.*

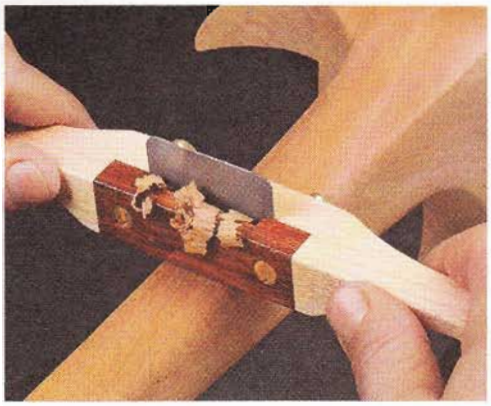
▲ **Shape & Burnish.** *A smooth mill file works great to form the 45° bevel on the edge of your shave blade. Once that's complete, use a piece of hardened steel to add a slight hook.*

the blade to your benchtop. Then I used a small triangular-shaped file to score a line across the width of the blade, as shown in photo A on the previous page. When that's complete, clamp it in a vise and snap off the blade, like you see in photo B. Then just repeat the process for the other side.

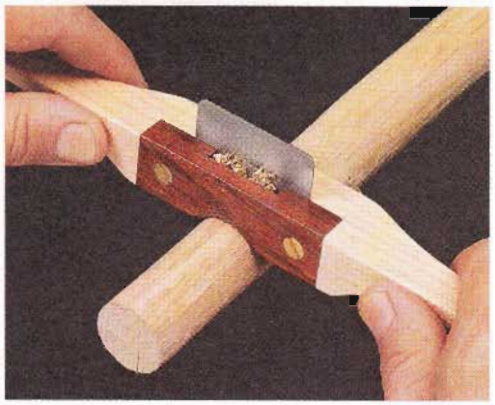
Sharpening the Scraper. Once you've cut the blade to size, it's easy to get it ready for use. You'll first need to file one edge of the blade to form a bevel at 45°. This means you'll only be able to form a single burr on the edge of your scraper. But, the nice thing is — creating the burr is simple. One or two strokes with a hardened-steel burnisher is usually plenty.

File. Start by filing the end of the scraper with a smooth mill file to about a 45° angle (photo C). (The exact angle isn't critical.) I used a smooth, even motion, pushing the file away from me and then lifting it up on the return stroke (photo D). Five or six passes with the file is just about right.

Add a Burr. Next you'll need to create a burr on the bevel. As you can see in the far right photo on the opposite page, I did this by clamping the scraper in a vise and drawing the burnisher over the bevel. The idea is to "turn" a slight hook away from the bevel.



▲ ***Flat-Bottomed Shave.*** *Use this shave on small flat surfaces, or any time a large cabinet scraper can't be used.*



▲ ***Shape On the Round.*** *Ridges are easy to remove on chair parts or round objects using either of the radius shaves.*

USING THE SHAVE

The beauty of a scraper shave is that it's extremely easy to use. And because you can use it with either a pushing or pulling action, you're always able to quickly handle changes in grain direction. Of course, this means flipping the tool often, especially on a piece of hardwood with a lot of figure.

A scraper shave makes it easy to shape and smooth a workpiece that would otherwise be difficult to work. I've used my flat-bottomed shave to do most of the prep work for finishing that I often had to tackle with sandpaper (top left photo). And the radius shaves are great for removing ridges left behind after using a spokeshave to make chair parts (top right photo).

Finally, when I need to soften an edge, the flat blade that protrudes just below the V-notch in the chamfer shave makes it easy. You can see what I mean in the photo above.

To produce a smooth, even surface with very little effort, a scraper shave is the tool to reach for. In fact, it might surprise you how often you end up using one.

◀ ***Ease an Edge.*** *The V-notch on the chamfer shave makes it easy to soften an edge on a 90° corner.*

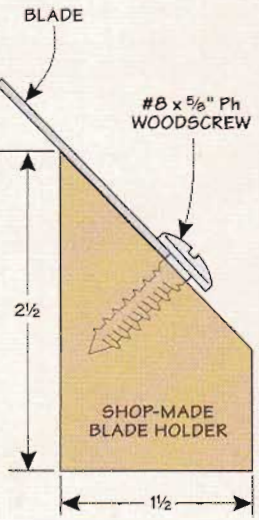
Creating a Curved Blade

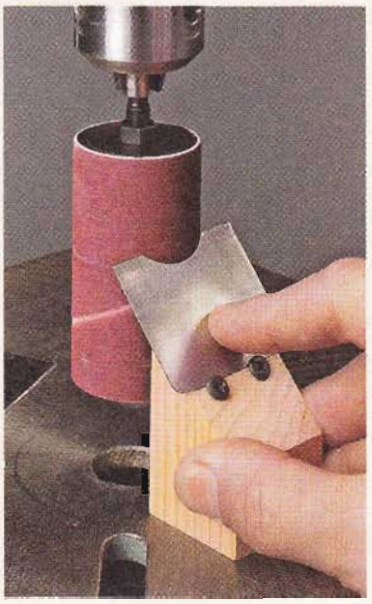
Before you can use the radius shaves, a profile needs to be formed in the small scraper blade to match the shape of the shave sole. Once they're shaped, you'll need to add the bevel. After a little experimenting, I found the best way to form the radius and the bevel is to use a sanding drum in my drill press.

Sand the Profile. Start by holding the blade with a pair of pliers, while using a 60-grit sleeve on a 1"-dia. drum to do some aggressive sanding to shape the profile. The blade heats up quickly, so be sure to dip it in water often.

To create a cutting edge, you'll need to form a 45° bevel, but no burr is necessary. The best way to do this is with a sanding drum and a shop-made holder made from a block of wood, like the one shown in the photo and drawing at right.

Switch to a 1½"-dia. drum and 100-grit sandpaper for this step. You may have to do a little free-hand sanding to make the bevel on the large-radius blade. Finally, hone the beveled edge and lap the back of the blade on a stone.





5 ideas for handy Clamp Storage

Organize your workshop more efficiently with these space-saving solutions for storing clamps.

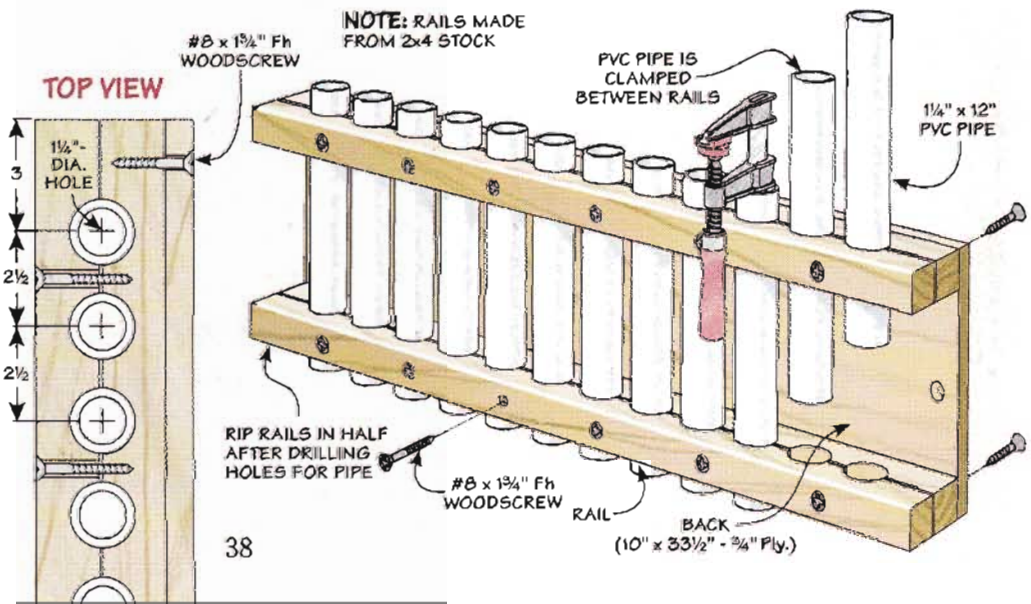
With cabinets lining the walls and tools positioned strategically around the shop, finding enough space to store your clamps can be a problem. Customizing that space to efficiently store each style of clamp is almost as critical. Here are five great ideas for custom storage.

COMPACT CLAMP STORAGE

A quick and inexpensive idea for storing a wide variety of clamps is to use heavy-duty shelf standards and brackets, like the ones shown in the photo above.

By using brackets of different lengths, and then positioning the brackets for different sized clamps, you can arrange them to hold just about any style of clamp. Just be sure to anchor the brackets and standards securely to wall studs.

You can store long clamps horizontally across a pair of brackets. And a board, screwed in place across two brackets, stores smaller clamps. Finally, individual brackets are handy for spring clamps, C-clamps, and handscrews.



BAR CLAMP RACK

Creating an easy way to store a lot of clamps efficiently is another goal. For example, you can use PVC pipe to make a rack for bar clamps, like the one you see at left.

The rack holds up to twelve bar clamps in a small space. Short lengths of PVC pipe held in the rack serve as compartments to store each clamp individually.

To build the rack, all you need to do is drill a series of large holes, sized for the PVC, in two rails. Then, rip the rails in half and screw them back together. This way, they grip the pipe tightly holding them in place. Finally, screw the rack assemblies to a piece of plywood and secure it to the wall.

PIPE CLAMP RACK

Sometimes, simpler is better. The pipe clamp rack shown in the upper right drawing, is a good example. Inexpensive broom clips hold the clamps to a 2x4 back rail.

The broom clips are spaced evenly and the clamps snap into them. To keep the clamps from sliding, the heads of the clamps rest securely on the 2x4.

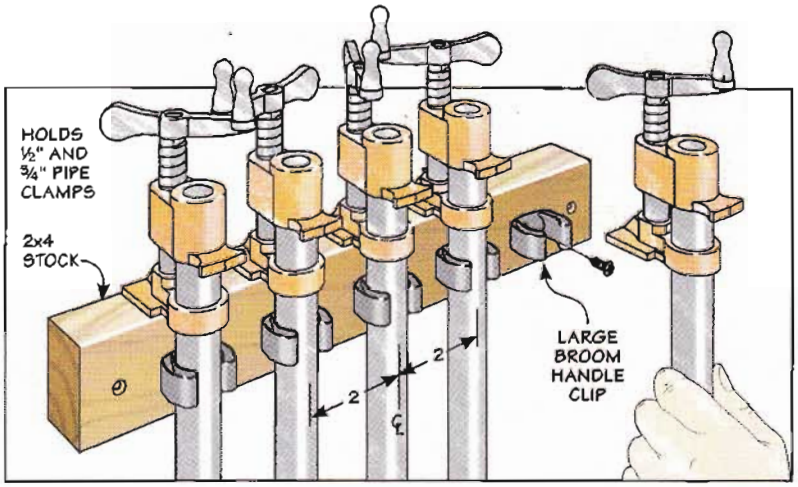
SMALL CLAMP HANGER

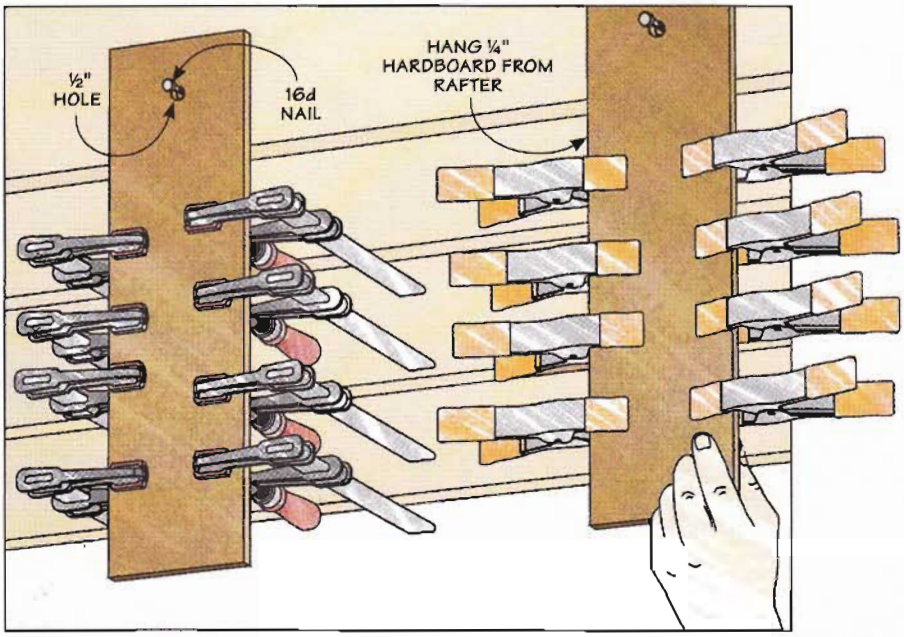
Unused and open space overhead provides a great solution for storing small clamps. As you can see in the drawing at right, I used a pair of hangers to keep everything handy. The hangers are simply wide strips of hardboard with a hole drilled in one end. And, to make them portable, the strips hang from nails I've set in the rafters.

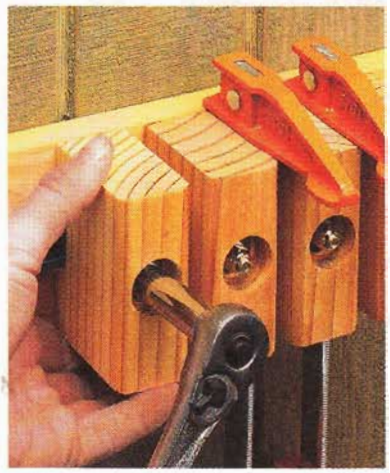
FLEXIBLE CLAMP STORAGE

The problem with some clamp racks is that they aren't adjustable for different types and numbers of clamps. The one shown below uses just two basic parts, a T-track that's attached to the wall and a series of adjustable blocks that fit over the track. You can position the blocks to accommodate just about any size and style of clamp.

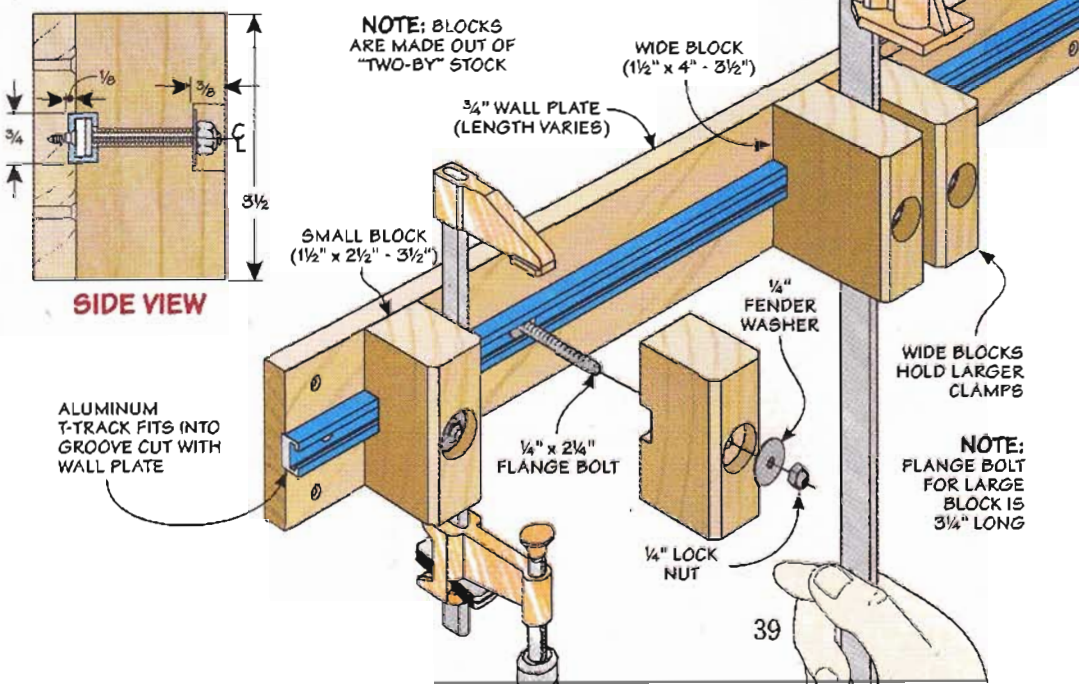
And if you buy more clamps down the road, this clamp storage system is easy to expand.







▲ ***Lock It Down.*** *This flexible clamp storage system can be easily readjusted for any size clamp with a ratchet and a socket.*

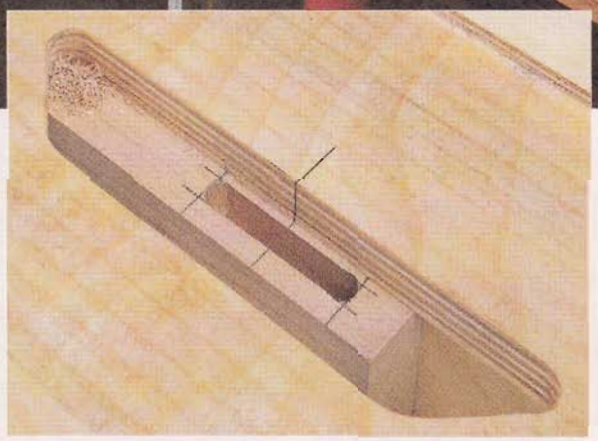


router Mortising Jig

You'll be making mortises in minutes with your hand-held router and this easy-to-build jig.

Creating a mortise with a hand-held plunge router is my favorite method for completing the task. The key to great results is guiding the router accurately so the sides of the mortise end up perfectly smooth, straight, and parallel to the faces of the workpiece.

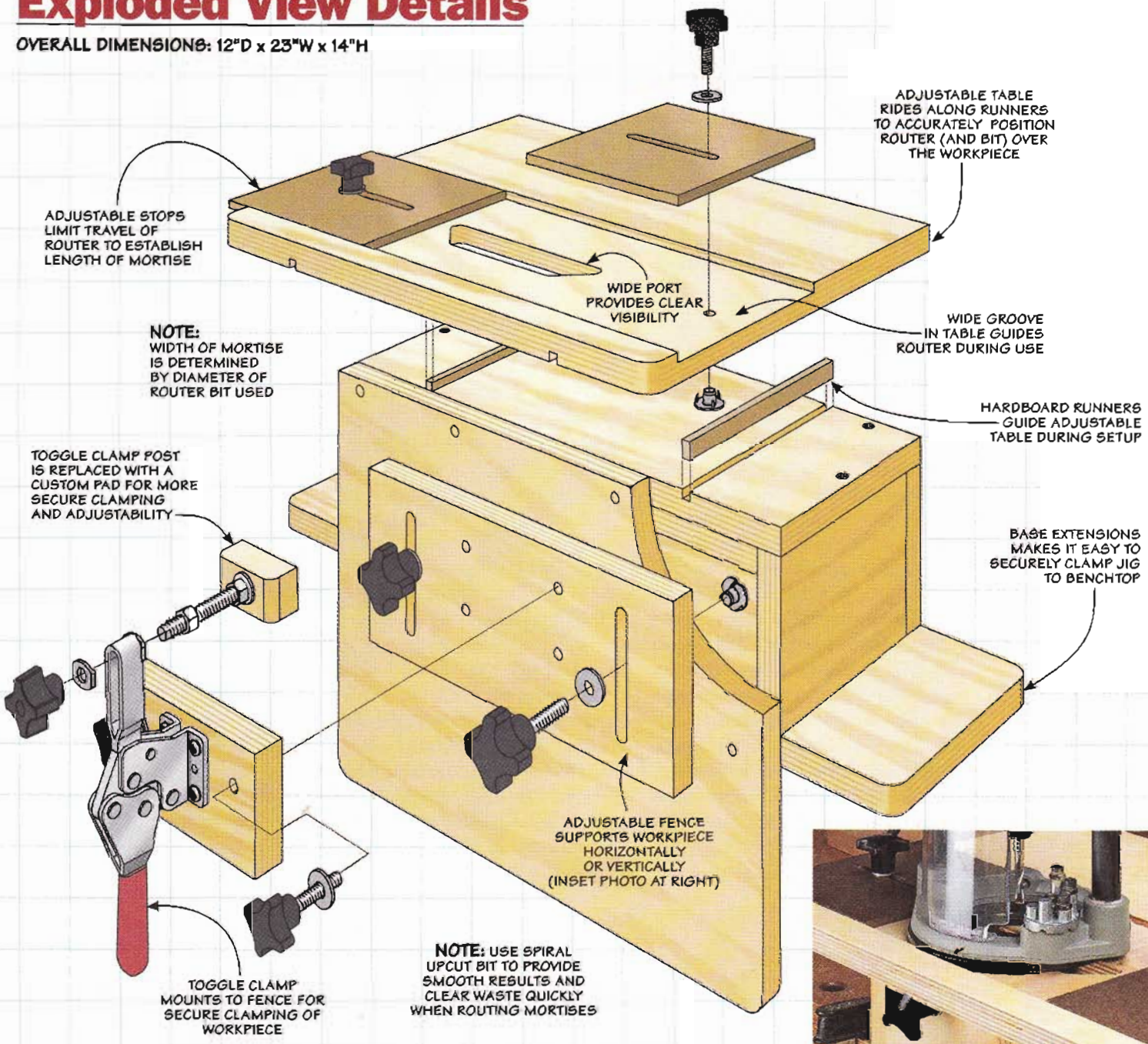
The solution I use in my shop is the mortising jig you see above. Clamping the workpiece in place only takes a second. Then, it's a simple task to adjust the table and stops to locate the mortise on the workpiece. Once everything is locked in place, you can knock out identical mortises quickly, easily, and accurately. As you can see in the photo at right, the result speaks for itself.

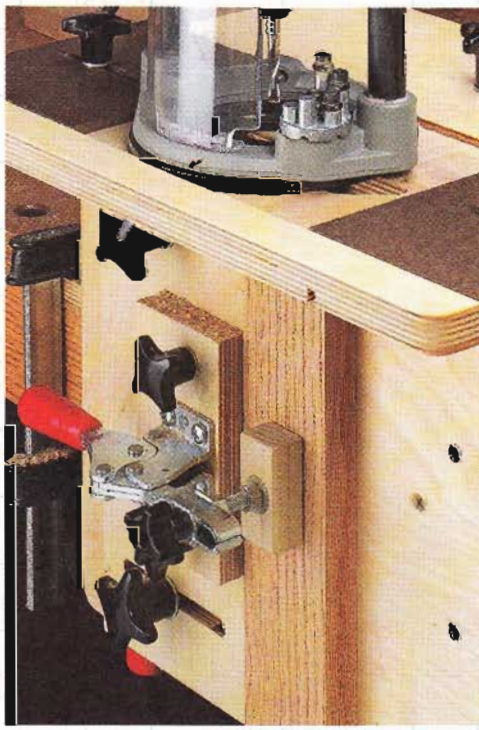


▲ ***Viewing Port.*** *A wide opening in the table makes the setup a snap. Plus, you can easily see your progress as you rout the mortise.*

Exploded View Details

OVERALL DIMENSIONS: 12"D x 23"W x 14"H





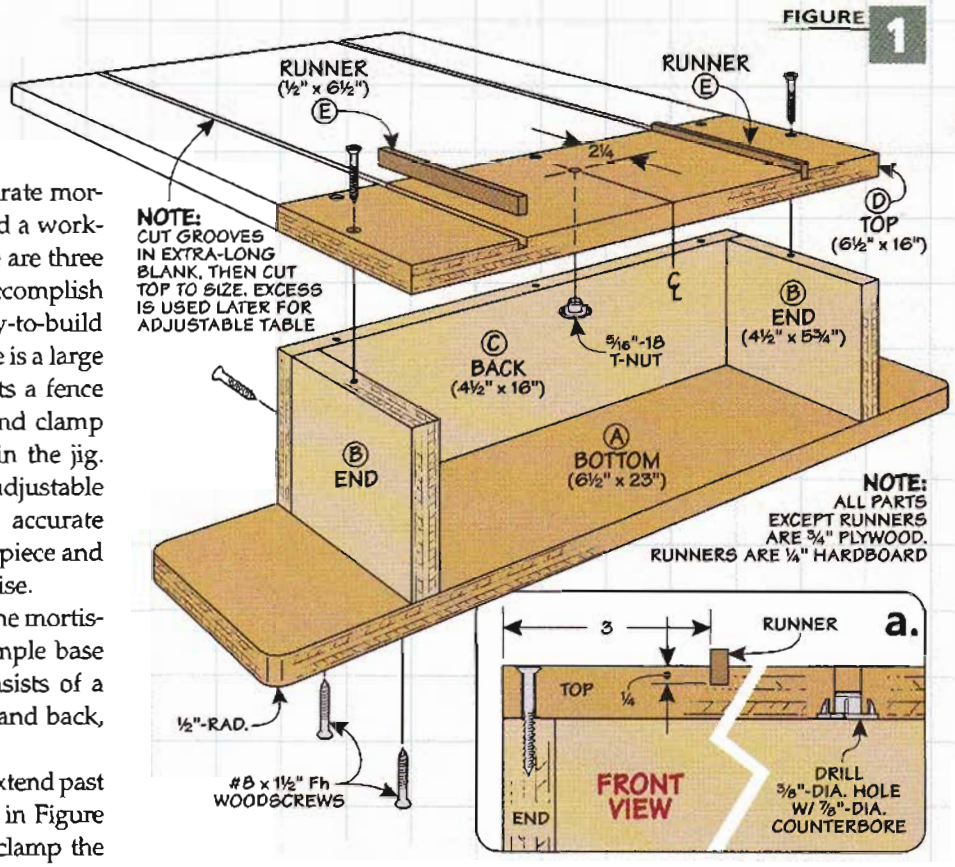
▲ ***Optional Orientation.*** *You can easily turn the fence 90° to mortise the end of a workpiece.*

Materials & Hardware

A	Bottom (1)	6½ x 23 - ¾ Ply.	• (1) 5/16"-18 Thru-Hole Knob
B	Ends (2)	4½ x 5¾ - ¾ Ply.	• (4) ¼"-20 x 1¼" Studded Knobs
C	Back (1)	4½ x 16 - ¾ Ply.	• (3) 5/16"-18 x 1½" Studded Knobs
D	Top (1)	6½ x 16 - ¾ Ply.	• (1) Toggle Clamp (De-Sta-Co TC-227-U)
E	Runners (2)	½ x 6½ - ¼ Hdbd.	• (6) ¼"-20 T-Nuts
F	Front (1)	12 x 16 - ¾ Ply.	• (9) 5/16"-18 T-Nuts
G	Adjustable Table (1)	12 x 16 - ¾ Ply.	• (4) ¼" Washers
H	Stops (2)	5 x 5½ - ¼ Hdbd.	• (4) 5/16" Washers
I	Fence (1)	5 x 11½ - ¾ Ply.	• (1) 5/16" x 3" Carriage Bolt
J	Clamp Block (1)	2¾ x 5 - ¾ Ply.	• (4) #8 x ¾" Ph Sheet Metal Screws
K	Clamp Foot (1)	¾ x 1 - 2	• (19) #8 x 1½" Fh Woodscrews

start with the Base

FIGURE 1



To make consistent, accurate mortises, the jig needs to hold a workpiece securely. And there are three key parts to the jig to accomplish this. The first is an easy-to-build base. Attached to the base is a large front panel which accepts a fence that's used to support and clamp the workpiece securely in the jig. And finally, there's an adjustable table that provides an accurate way to position the workpiece and router for routing a mortise.

Start with the Base. The mortising jig starts out as a simple base (Figure 1). The base consists of a top and bottom, a front and back, and a pair of ends.

The bottom is sized to extend past the ends, as you can see in Figure 1. This makes it easy to clamp the jig securely to the top of any worksurface. After cutting the ends and back to final size, they're ready to be glued and screwed to the bottom.

Adding the Top. There are a couple of tasks to take care of on the top before you can attach it to the base. First, you'll need to cut grooves for a pair of hardboard runners. The runners guide the adjustable table that's added later.

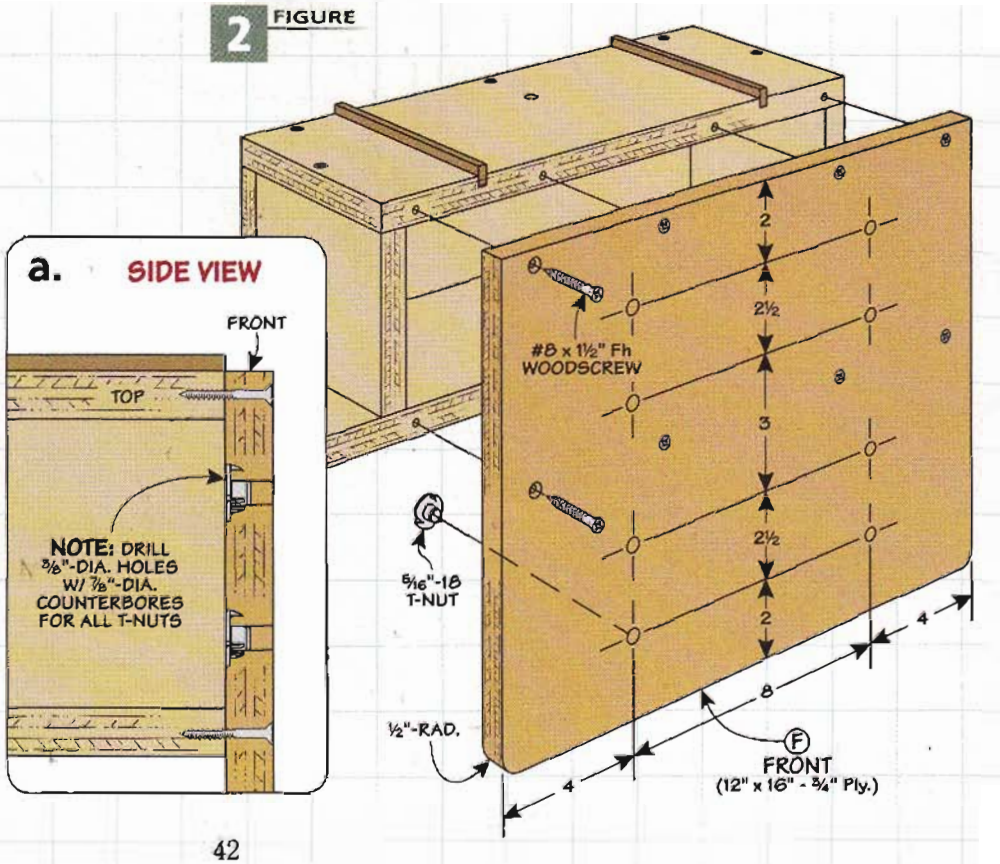
Since the adjustable table has matching grooves, I found it easiest to start with an extra-long blank (20") cut to final width and cut both pieces from the same blank (Figure 1). This ensures that the grooves in both parts will line up perfectly. Then, after cutting the grooves to match the thickness of the hardboard runners, all that needs to be done is to cut the top and adjustable table to their final lengths.

Before installing the runners, you'll need to drill a counterbored hole on the underside of the top and install a T-nut. The T-nut is used to secure the adjustable table in place. After gluing the runners into the grooves in the top, simply glue and screw the top flush with the edges of the back and ends.

Completing the Base. Adding the front shown in Figure 2 will complete the base. As you can see, other than cutting the front to size and sanding a radius on the lower corners, the only other thing to do is drill a few holes.

Like those on the top, these holes are counterbored for a set of T-nuts.

FIGURE 2



Here, the T-nuts are used to hold the fence in a variety of positions. Careful layout and drilling of the holes ensures that you can install the fence horizontally or vertically, to suit the size of the workpiece and the mortising task at hand.

The front is glued and screwed to the base. Just be sure the top edge of the front is flush with and square to the top of the base.

ADDING THE TABLE

With the base complete, the next step is to create a way to position the router easily and accurately so you can route the mortise. That's the job of the adjustable table you see detailed in Figure 3.

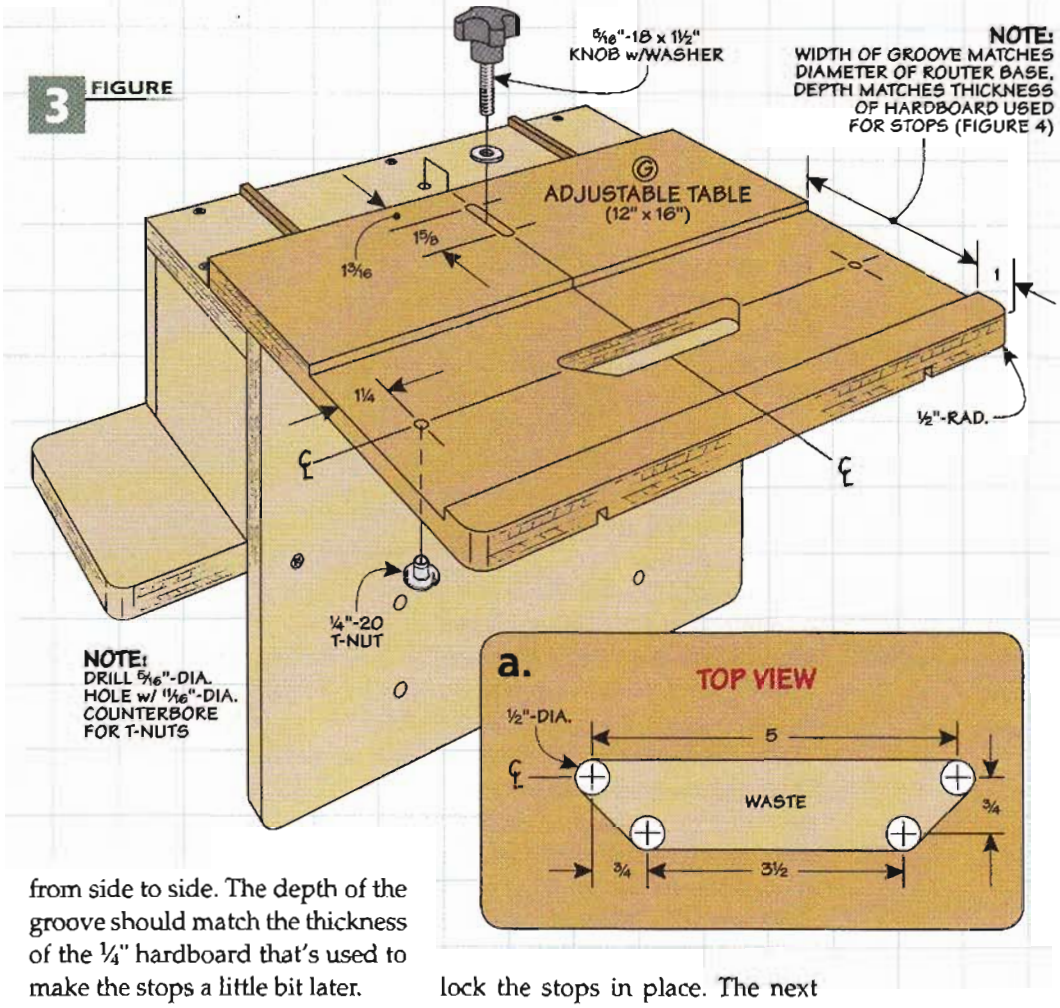
The adjustable table (with its matching grooves) can now be trimmed to final size from the blank you cut earlier. So the next step is to customize it for your router. What I mean by this is cutting a wide groove along the front edge, as in Figure 3. The groove acts as a guide for the router (and stops) as you rout the mortise.

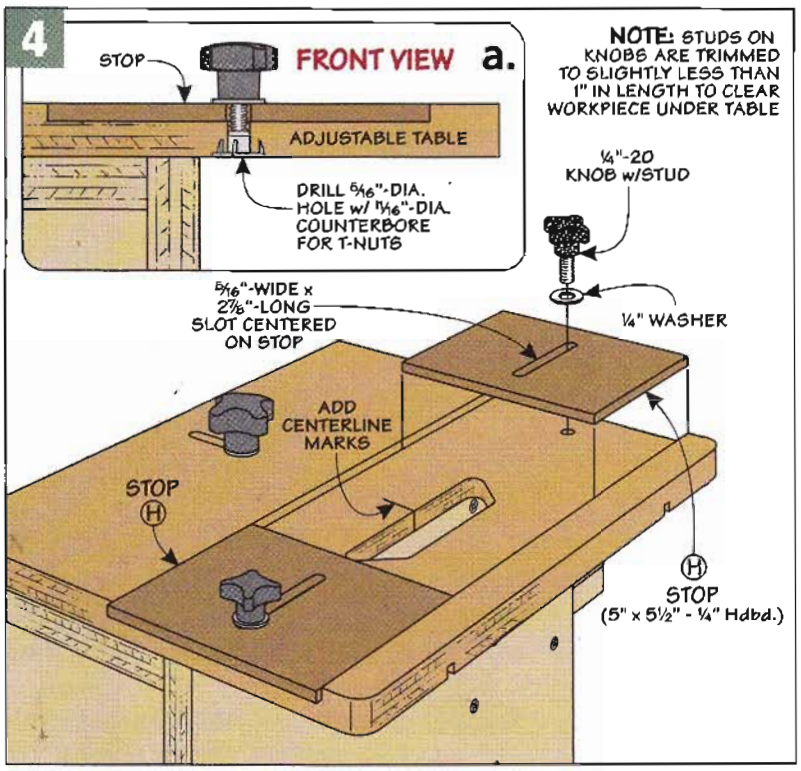
I used a dado blade in my table saw to cut the shallow groove, widening it until the base of my router fit and traveled smoothly from side to side. The depth of the groove should match the thickness of the ¼" hardboard that's used to make the stops a little bit later.

Once the groove is complete, there are a few more things to do. The first is to drill a counterbored hole at each end of the groove for a pair of T-nuts. These are used to lock the stops in place. The next task is to cut a centered slot near the back edge of the adjustable table. After positioning the table for routing the mortise, you can lock it securely in place by passing a studded knob through the slot and into the T-nut installed in the top of the base.

Viewing the Mortise. The last task on the list is to create a viewing port. You can see what I mean in Figures 3 and 3a. The viewing port gives you good visibility of the workpiece and router bit. By adding a centerline to the port, you can easily locate the workpiece and stops to match the size of the mortise you laid out. Plus, it's a handy way to check on the progress of your mortise as you're routing.

Limiting the travel of the router establishes the length of the mortise. To accomplish this, you'll need to add a pair of stops, as in Figure 4. The stops are just pieces of ¼" hardboard sized to match the width of the groove. A centered slot makes it easy to lock them in place using studded knobs.





adding a hold-down

System

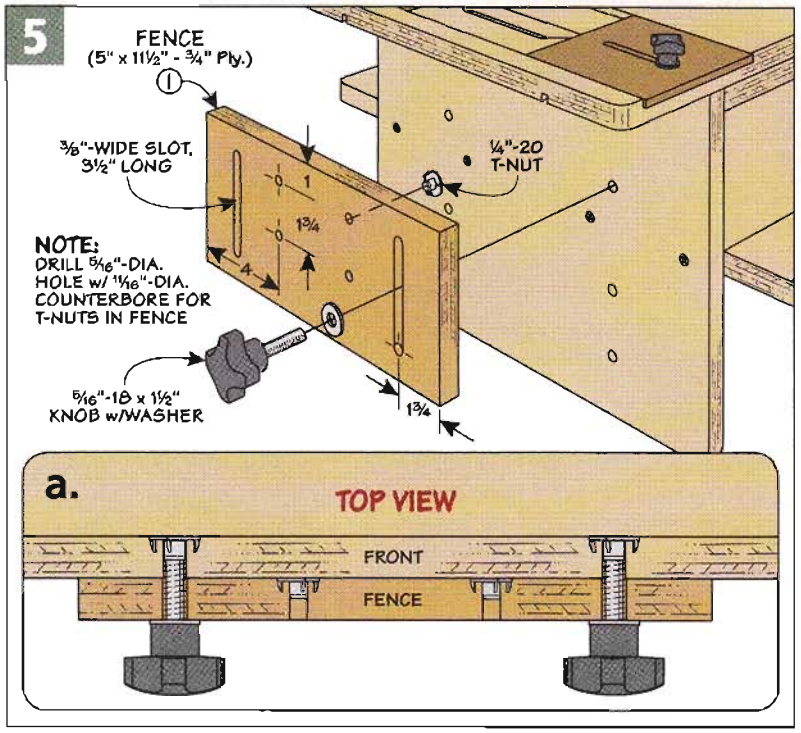
The main part of the mortising jig is complete. But you still need a way to support and secure the workpiece when you start routing. That's the job of the fence and hold-down system you see in Figures 5 and 6. It consists of a fence that supports the workpiece and a clamping mechanism that's attached to the fence.

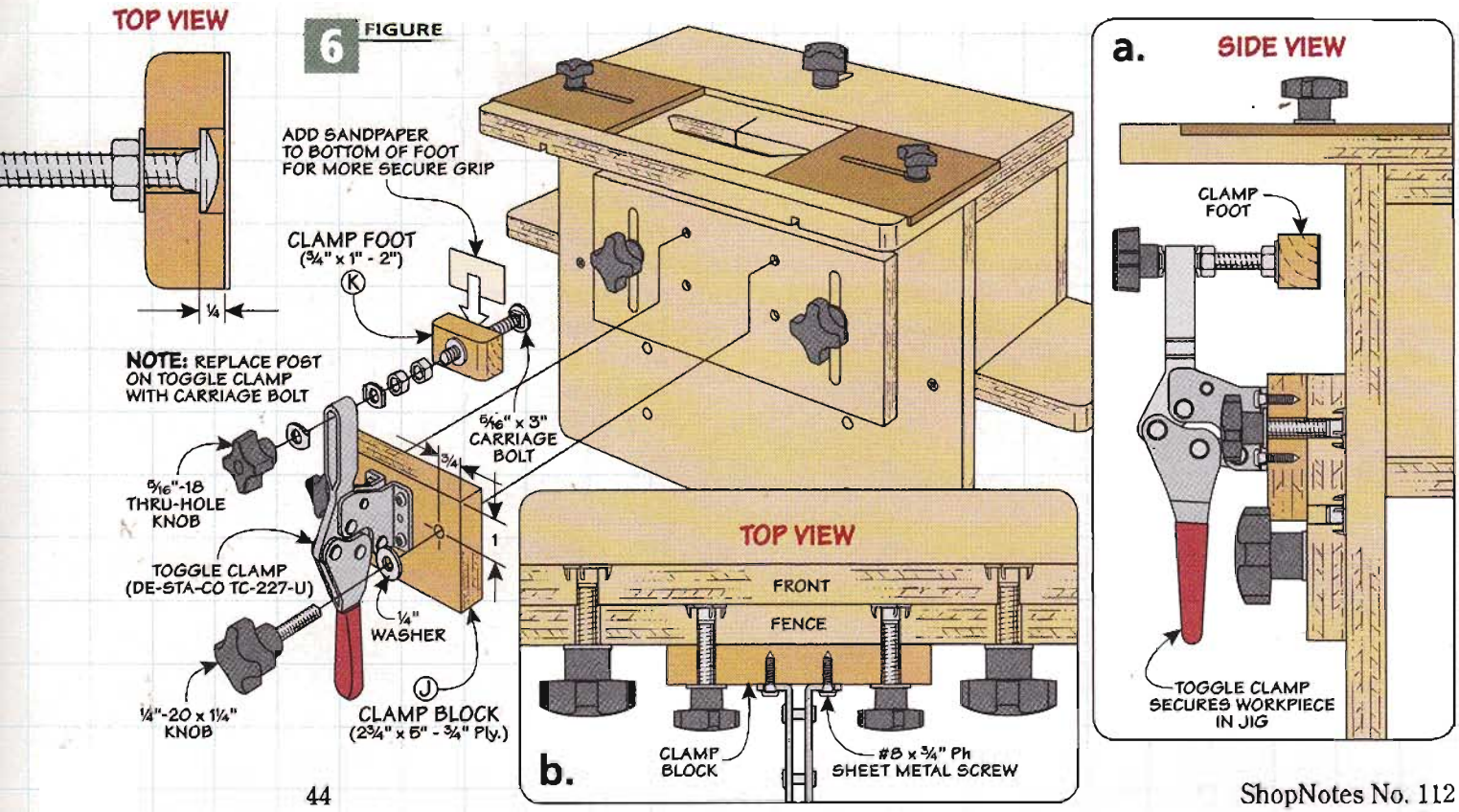
A Simple Fence. The fence couldn't be much simpler. It's just a rectangular piece of ¾" plywood with a pair of slots. The slots are located to match the position of the T-nuts installed in the front earlier. Then, to provide a way to mount the clamping mechanism, there's a set of four counterbored holes for another set of T-nuts.

Securing the Workpiece. Once the fence is completed, it won't take long to add the clamping mechanism. As you can see in Figure 6, the clamping mechanism consists of three parts. The first is a clamp block with a pair of holes drilled in it. This allows you to mount it to the fence in two different locations to suit the size of the workpiece. The second is a basic toggle clamp for securing the workpiece.

The third part is a modification to the clamp. Since I didn't think the toggle clamp's standard rubber tip was up to the task of securing a workpiece, I replaced it with a larger, hardwood foot. To install it, I used a carriage bolt (Top View below at left). I also added a small piece of sandpaper to the face of the foot to prevent the workpiece from slipping.

Once you have the clamp foot installed, you're ready to rout a mortise. For more on that process, check out the instructions detailed on the opposite page.



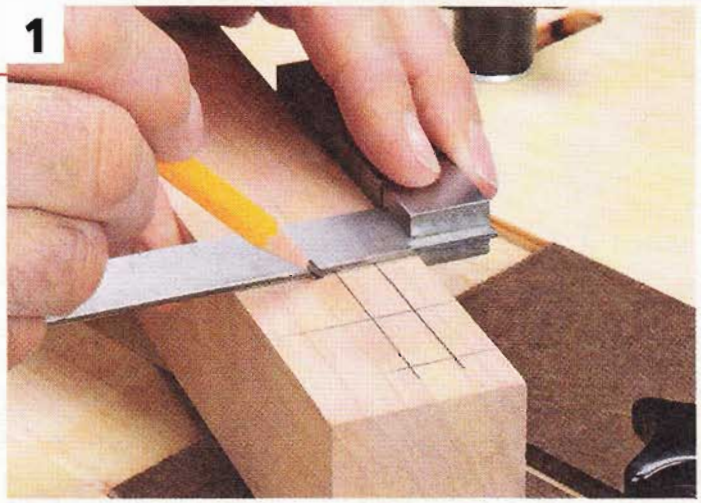


Routing a Mortise

If you thought building the mortising jig was simple, you'll find the overall process of routing a mortise even easier. The basic steps are detailed in the photos you see here.

The Layout Drives the Process. As you can see in photo 1 at right, the key to helping you position the workpiece is laying out the location of the ends of the mortise and the centerline. As a matter of fact, routing identical mortises is easy. After using the first piece to set the stops, all you really need on the rest of the pieces is a centerline.

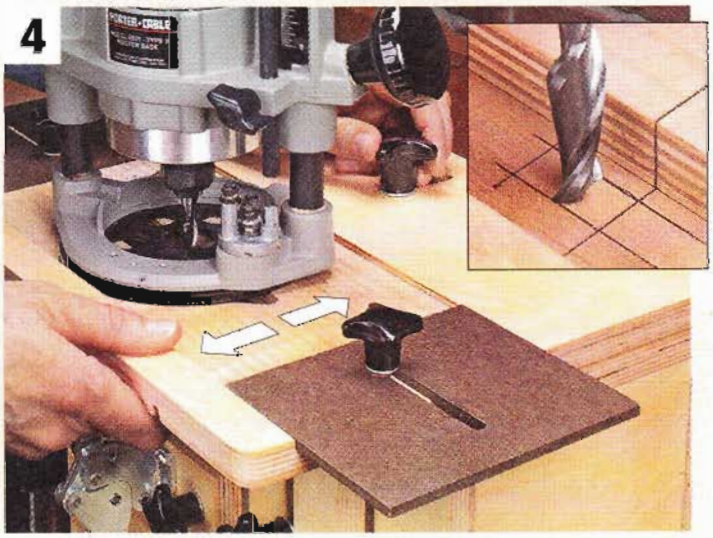
Choosing a Bit. I find that a spiral upcut bit is the best choice for routing mortises. This type of bit pulls the chips up and out of the mortise as you rout. And for the best results, make multiple, shallow (¼"-deep) passes until you reach the final depth of the mortise. Finally, using the depth stop on your router makes it easy to cut each mortise to exactly the same depth.



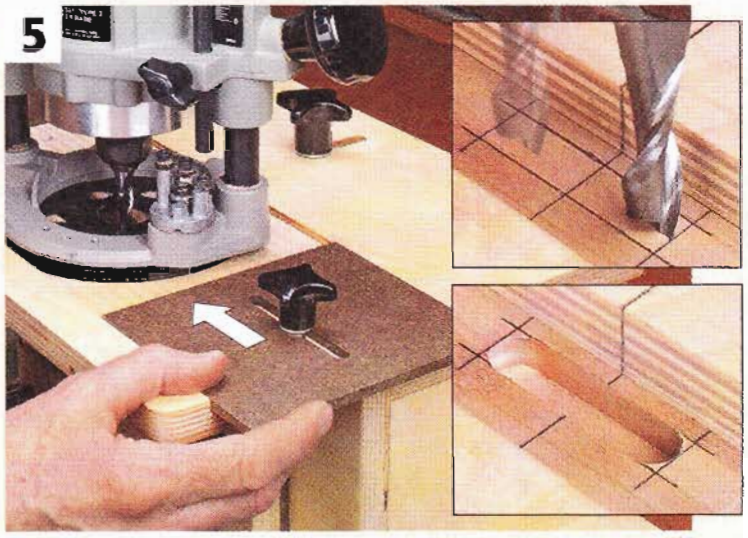
▲ ***Start with a Layout.*** *You'll need to lay out the width and length of the mortise along with a centerline. The centerline will make positioning the workpiece an easy process.*

▲ ***Support the Workpiece.*** *Adjust the fence so the workpiece butts against the table. (You can use spacers under the fence and clamp block to accommodate thicker workpieces.)*

▲ ***Clamp Securely.*** *After aligning the centerline of the mortise with the reference line on the adjustable table (inset), clamp the workpiece securely with the toggle clamp.*



▲ ***Match the Mortise.*** *At this point, you can position the adjustable top so the bit lines up with the location of the mortise (inset). Then, tighten the knob to lock the adjustable table in place.*



▲ ***Setting the Stops.*** *Finally, adjust each stop to set the length of the mortise (upper inset). To rout the mortise, make shallow cuts (lower inset) until you reach the desired depth.*

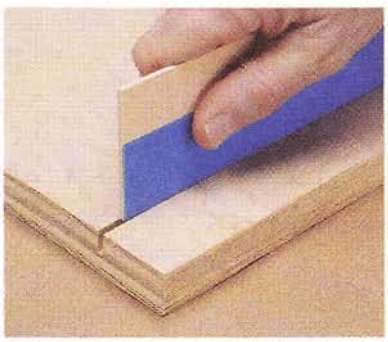
custom Dadoes

Here's a quick and easy technique for cutting dead-on dadoes with a single blade and two easy-to-make spacers.

A dado blade in the table saw is the best choice for cutting dadoes and grooves when you have a lot of them to make. But if I only need to cut a dado or two, setting up a blade for a custom fit often seems to be more trouble than it's worth.

However, there's a technique to cut perfect-fitting dadoes with a standard blade. The secret is to use custom spacers.

It's a simple, three-step technique. Steps one and two use a pair of spacers to define each shoulder of the dado. The final step is to remove the waste in between.



▲ **Exact Match.** *Strips of tape shim the blade spacer so it's the same width as the blade kerf.*

MAKING THE SPACERS

The keys to getting a good, snug dado joint are the two spacers (left margin photo). Each spacer needs to be sized to a specific thickness.

One of the spacers matches the thickness of the piece that will fit in the dado. The other spacer is sized to match the kerf created by the saw blade you use.

The two spacers work together to create a perfectly sized dado. They do this by offsetting the workpiece for each shoulder cut as well as accounting for the thickness of the saw blade.

Dado Spacer. Making the first spacer is simple. All you need to do is to use a cutoff from the material that's going into the dado.

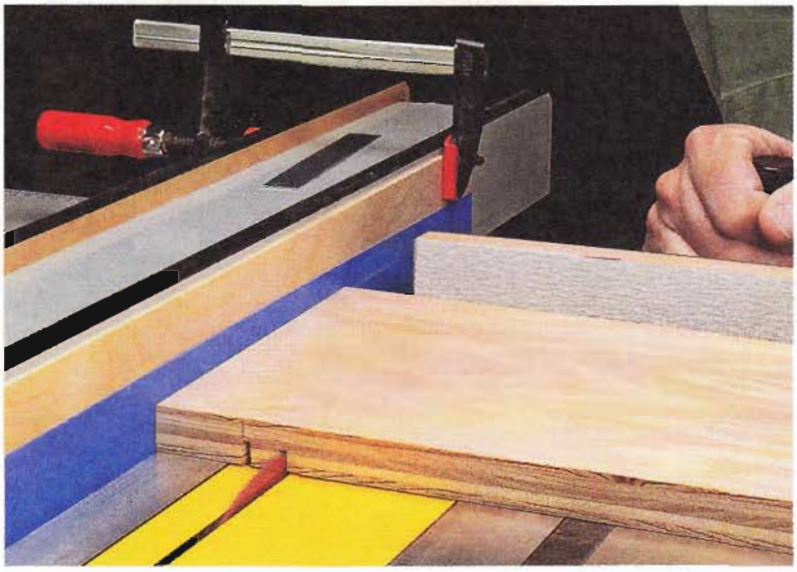
Blade Spacer. Sizing the other spacer is just as easy. The goal is to create a spacer that fits snugly into the kerf created by your saw blade. There are a couple of ways to go about creating it.

You could carefully plane a strip of hardwood until it just slips into a test kerf. But I find it's easier to use a piece of ⅛" hardboard or plywood, as in the lower left margin.

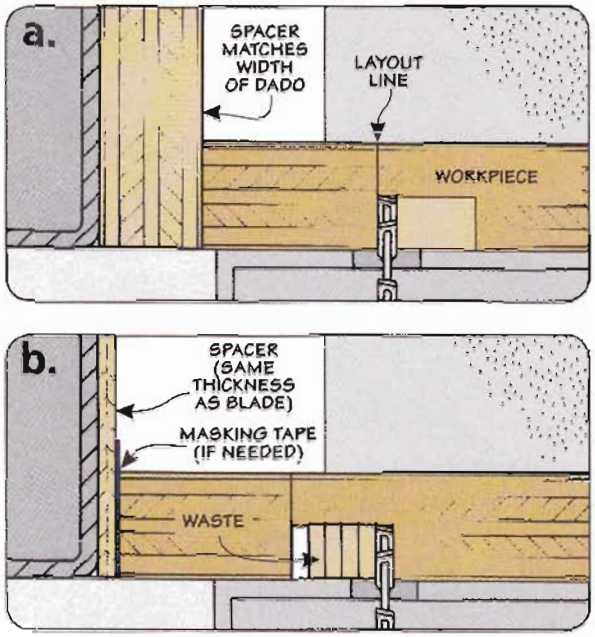
You'll likely find that when you slip the plywood into a test kerf, the fit will be a little loose. To get a dead-on match, shim the spacer with a strip of masking tape and try again. Keep adding tape (on one side only) until you get a nice slip fit with no slop, as shown in the lower left photo.

One thing to keep in mind is that you don't want the spacer to fit too snugly. This may cause the finished joint to be very tight, as well. And that can lead to problems when it's time to assemble the joint later on.

Finally, it's a good idea to keep this spacer for the next time you use this technique. I labeled the



▲ **Second Cut.** *To position the workpiece to cut the opposite shoulder of the dado, clamp the blade spacer to the rip fence.*



backside of the spacer so I know which blade it matches.

CUTTING A DADO

With the spacers in hand, there are just a few more things to do before you can start cutting a dado. The first thing is to mark one shoulder of the dado on the edge of the workpiece. This helps me set up the rip fence to make the cuts.

Saw Setup. After clamping the thick dado spacer to the rip fence, position the fence to cut on the inside edge of the layout line closest to the fence (detail 'a' above).

Then, to guide the workpiece, I use the miter gauge with an auxiliary fence. It provides more support and backs up the cut to prevent tearout, as you can see in the main photo on the opposite page.

Note: Since this isn't a through cut, I can use the rip fence as an end stop without any danger of the piece binding and kicking back.

First Shoulder Cut. At this point, you can go ahead and make the first cut. Be sure to maintain firm downward pressure on the workpiece as you feed the workpiece. This keeps the depth of the cut consistent.

Second Shoulder. The next step is to make a second cut to define the width of the dado. To do this, you don't have to adjust the rip fence. Instead, simply replace the thick spacer with the blade spacer. Then make another pass, as shown in the photo and detail 'b' above.

Remove the Waste. Now that you've established the width of the dado, you can remove the remaining waste. For this you simply nibble away the waste with multiple passes.

Finally, depending on the saw blade you use, the bottom of the dado may be a little ragged. So you need to clean it up for a solid glue joint. You can read about a couple of solutions in the box at right.

Grooves, Too. You can use this technique for more than just dadoes. I use it to cut grooves for drawer bottoms. Since ¼" plywood is always a little undersized, I can't use a dado blade to make a snug-fitting groove.

In the past, I made the groove by sneaking up on the width, adjusting the fence and making several test cuts. Using this technique, I can cut the groove in two quick passes with minimal setup.

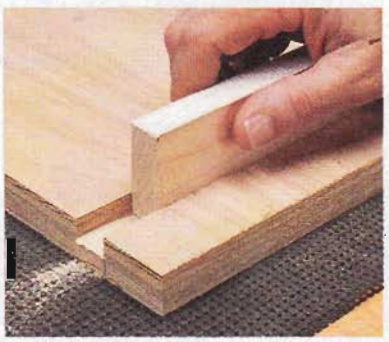
When you cut grooves, make the spacers as long as your rip fence. This way, the workpiece is fully supported throughout the cut.

Whether you're making a few custom dadoes or just cutting some grooves, this is a handy technique. And the result is a perfect-fitting joint, every time.

remove the Ridges

Cutting a dado with a single blade usually leaves some small ridges. For the strongest joint and best look, the pieces need to seat tightly. There are two keys here. You want to flatten the bottom of the dado, but you don't want to change the width of the dado. Here are two simple ways to get the job done.

▲ **Ridges.** *An uneven bottom keeps the joint from closing and reduces its strength.*



◀ **Sand.** *Apply sandpaper to the bottom edge of a block to even out the dado bottom.*

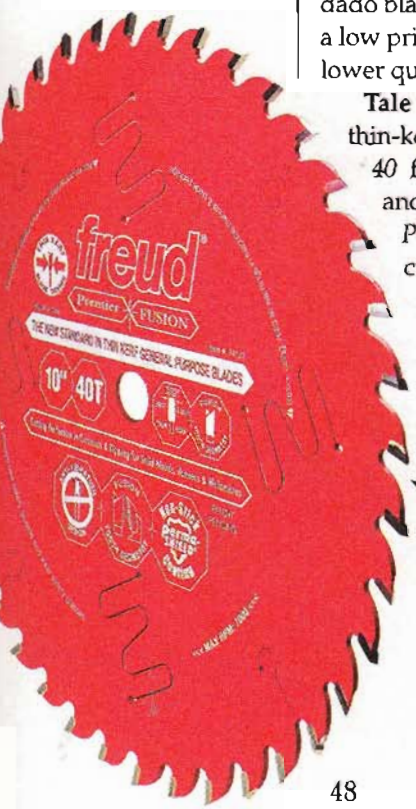
◀ **Plane.** *A shoulder plane will shave away the ridges, leaving a smooth, flat bottom.*

what's new in Table Saw Blades

Great results come from both ends of the price range. See how with these new products.

When shopping for a new table saw blade or dado set, I'm always looking for the best quality cut I can get for the lowest price. Recently, I tried out two new thin-kerf blades, and a low-priced dado blade set. And I learned that a low price doesn't always mean a lower quality cut.

Tale of Two Blades. The two thin-kerf blades, the *Micro-Kerf 40* from *Total Saw Solutions*, and the *Freud 10x40 Fusion P410T* each produced great cuts, even though they're priced at opposite ends of the spectrum.

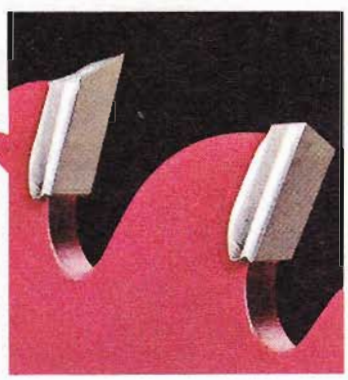


For example, the *Micro-Kerf 40*, shown in the photo at the top of the next page, costs $175. There's no getting around it; that's a lot of money for a saw blade.

On the other hand, the *Fusion P410T* 10", 40-tooth thin-kerf blade, shown in the margin photo at left, sells for just under $80.

As for dado blades, the *Oshlun 8" Stack Dado Set* (shown in the box on the opposite page) is priced well below $100, yet it makes cuts normally found only on higher-priced sets. You'll find sources for all these blades on page 51.

Thin Kerf. Thin-kerf saw blades offer some real advantages, especially for lower-powered table saws. When you give it some thought, it's not too hard to understand why.



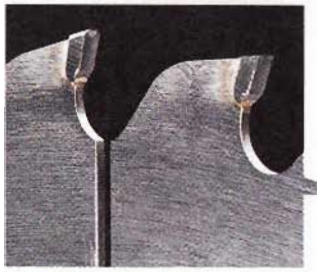
◀ ***"Fusion."*** *A combination of Hi-ATB and double-side grind on the teeth make this a great general purpose blade.*

Most thin-kerf teeth are only 3/32" wide. Since less material is removed, they require less power. The challenge is to do this while also maintaining the quality of cut.

Fusion TK. If you look closely at the teeth on this blade, you'll see that there are two things going on. The *Fusion P410T* features a combination of double side grind and Hi-ATB (alternate top bevel) teeth. The scoring action of the steep top bevel produces a chip-free edge. But what's really unique is the beveled side grind on each tooth.

If you look at the inset photo at left, you'll see each tooth has a flat area just behind the cutting edge that basically burnishes the workpiece as it cuts, leaving a super-clean, glass-smooth surface. These factors, and an aggressive positive hook angle, make it a perfect blade for all kinds of materials.

Another great feature found on most *Freud* saw blades is a non-stick coating that protects the blade from pitch build-up. And, to combat the flexing that can cause



overheating, the blade has laser-cut slots in the body to decrease the chance of burning and tear-out.

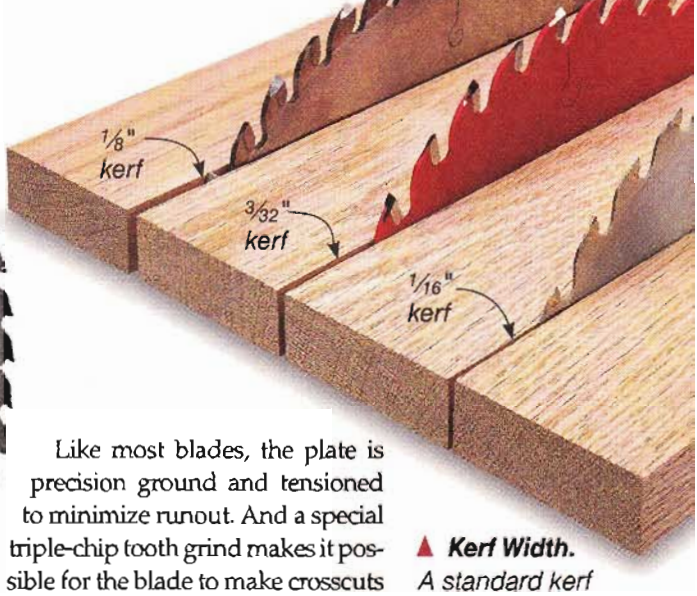
Finally, blade stiffeners are typically recommended for thin kerf blades. *Freud* feels the combination of high-quality steel and their blade design eliminates the need for one.

Micro-Kerf 40. The teeth on a *Micro-Kerf 40* (only 1/16" thick) are half the thickness of a standard carbide tooth, so it requires a lot less power to cut while retaining an amazing cut quality. In fact, it cut so cleanly, and with so little effort that I was soon looking for scraps to cut just for the fun of it.

All the materials for the *Micro-Kerf 40*, including the steel and the packaging it's shipped in, are made or purchased in the USA. But, don't look for this blade at the local hardware store. Distribution at this time is limited. (I found it online at just one retailer.) Still, the performance of this blade makes it worth looking for.

▲ ***Micro-Kerf.*** *With its 1/16"-wide kerf, this state-of-the-art saw blade makes super-clean cuts.*

Part of the reason the blade cuts so smoothly is the built-in dampening system (photo above). The dampener acts as a heat sink, minimizing blade distortion. It will limit the depth of cut by about ½". So you won't be able to make as deep a cut as a regular blade.



▲ ***Kerf Width.*** *A standard kerf blade (top) requires more power to make clean cuts. While thin-kerf blades like the Fusion TK and Micro-Kerf 40 (center & bottom) require less power and remove less material.*

Like most blades, the plate is precision ground and tensioned to minimize runout. And a special triple-chip tooth grind makes it possible for the blade to make crosscuts and rip cuts with ease in all types of hardwoods and softwoods.

Don't send this blade just anywhere to be resharpened though. The manufacturer recommends that it be sent to the factory for sharpening, but their cost for doing so is reasonable ($20).

One more thing. If you use a splitter, most are too wide for this blade, so an easy-to-install aftermarket splitter kit is available (main photo on opposite page).

When all is said and done, price and quality of cut should be considered when choosing a blade. That's why both blades will have a proud home in my shop.

an inexpensive Dado Set

Of course, there are times when price really does matter. At those times, it's good to know that there are still manufacturers out there who have figured out how to keep costs down while producing a good product. The *Oshlun* 8" stacked dado set, shown in the photo at right, is a good example of this. It offers affordable quality with a retail price under $90.

As you can see in the inset photo, this dado blade offers the same quality, flat-bottom cuts provided by other more expensive dado sets. It has two 42-tooth cutters (the cutters in most dado sets have only 24 teeth), and six teeth per chipper (some only have two). In this case, more teeth means smoother cuts.

A 3/32"-wide chipper is also included in the set for cutting grooves and dadoes for undersized plywood.

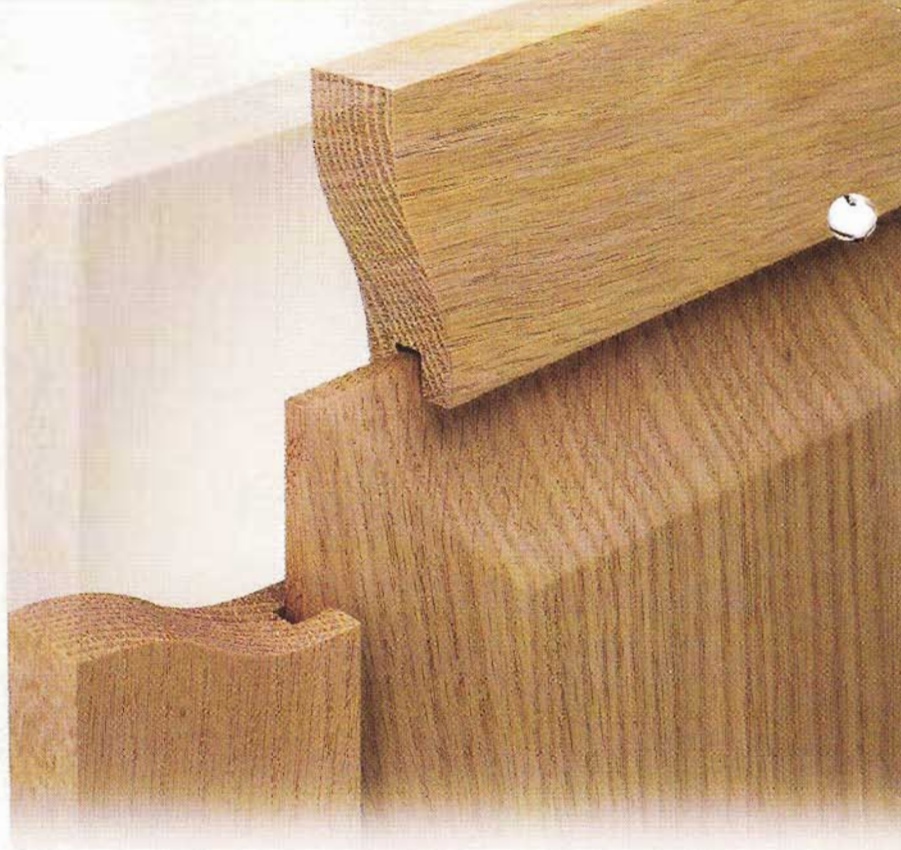
► ***Dado Set.*** *Get all the features of higher-priced sets, along with quality cuts, at half the price.*

◄ ***Flat Bottom.*** *Two 42-tooth cutters and six 6-tooth chippers provide an extra-clean bottom surface.*

Q&A

questions from
Our Readers

sizing a Door Panel



I'm building frame and panel doors with solid-wood panels. Does the time of year I'm building the doors affect the size of the panel I cut?

Tim Kabrick
via email

Frame and panel construction is a basic woodworking technique used for building both doors and cabinets. It allows you to use solid-wood panels and, at the same time, solves the problem of expansion and contraction of the panel with changes in humidity.

Here's how it works: Grooves on the inside edges of the frame trap a solid-wood panel, as shown in the photo above. The panel is sized slightly narrower than the distance between the grooves. This way, it's allowed to "float" free and expand or contract with changes in humidity while the frame stays intact. To allow the panel to move, only the frame joints are glued. And it's why you should avoid gluing a wood panel inside the frame.

It's important to note that a solid-wood panel shrinks and swells mostly across the grain. This means the width of the panel will change (but the length stays fairly constant). And, the wider the panel, the more it will eventually move, regardless of which species of wood it's made from.

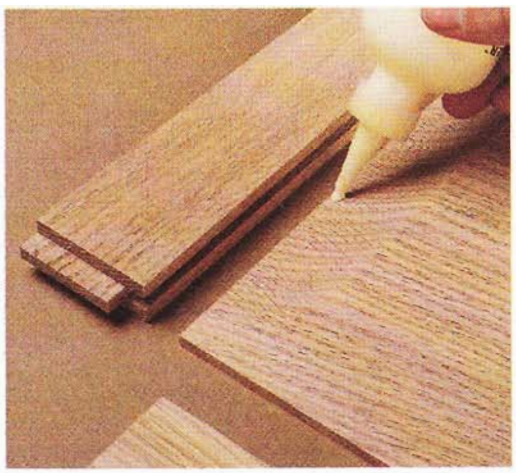
Panel Size. When you make the panel, the time of year *does* have an affect on how it's sized. You need to consider how the humidity level in your shop is affecting the stock. As I mentioned earlier, the height isn't as critical as the width. However, I still cut the panel at least $\frac{1}{16}$" less than the opening, regardless of the season, as shown in the photo above. This way, I don't have to worry about it bottoming out in the grooves and keeping the frame joints from closing tightly.

If you're working in low humidity areas of the country or during the winter, your panel is most likely to be as dry (and narrow) as it's ever going to get. In that case, it's a good idea to reduce the width of the panel by $\frac{1}{8}$" for every 12" of width to allow for expansion when the humidity goes up.

But on a hot, humid day, you only need to have about $\frac{1}{16}$" gap. For example, if the distance from one stile groove bottom to the other is 12", the total width of your panel during high humidity conditions should be $11\frac{15}{16}$".

Loose Panels. One of the downsides of a loose panel inside a frame is that it could rattle. An easy solution to this problem is to place a drop of glue centered at the top and bottom of the panel, as shown in the photo at left. This locks the panel in place, but still permits expansion and contraction out toward the edges.

By following these simple guidelines, you can rest assured that the frame and panel assemblies you build will stay solid.



► ***Rattles.*** *A loose panel can rattle inside a frame. One way to avoid this problem is to apply a drop of glue to the center of the panel at the top and bottom.*

Sources

Most of the materials and supplies you'll need for projects are available at hardware stores or home centers. For specific products or hard-to-find items, take a look at the sources shown below. You'll find each part number listed by the company name. See the right margin for contact information.

The *Woodsmith Store* in Des Moines, Iowa is an authorized *Rockler* dealer. They carry many of the hardware items used in our projects. And they ship nationwide. Their customer service representatives are available for your calls from 8am – 5pm Central Time, Monday through Friday.

COVE MOLDING (p.8)

- **Amazon**
  - *3-pc. Horiz. Cove Bits* . . . WL-2094
  - *Large Cove Classic Bit, 1"* . . . 3941
  - *Large Cove Classic Bit, 1½"* . 3944
  - *Large Cove Classic Bit, 2"* . . . 3942
- **MLCS**
  - *Horiz. Crown Molding Bit, 1¾"* . .7873
  - *Horiz. Crown Molding Bit, 2½"* . .7875
  - *Horiz. Crown Molding Bit, 2¾"* . .7876
- **Woodworker's Supply**
  - *Horiz. Crwn Mldg. Bit, 1¾"* . . 957-993
  - *Horiz. Crwn Mldg. Bit, 2½"* . . 958-000
  - *Horiz. Crwn Mldg. Bit, 2¾"* . . 958-007

DOVETAIL SQUARES (p.10)

- **Lee Valley**
  - *Dovetail Markers (pr.)* . . .05N61.06
  - *14° Dovetail Marker* 05N61.08
- **Woodcraft**
  - *Cosman Dovetail Marker* . . .842423
- **Woodjoy Tools**
  - *Precision Dovetail Template* . . PDT
  - *Dovetail Saddle Square* . . . . . .DTS
- **Lie-Nielsen Toolworks**
  - *Dovetail Marker* 1-DM

WORKBENCH (p.12)

- **Lee Valley**
  - *9" Quick-Release Vise* . . .10G04.12
  - *Veritas Surface Clamp* . . .05G19.01
  - *Veritas Surface Vise* 05G10.50
- **McFeely's**
  - *7 x 70mm Joint Screw* . . .1426-CWB-D
  - *7 x 60mm Joint Screw* . . . 1423-CWB

HARDWARE CABINET (p.24)

- **Lee Valley**
  - *No-Mortise Hinges* 00H51.31
  - *Draw Latches* 00S55.90
  - *Full-Extension Slides* 02K42.08
- **McMaster-Carr**
  - *Plastic Bins, 4⅛" x 7⅜"* . .42185T43
- **Reid Supply**
  - *Rectangular Pull Handle* . . KHO-5
  - *Plastic Bins, 4⅛" x 7⅜"* AKR-2

WATERSTONES (p.30)

- **Rockler**
  - *Norton Flattening Stone* 33463
  - *DMT Diamond Stone* 22524

SCRAPER SHAVES (p.32)

- **Woodcraft**
  - *0.80mm Scraper, 6" long* 02Z08
- **Woodsmith Store**
  - *0.80mm Scraper, 5⅞" long* 312306
- **McMaster-Carr**
  - *10-32 Knurled Nuts* 92741A140
  - *10-32 Machine Screws* . . .92480A837

MORTISING JIG (p.40)

- **Reid Supply**
  - *5/16"-18 Knob* DK-138
  - *¼"-20 x 1¼" Knob* RST-101
  - *5/16"-18 x 1½" Knob* RST-103
  - *Toggle Clamp* TC-227-U
  - *¼"-20 T-Nut* WN-115
  - *5/16"-18 T-Nut* WN-130

SAW BLADES (p.48)

- **Rockler**
  - *Micro-Kerf 40 10" Blade* 33300
  - *Micro-Kerf Splitter Kit* 39262
- **Woodsmith Store**
  - *Freud 10x40 Fusion* 222264
- **Tool City**
  - *Oshlun 8" Dado Set* SDS-0842

MAIL ORDER SOURCES

Woodsmith Store
800-444-7527

Rockler
800-279-4441
rockler.com

Amazon.com

Lee Valley
800-871-8158
leevalley.com

Lie-Nielsen Toolworks
800-327-2520
lie-nielsen.com

McFeely's
800-443-7937
mcfeelys.com

McMaster-Carr
630-600-3600
mcmaster.com

MLCS
800-533-9298
mlcswoodworking.com

Reid Supply
800-253-0421
reidsupply.com

Tool City
800-999-9195
toolcity.com

Woodcraft
800-225-1153
woodcraft.com

Woodjoy Tools
508-669-5245
woodjoytools.com

Woodworker's Supply
800-645-9292
woodworker.com

Scenes from the Shop

Despite its unconventional top design, this workbench has all the features you need — strength and stability, a dead-flat worksurface, and multiple clamping options. Plus, it's inxpensive to build. To learn more about it, turn to page 12.

Time-tested, torsion box construction is the key to building this strong and sturdy benchtop. You'll find all you need to know in the article starting on page 19.