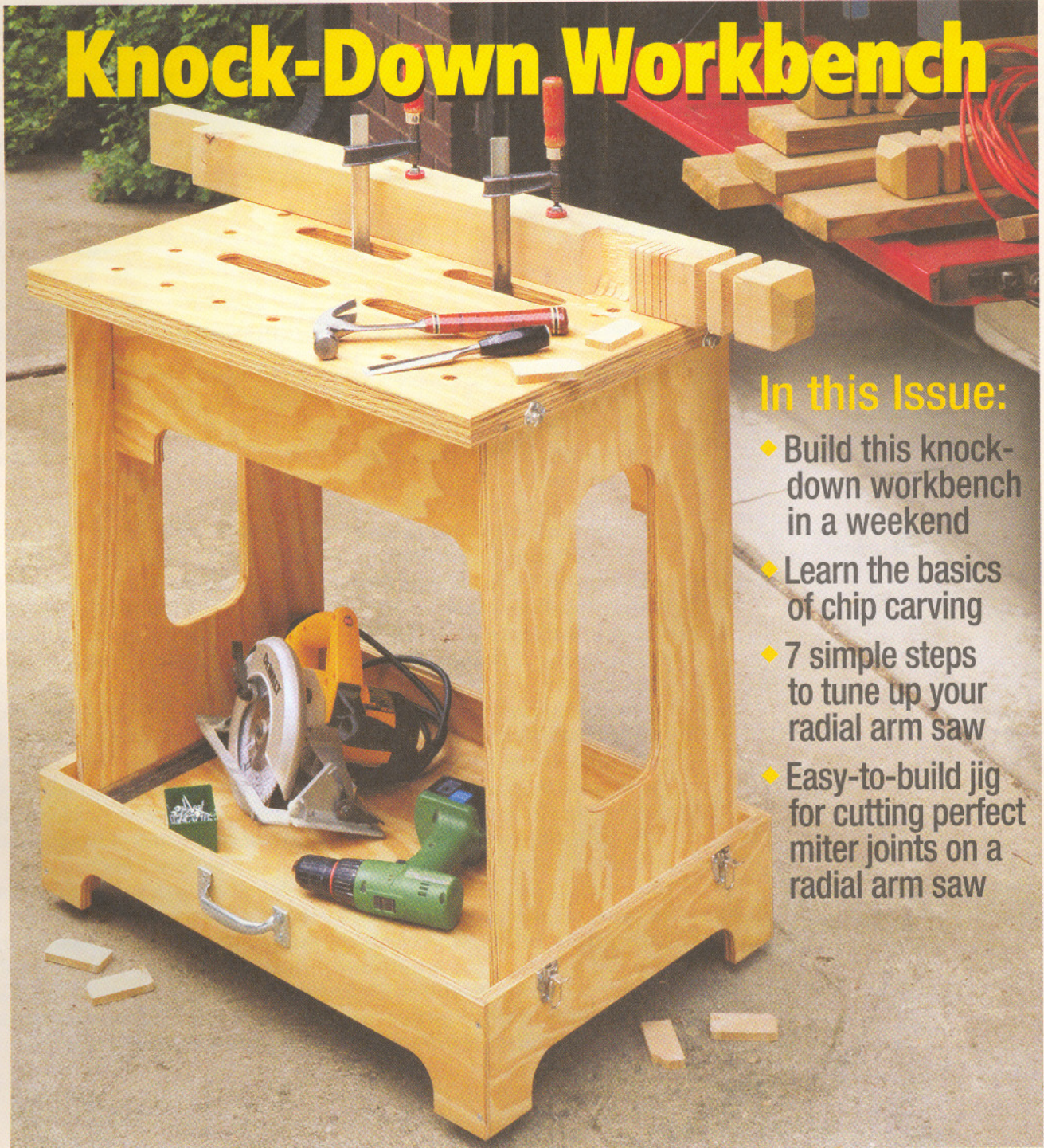


ShopNotes®

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Issue 52

Knock-Down Workbench



In this Issue:

- ◆ Build this knock-down workbench in a weekend
- ◆ Learn the basics of chip carving
- ◆ 7 simple steps to tune up your radial arm saw
- ◆ Easy-to-build jig for cutting perfect miter joints on a radial arm saw

Knock-Down Workbench



Turn a single sheet of plywood and a few pieces of hardware into a portable workbench that “knocks down” for compact storage.

A bench in a box. No, it's not a new magic act. It's what one of the guys calls my new knock-down workbench. When you think about it, it's a fitting description.

That's because the bench provides a solid, stable work surface like you'd expect from a bench. (There's even a tool tray underneath.) Then, once a job is completed, the bench can be “knocked down” and stored in a compact box that you carry like a suitcase. (See photo at right.)

The best thing about this knock-down design is it makes it easy to take the bench out to the driveway or back yard, or to a friend's house to help on a project. No matter where you're working, setting up the bench only takes a minute.

Setup – To do this, start by unlatching the lid on the box and setting it aside. (The lid doubles as the top of the workbench.) Then simply remove the two stretchers and flip up the sides of the bench, as shown in photo A below.

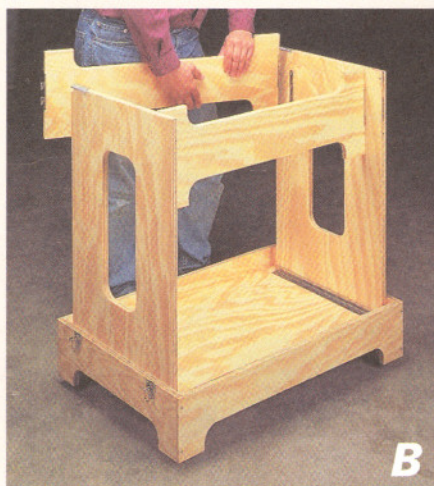
The sides are hinged to the base, so you'll need to “spring” them apart a bit to fit the stretchers between them (Photo B). These stretchers hook securely into the sides with an ordinary set of bed rail fasteners. Then just set the top down over the sides and pull it toward you to lock it in place (Photo C).

Clamping Options – Once the bench is set up, there are three different ways to clamp a workpiece to the benchtop. That explains the holes and slots in the top as well as the notches in the top of the stretchers. Note: For a closer look at the different clamping options, turn to page 23.

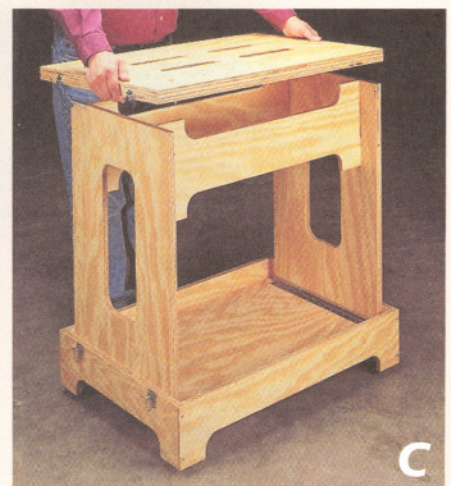
Plywood – Just one more note. You won't need a lot of material to build this bench. The entire project is made from a single sheet of 3/4" plywood. (I used pine plywood.)



A



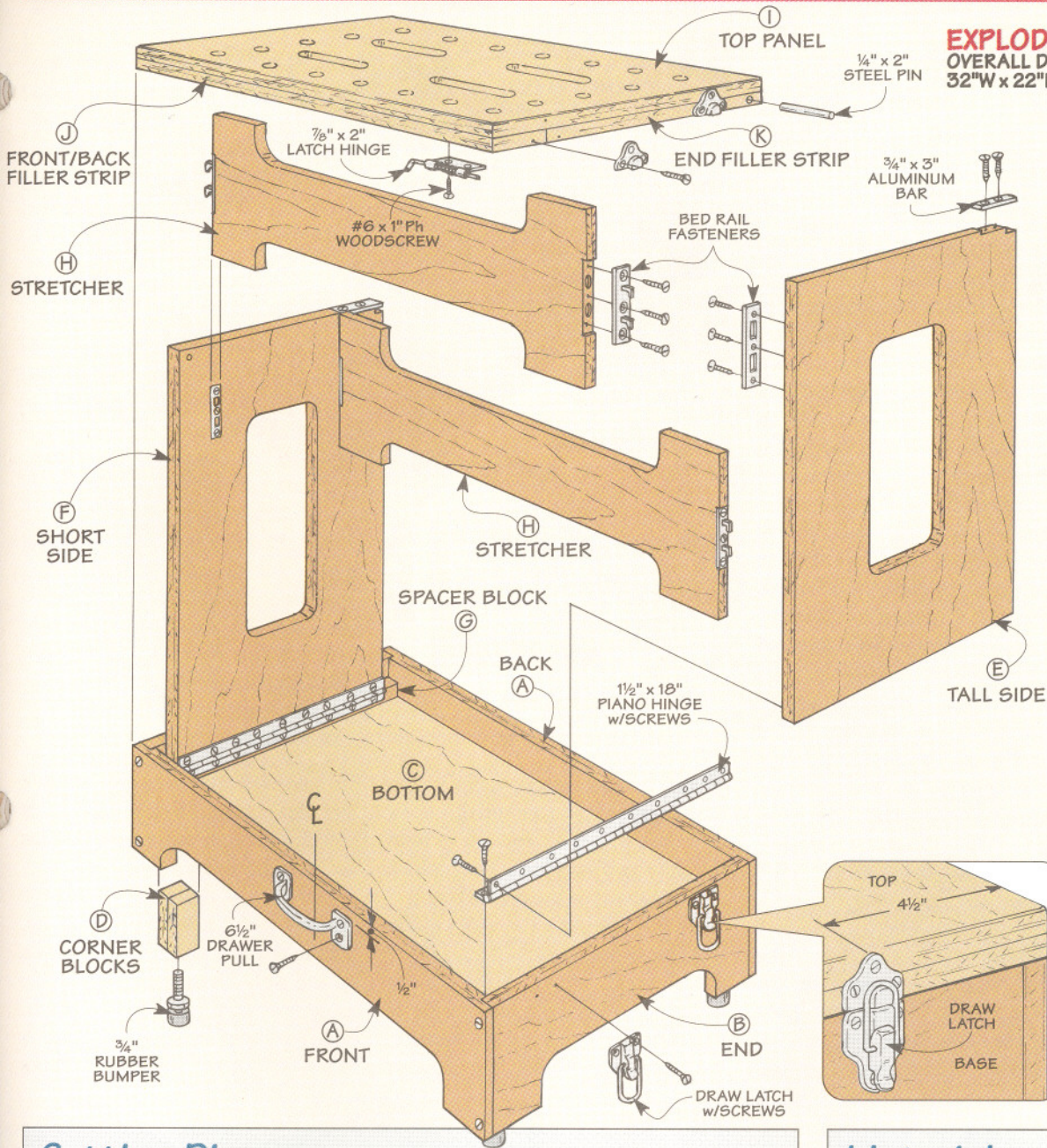
B



C

Setup. It only takes a minute to set up the workbench. After unlatching the top and setting it aside, remove the stretchers and flip up the sides, as shown in photo 'A.' To provide rigid

support for the top of the bench, the stretchers hook into the sides (Photo B). Then just fit the top down over the sides of the bench and pull it toward you to “lock” it in place (Photo C).

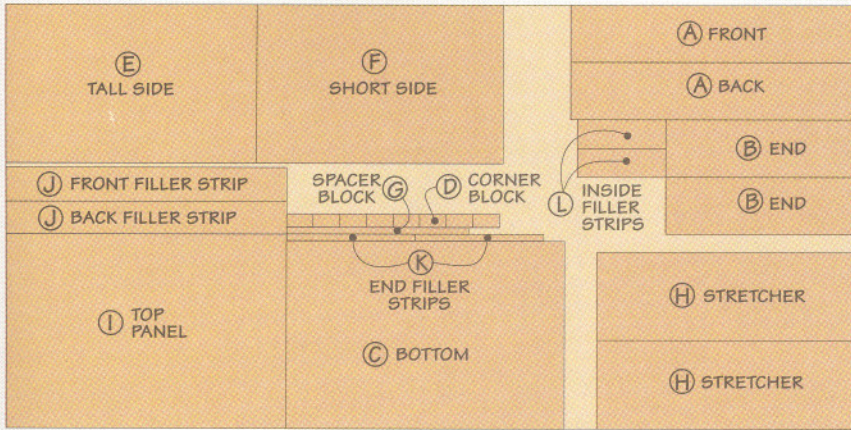


Hardware

- (12) #8 x 1/2" Fh Woodscrews
- (20) #8 x 1 1/2" Fh Woodscrews
- (4) #8 x 2" Fh Woodscrews
- (4) #10 x 1/2" Fh Woodscrews
- (4) #6 x 1" Panhead Woodscrews
- (1 Set) 4" Bed Rail Fasteners
- (2) 1/4" x 2" Steel Pins
- (2) 3/4" x 3" Aluminum Bar (1/4" thick)
- (1) 6 1/2" Drawer Pull
- (1 Set) 7/8" x 2" Latch Hinges
- (2) 1 1/2" x 18" Piano Hinges w/Screws
- (4) Draw Latches w/Screws
- (4) 3/4" Rubber Bumpers w/1/6"-18 x 1/4"-Long Stud
- (4) 5/16"-18 T-Nuts

Cutting Diagram

48" x 96" x 3/4" PLYWOOD



Materials

Base

- A Front/Back (2) 6 1/2" x 32" - 3/4 Ply.
- B Ends (2) 6 1/2" x 21 1/4" - 3/4 Ply.
- C Bottom (1) 21 1/4" x 31 1/4" - 3/4 Ply.
- D Corner Blocks (4) 1 1/2" x 3" - 1/2 Ply.

Supports

- E Tall Side (1) 18" x 28 1/2" - 3/4 Ply.
- F Short Side (1) 18" x 27 3/4" - 3/4 Ply.
- G Spacer Block (1) 3/4" x 20 1/2" - 3/4 Ply.
- H Stretchers (2) 10" x 29" - 3/4 Ply.

Top

- I Top Panel (1) 22" x 32" - 3/4 Ply.
- J Fr./Bk. Filler Strips (2) 3 3/4" x 32" - 3/4 Ply.
- K End Filler Strips (2) 3/4" x 14 1/2" - 3/4 Ply.
- L Inside Filler Strips (2) 3/4" x 10" - 3/4 Ply.

Base

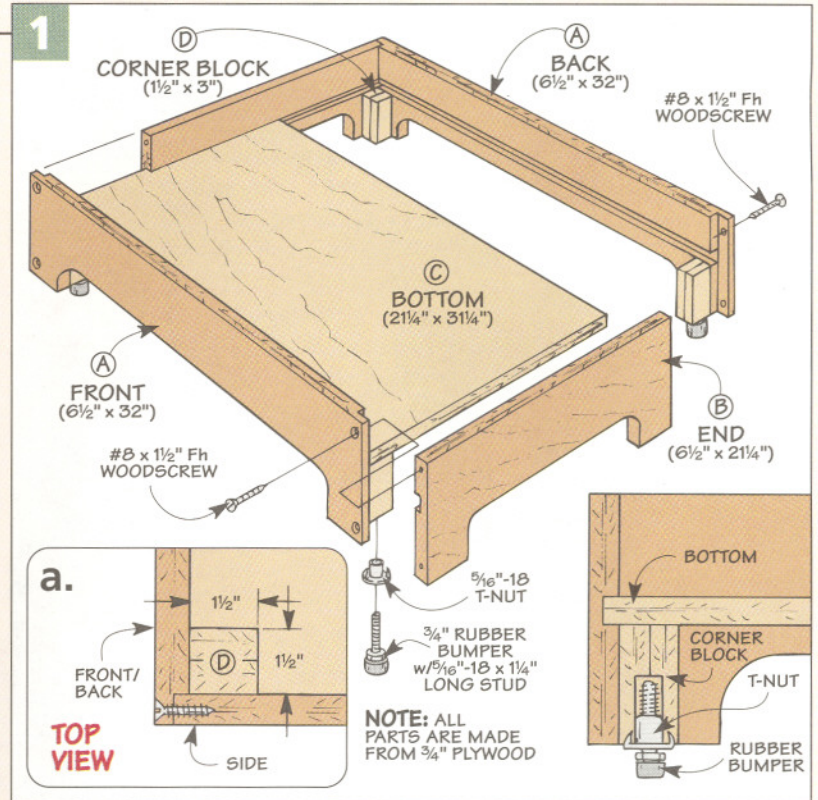
I began work by making the *base* of the bench. As you can see in Figure 1, it's a shallow box with a large "foot-print" that helps the bench resist tipping. The base provides a handy compartment for tools while you're working. And when you "knock down" the bench for storage, the base holds the sides and stretchers.

Frame – The base starts out as a plywood frame that's made up of a *front/back* (A) and two *ends* (B). To strengthen the base (and help align the pieces during assembly), the front and back are rabbeted at each end.

An easy way to cut these rabbets is to use a dado blade mounted in the table saw. As you can see in Figures 2 and 2a, part of the blade is "buried" in an auxiliary fence that's attached to the rip fence with carpet tape.

The fence is positioned so the blade will cut the *shoulder* of the rabbet. The only problem is the front and back pieces are fairly narrow, too narrow to ride against the fence without twisting. To prevent that, I attached a long fence to the miter gauge and used it to guide the workpiece through the blade.

Cut Grooves – In addition to the rabbets, there's a groove in the inside face of each piece that holds the *bottom* of the base. The location of this groove determines the *depth*

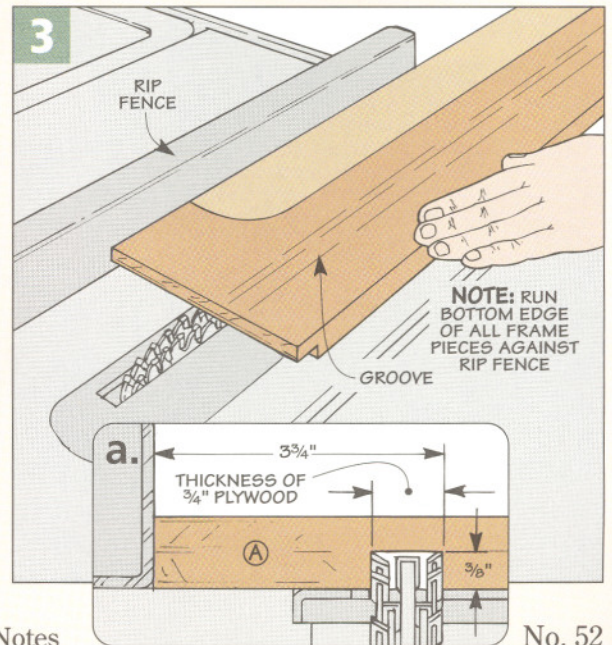
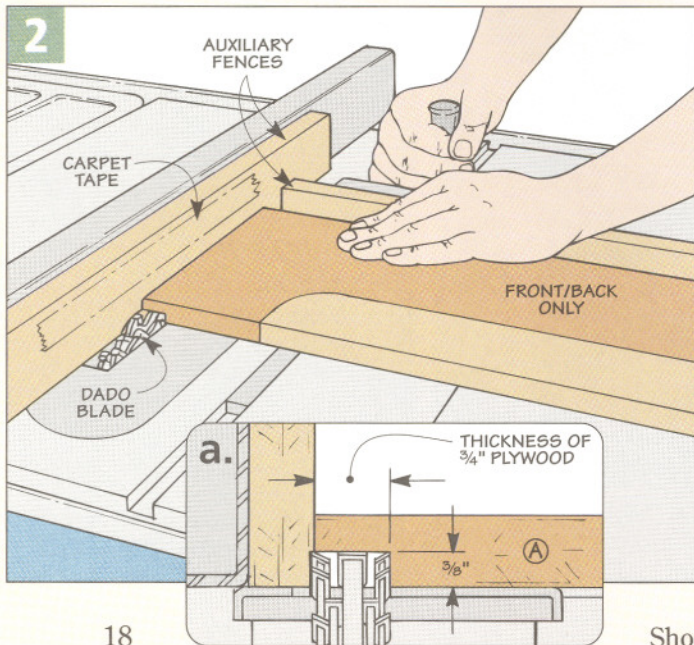


of the storage compartment in the base. I wanted to make sure the compartment was deep enough to hold the sides and stretchers (and still be able to fasten the top on the base).

So after adjusting the width of the dado blade to match the thickness of the plywood bottom, I set the rip fence $3\frac{3}{4}$ " away from the outside of the blade (Figures 3 and 3a). Running the *bottom* edge of each piece against

the fence will produce a groove that's $2\frac{3}{4}$ " down from the top edge. This provides enough room for the sides and stretchers plus a little extra.

Notches – After completing the grooves, I cut a long notch in the bottom edge of each piece (Figures 4a and 4b). These notches provide some "toe room" so I can work at the bench without kicking the base. A sabre saw (or band saw) is all that's



needed to cut the notches to rough shape. And a drum sander chucked in the drill press makes quick work of removing the rest of the material.

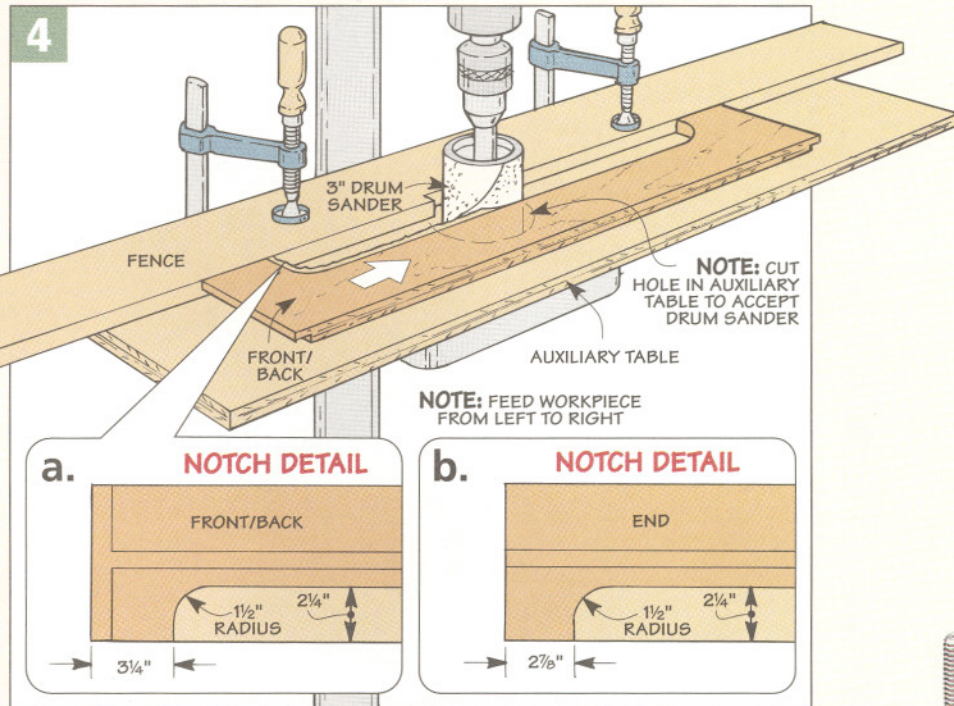
But a drum sander can create a scalloped edge if you're not careful. To prevent that, I used a long, straight scrap piece as a fence (Figure 4). With the "feet" of the workpiece riding against the fence, it's easy to sand a straight edge.

To sand the entire thickness of the edge, you'll need to attach an auxiliary table to the drill press and cut a hole in it to accept the drum sander. Then, after notching the fence to fit around the drum sander, position it to sand to the desired depth and clamp the fence in place.

Now turn on the drill press, and push the workpiece into the drum sander until it contacts the fence. The idea is to start at the *right* end of the notch, then slowly feed the workpiece from left to right to sand the edges smooth.

Bottom – Before assembling the base, there's one more thing to do. That's to cut the plywood *bottom* (C) to fit. Then just glue and screw the base together. I also "eased" all of the edges with a sanding block to keep them from splintering when they get bumped or knocked around.

Corner Blocks – All that's left to complete the base is to add four



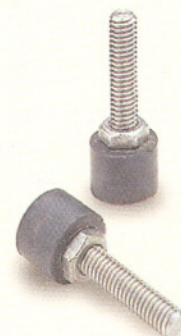
thick *corner blocks* (D). These blocks "beef up" the corners of the base to hold a set of rubber bumpers that are added later (Figure 1).

Each corner block is made up of two pieces of 3/4" plywood. To avoid working with small pieces, I glued up two long strips of plywood first (Figure 5). Then it's just a matter of cutting each corner block to length.

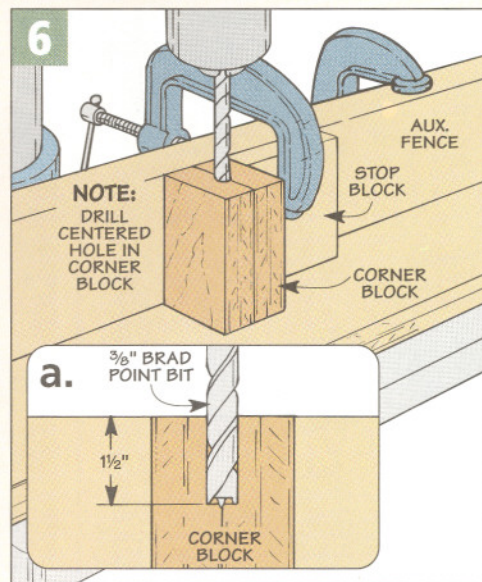
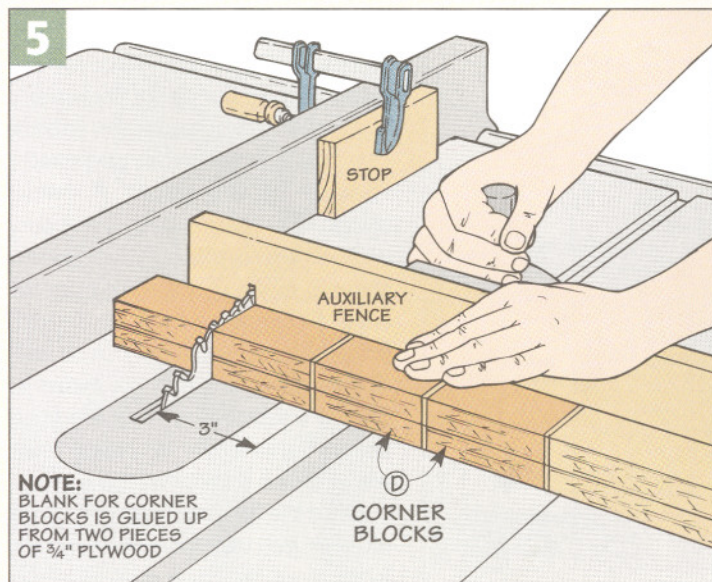
Here again, a fence attached to the miter gauge provides support for the blank. But this time, to cut each block to the same length, I clamped a

scrap piece of wood to the rip fence and used it as a stop. The idea is to set the fence so that when you butt the end of the blank against the stop, it will produce a 3"-long corner block.

Rubber Bumpers – After cutting all the corner blocks, the next step is to add a set of four rubber bumpers. (We've shown two in the margin.) These bumpers thread into T-nuts that fit into a hole drilled in each corner block (Figures 6 and 6a). After gluing the blocks in place, simply tap in the T-nuts and install the bumpers.



▲ Hard rubber bumpers thread into the base of the bench to keep it from sliding around and to prevent damage to a finished floor. (See page 31 for sources.)



Supports

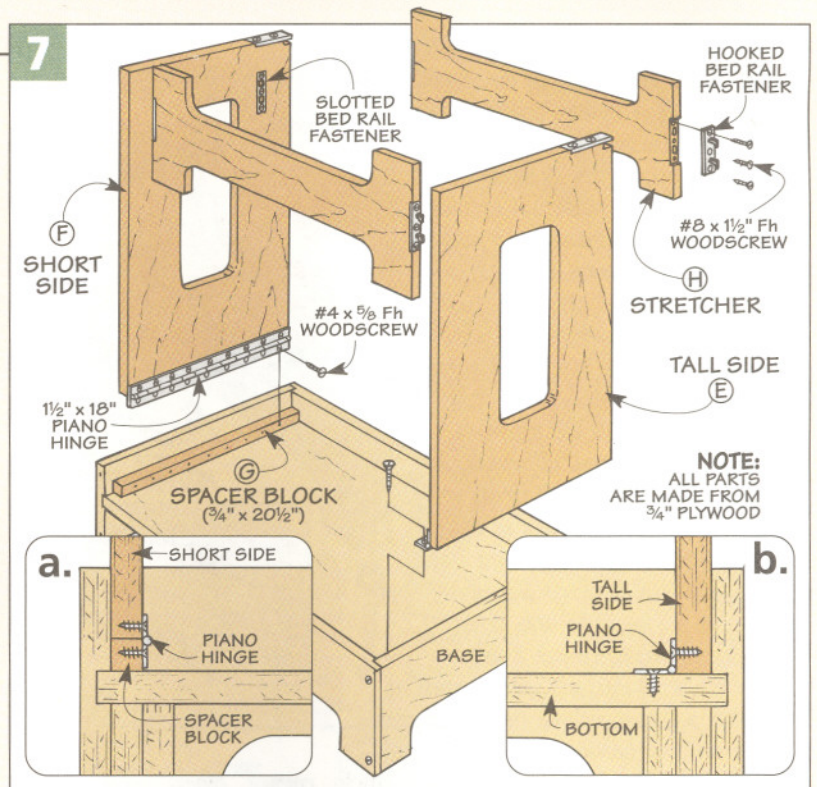
This workbench is designed with a simple system of interlocking parts that provide solid support for the top. As you can see in Figure 7, it consists of two hinged *sides* connected by a pair of *stretchers*.

To prevent the bench from racking, the connection between the sides and stretchers must be rigid and strong. At the same time, I wanted a quick and easy way to take them apart.

Bed Rail Fasteners – The solution is a mechanical fastener like the type used to hold the parts of a bed together. (See photo at left.) One part of the fastener (attached to the end of the stretcher) has two hooks that fit into slots in the other part (mounted to the sides). This “locks” the parts together, yet still allows them to be quickly disassembled.

Sides – I started by making the two sides of the bench. Both sides are the same width (18"). And they appear to be the same length. But that's not the case. To allow both sides to fold flat inside the base, the *tall side (E)* is $\frac{3}{4}$ " longer than the *short side (F)*, as shown in Figure 8.

Aside from the difference in length, the sides are identical. To reduce the weight of the bench, I cut a large opening in each side. Also,



▲ A two-piece bed rail fastener creates a strong, rigid connection that's quick and easy to take apart. (See page 31 for sources.)

there's a short, metal bar on the upper back corner of each side that's used to secure the top to the bench.

Bars – The two metal bars are easy to make. I bought a $\frac{1}{4}$ "-thick aluminum bar at a home center and used a hack saw to cut each one to length. Then I drilled a couple of countersunk shank holes in each piece for mounting screws.

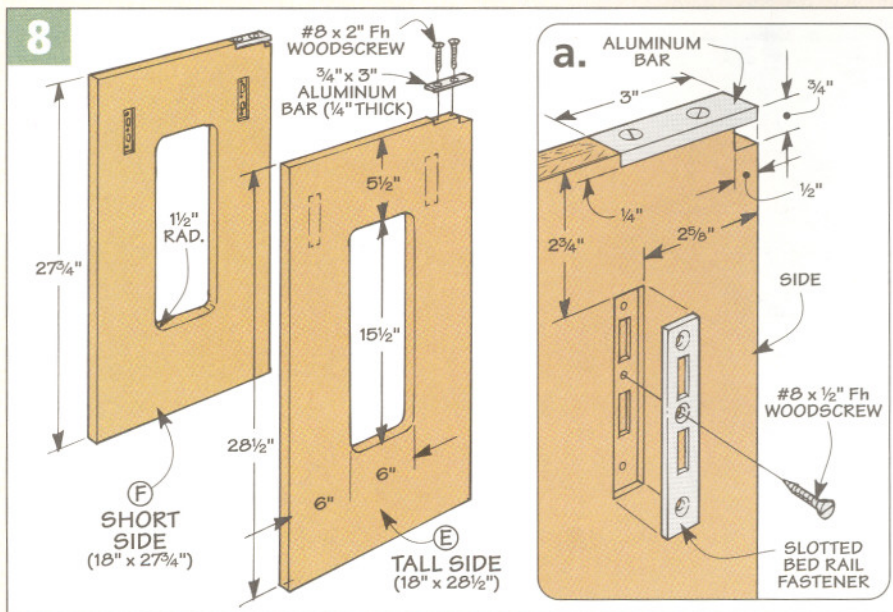
Before attaching the bars, you'll

need to cut a “stairstep” notch in the corner of each side. The upper part of this notch is sized to fit the bar (Figure 8a). When you screw the bar in place, it forms a lip over the lower part of the notch. This lip captures a pin that's installed later in the top.

Cut Mortises – The next step is to cut the mortises that hold the *slotted* part of the bed rail fasteners. As you can see in Figure 8a, the idea is to cut a two-tiered mortise. A wide, shallow mortise is sized to accept the fastener, and two narrow, deep mortises provide clearance for the hooks on the other part of the fastener.

An easy way to make the shallow mortises is to use a drill press and a Forstner bit (Figure 9). A careful layout will ensure that the upper ends of the mortises align. As for the distance of the mortises in from the edge, I clamped a fence to the drill press table and used it to position each workpiece. Now it's just a matter of drilling a series of overlapping holes and paring away the remaining waste with a chisel (Figure 9a).

Once the fastener fits neatly in the mortise, you can use it to lay out the location of the two *deep* mortises



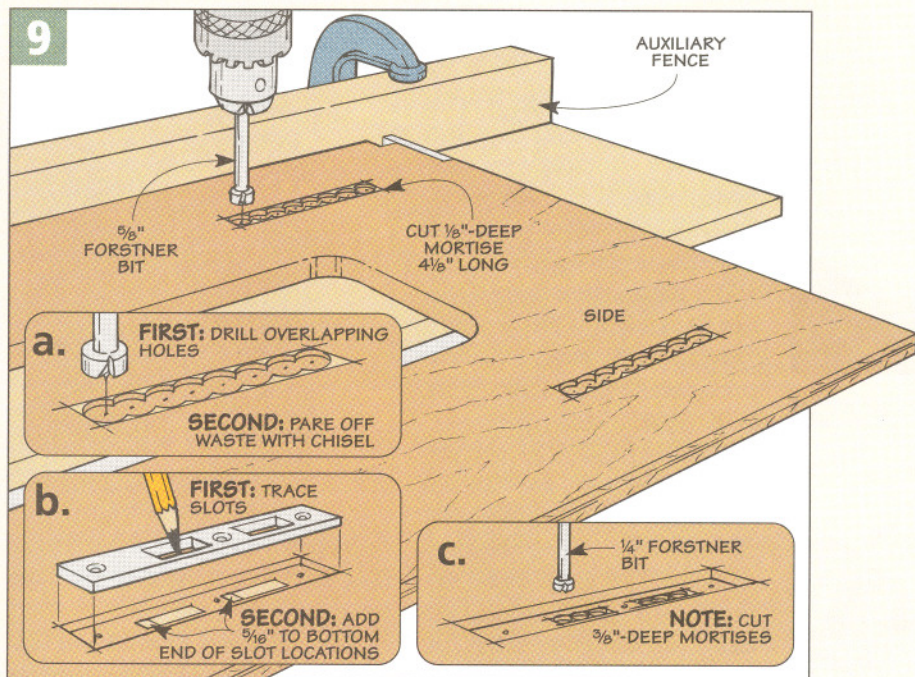
(Figure 9b). The thing to be aware of is these mortises are $\frac{5}{16}$ " longer than the slots in the fastener. The reason has to do with the hooks on the mating fastener. To lock the two parts of the fastener together, the hooks have to fit straight into the slots and then slide *downward*. Increasing the length of the mortise provides the clearance that's needed for the hooks.

After laying out the deep mortises, chuck a smaller bit in the drill press and use the same procedure as before to cut two pockets (Figure 9c). Then screw the fasteners in place.

Install Sides – Now you're ready to install the sides. The tall side (E) is hinged directly to the base (Figure 7b). But as you can see in Figure 7a, the short side (F) is hinged to a *spacer block (G)*. This is a $\frac{3}{4}$ "-square strip of plywood that's glued to the base. The spacer block raises the short side so it can fold down flat across the tall side.

Stretchers – The next step is to add the *stretchers (H)*. As you can see in Figure 10, these are long, I-shaped pieces of plywood that are cut to length to fit between the sides.

Each stretcher has a long notch cut in the top and bottom edge. The upper notch lets you slip a pipe clamp underneath the benchtop so you can clamp a workpiece against



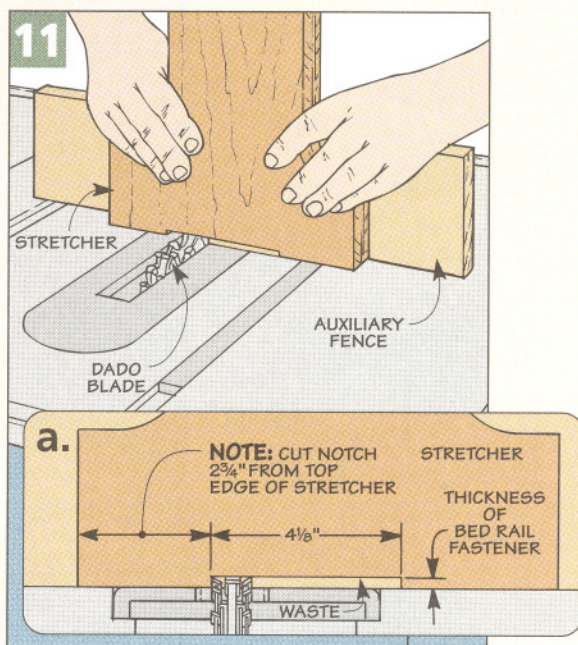
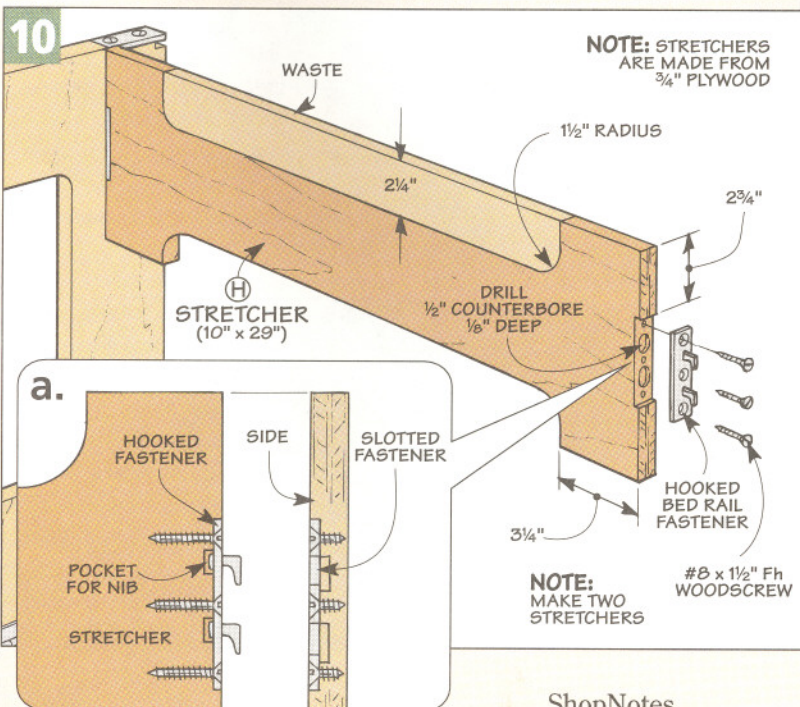
the edge of the bench. The lower notch is simply cut to match.

After sanding the edges smooth, all that's left is to add the *hooked fasteners* (Figures 10 and 10a). Each of these fasteners fits in a shallow notch in the end of the stretcher.

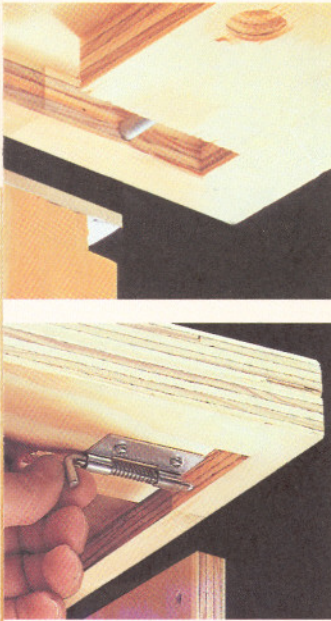
The location of these notches determines the up and down position of the stretchers. I wanted the stretchers to sit flush with the top of the sides, so the notch is $2\frac{3}{4}$ " down from the top edge (Figure 11a).

An easy way to cut the notches is to mount a dado blade in the table saw and to attach a tall fence to the miter gauge (Figure 11). Then stand the stretcher on end, hold it firmly against the fence, and nibble away the waste.

Before attaching the fasteners, take a look at the back of each one. You'll notice there's a large "nib" behind each hook. To make the fastener sit flat in the notch, you'll need to drill a pocket for each nib. Then just screw the fasteners in place.



Top



▲ A simple two-part system is used to fasten the top to the bench. Metal pins in the top fit under the aluminum bars on the sides (upper photo). And spring-loaded latches lock the top in place (lower photo).

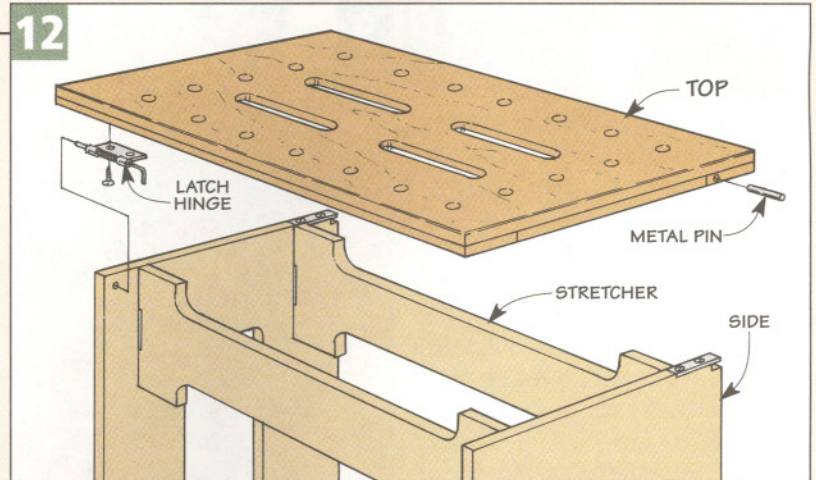
The top of the workbench that's shown in Figure 12 has two main jobs. It creates a solid worksurface. Plus it serves as a lid for the base when you knock down the bench for storage.

But the handiest thing about this benchtop is it provides three different ways to clamp a workpiece to the bench. (Refer to the photos on page 23.)

Built-Up Top – To increase the thickness of the top, it's "built up" from two layers of 3/4" plywood. The upper layer is formed by a *top panel* (I) that's sized to fit flush with the base (Figure 13). And the lower layer is made up of several smaller *filler strips*.

Filler Strips – These strips create a long, narrow recess underneath the top which fits down over the sides of the bench. Plus they provide the thickness that's needed to hold a set of bench dogs. (For more about the bench dogs I used, turn to page 31.)

The *front* and *back filler strips* (J) are simply cut to match the length of the top panel. To fit over the sides of



the bench, you'll need to cut a notch near each end of these strips. Then just glue them in place.

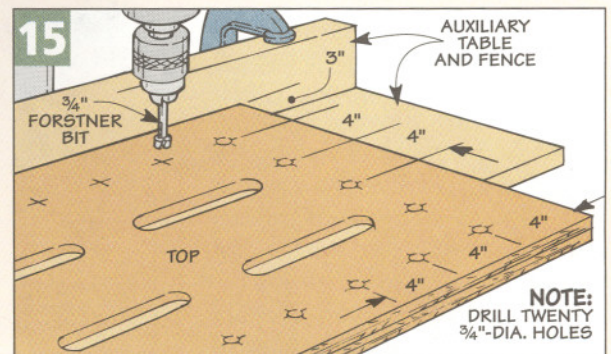
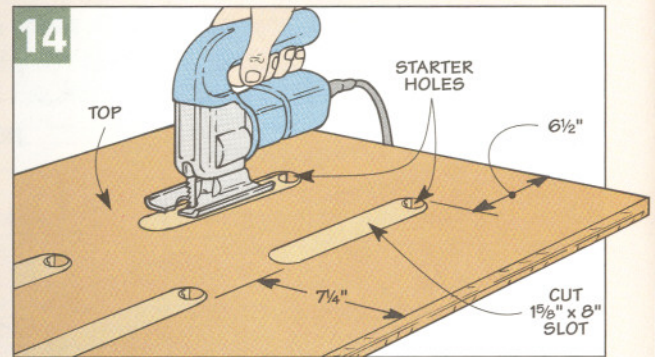
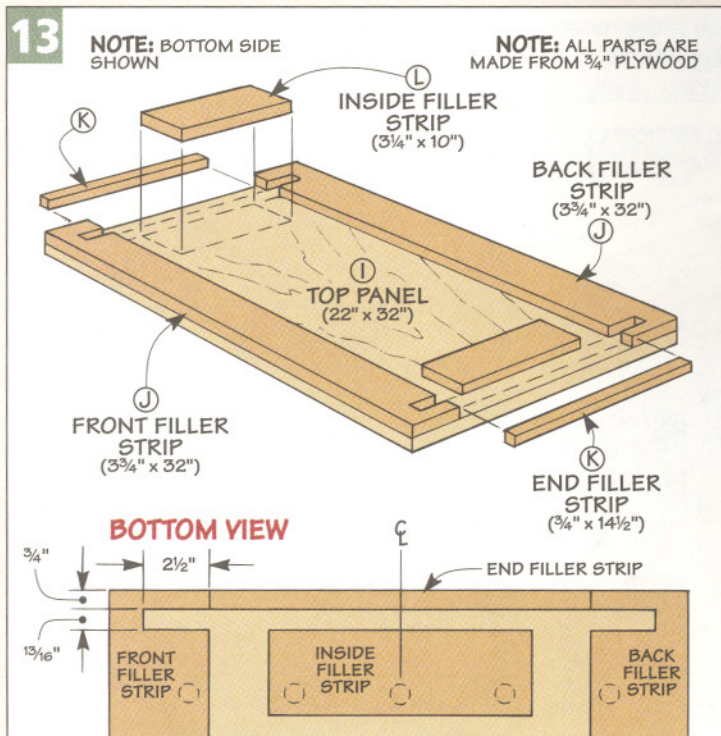
Next, I added two narrow *end filler strips* (K). They're ripped to width so when they're flush with the outside edge of the top, they align with the notch in the front/back strips. As for length, it's just a matter of cutting them to fit the opening.

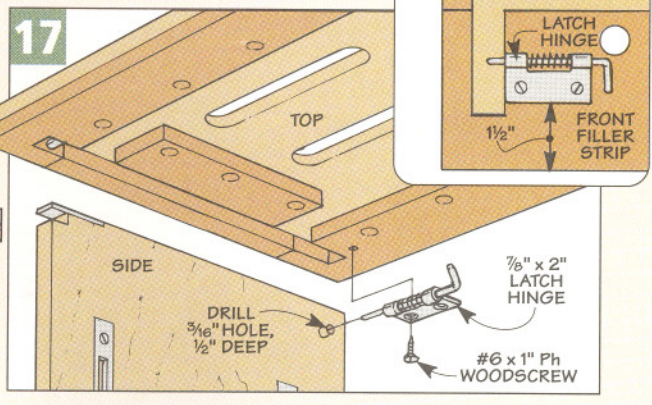
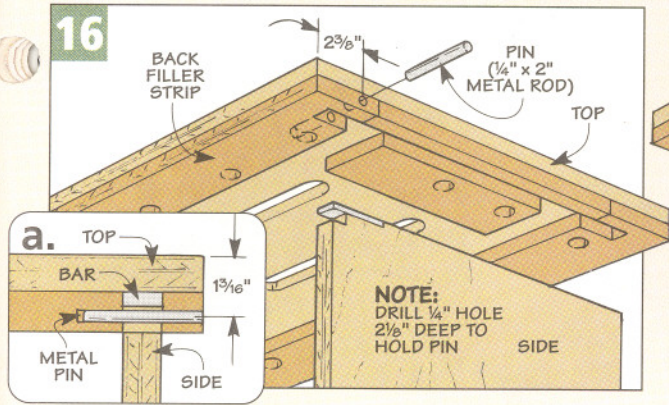
After gluing on the end strips, I added two *inside filler strips* (L). To provide clearance for the stretchers, these strips are *shorter* than the end strips. Here again, the strips are aligned flush with the notch and

then glued in place.

Slots for Clamps – With the filler strips in place, the next step is to cut four slots in the top. Each slot forms an opening for a bar clamp that lets you clamp work near the middle of the benchtop. A quick way to cut each slot is to drill a small starter hole and then remove the rest of the waste with a sabre saw (Figure 14).

Bench Dog Holes – In addition to the slots, I drilled a number of holes in the top to hold the bench dogs. Since the top is quite large, I clamped an auxiliary table to my drill press to support it (Figure 15). It's





also a good idea to clamp a fence to the table to make sure the holes are located the same distance in from the edge. Then lay out and drill the holes.

Locking System – At this point, the top is almost complete. But before setting it on the bench, I added a simple, two-part system that “locks” it securely in place.

If you look at the photos on page 22, you can see how this works. In back, the top is held in place with two metal pins that fit under the aluminum bars installed earlier. In front, it’s secured with a couple of spring-loaded latch hinges.

Install Pins – As you can see in Figure 16, each pin is a short piece of 1/4"-dia. metal rod. The pin fits into a hole drilled in the end of the back filler strip (Figure 16a). After applying a small amount of epoxy in the hole, tap in the pin and clean up any excess that squeezes out.

Latch Hinges – The second part of the locking system is a pair of latch hinges. Each latch hinge has a spring-loaded pin that fits into a hole in the side of the bench (Figure 17). (For a source of latch hinges, refer to page 31.) An easy way to locate the holes for the spring-loaded pins is to screw the latch hinge to the top, as shown in Figure 17a. Note: The latch hinges I purchased didn’t have mounting holes, so I had to drill a couple of holes in each one.

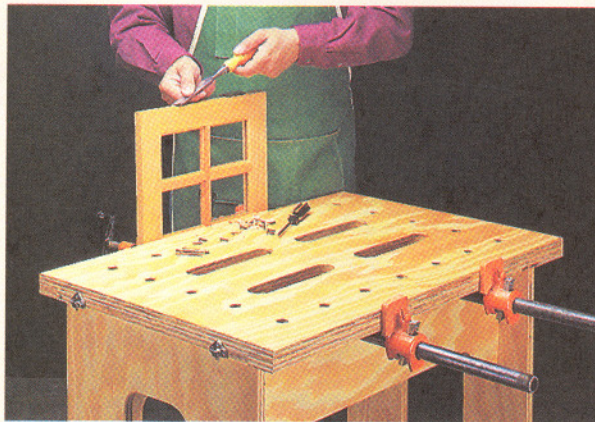
Now lower the top down over the sides and pull it toward you so the metal pins in back slip under the aluminum bars. After centering the top from front to back, tap each of the spring-loaded pins to make a

dimple in the side. Then simply remove the top and drill the holes for the latch pins.

Draw Latches – In addition to the latch hinges, I also installed two draw latches on each end of the bench. (Refer to Exploded View on

page 17.) These latches hold the top and base together when you knock the bench down for storage.

Handle – All that’s left is to add a handle to make it easy to carry the bench. It’s centered on the front of the base and screwed in place.



◀ **Pipe Clamps.** To hold a workpiece against the edge of the bench, slip pipe clamps through the notches at the top of the stretchers.



◀ **Bar Clamps.** Fit the head of a bar clamp down through one of the slots in the top to clamp work near the middle of the benchtop.



◀ **Bench Dogs.** Using one (or more) pairs of bench dogs lets you hold work tightly against the top without clamps getting in the way.