QUICK CUTS MADE EASY!

ShopNotes

ShopNotes.com

Vol. 20 Issue 115

Ultimate Router Jig

Cuts Flutes, Spirals, Tapers, Coves & More!

PLUS:

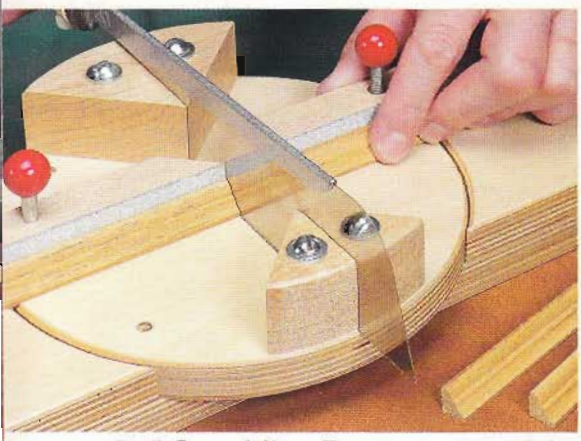
NEW: Long-Lasting Router Bits

The Secret to Fast Case Construction

Master the Miter with a Simple Jig!

A Publication of August Home Publishing

Biscuit Joinery page 14



Pull Saw Miter Box page 36

Cordless Circular Saws page 10

Contents

Features

Departments

All-Purpose, Expandable Worktable *page 16*

Cutoffs

One of the more enjoyable aspects of working here is seeing the ingenuity of the staff. From the editors and illustrators, to the designers and builders, they all contribute to the look and style of the magazine and the projects. But I want to single out the efforts of one designer and his one-of-a-kind project.

Chris Fitch challenged himself to find a way to create decorative table legs using nothing more than a router and a handful of bits. After months of work, the result was the router milling machine shown on page 24. Watching him as he designed and tested the project reminded me of a mad scientist at work, puttering around the lab, trying one thing and then another until, "EUREKA!", he ended up with the result he was looking for. Thanks for the effort Chris. It's a fantastic project.

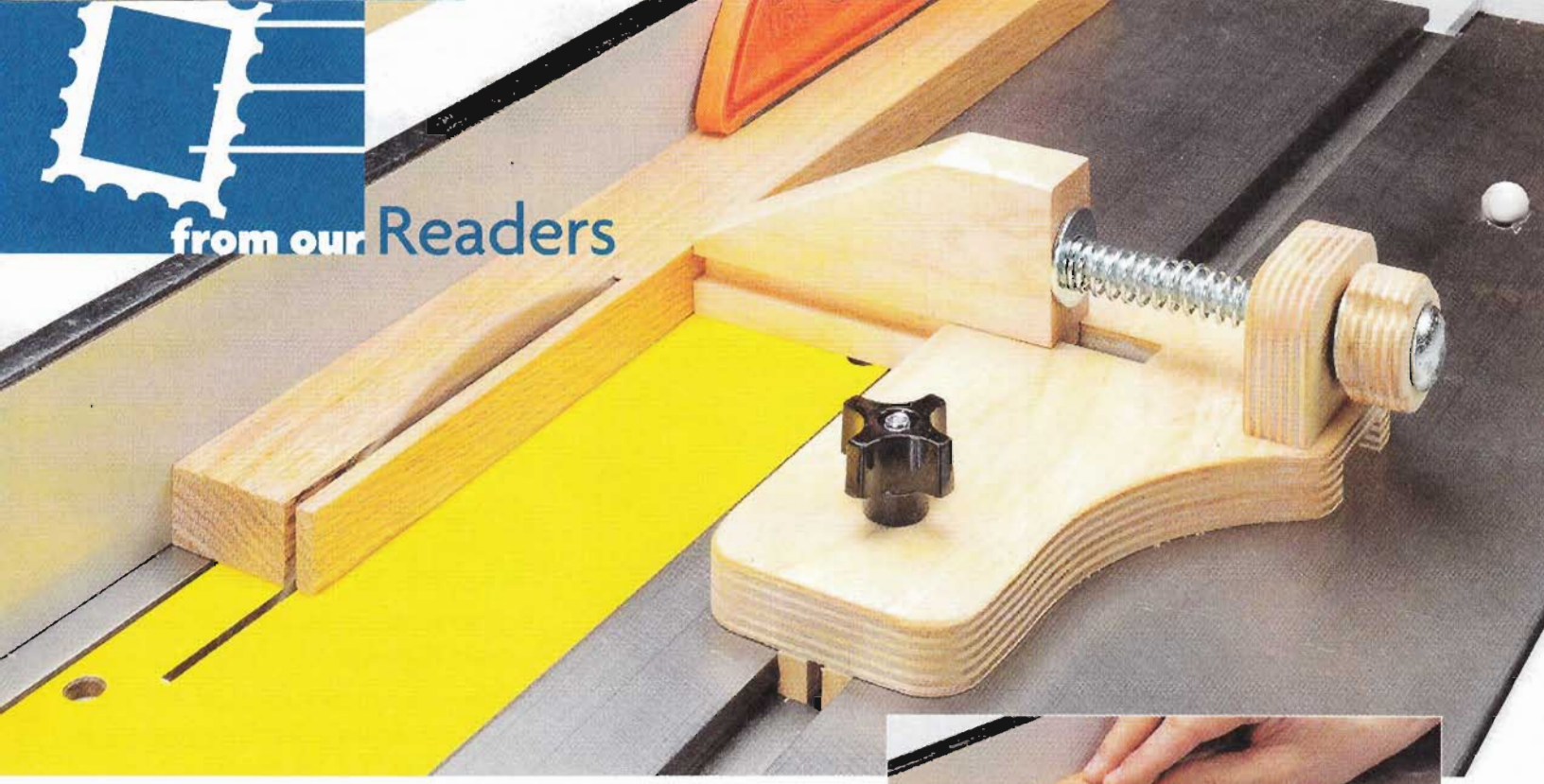
But I'll be honest, trying to explain how to build and use this unique project with just a few paragraphs of text, some detailed art, and sequence of photographs was a big challenge. To give you a better idea, we've put together a short video of how it works at *ShopNotes.com*.

New Face. Finally, I'd like to mention an addition to our staff. James Bruton has joined us as an assistant editor. James has a wide range of experience, from spending time in a production furniture shop to working at the *Woodsmith Store*. We expect he'll bring some fresh new ideas to our future issues.

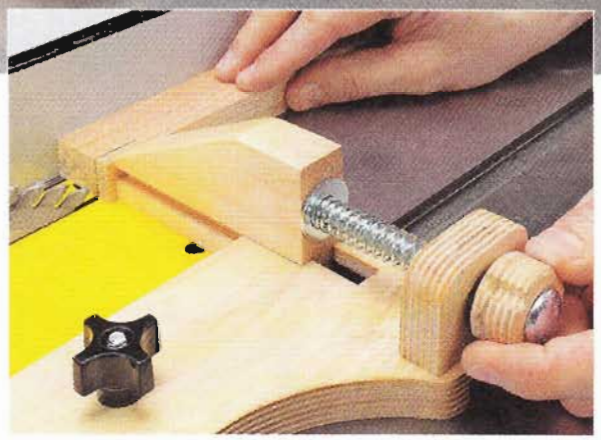
Terry

ShopNotes GO ONLINE EXTRAS

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



Tips for Your Shop



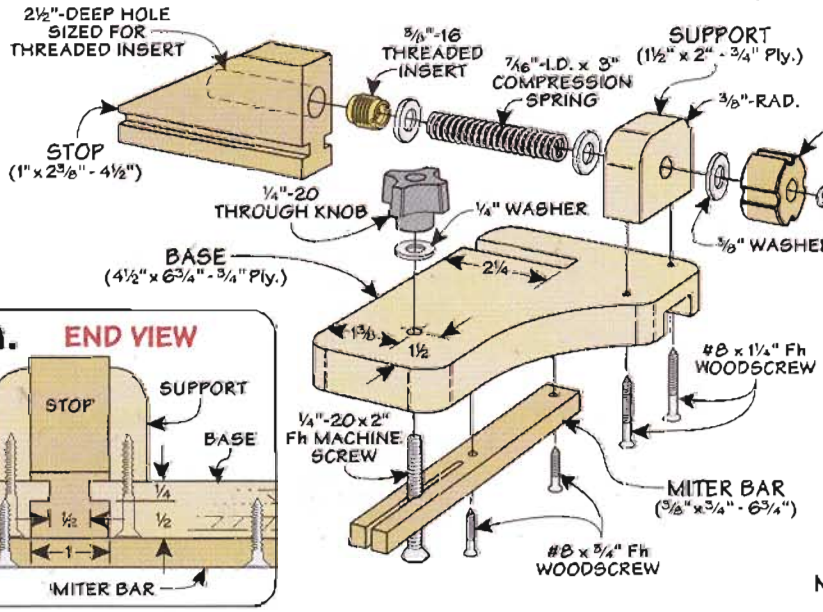
Micro-Adjust Ripping Jig

Ripping consistent, thin strips on the table saw can be a hit-or-miss proposition. This shop-made jig brings accuracy in ripping to a whole new level.

The drawings below show how to make all the pieces, starting with the base. A tapered stop slides along a slot in the base controlled by a shop-made knob and carriage bolt. Each complete turn of the knob moves the stop 1/16". The spring supplies constant pressure on the workpiece.

To use the jig, slide it adjacent to the saw blade so you can "zero out" the stop against the blade. Then, pull the jig back just in front of the blade and lock it down. Now, rotate the knob counterclockwise to dial in the thickness of the strip you need to cut. Slide your workpiece and rip fence over until the workpiece contacts the stop. Finally, you're ready to make the cut. The great thing is, you can make repeated rip cuts without a lot of setup or fuss.

Bill Wells
Olympia, Washington

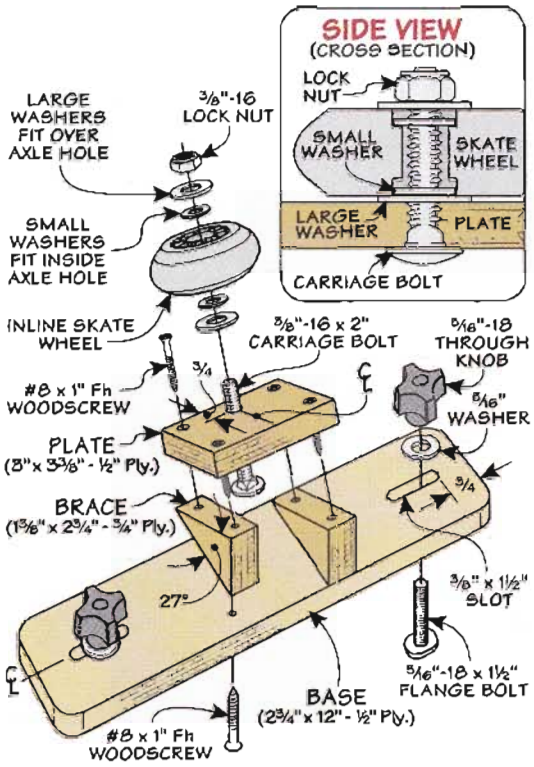


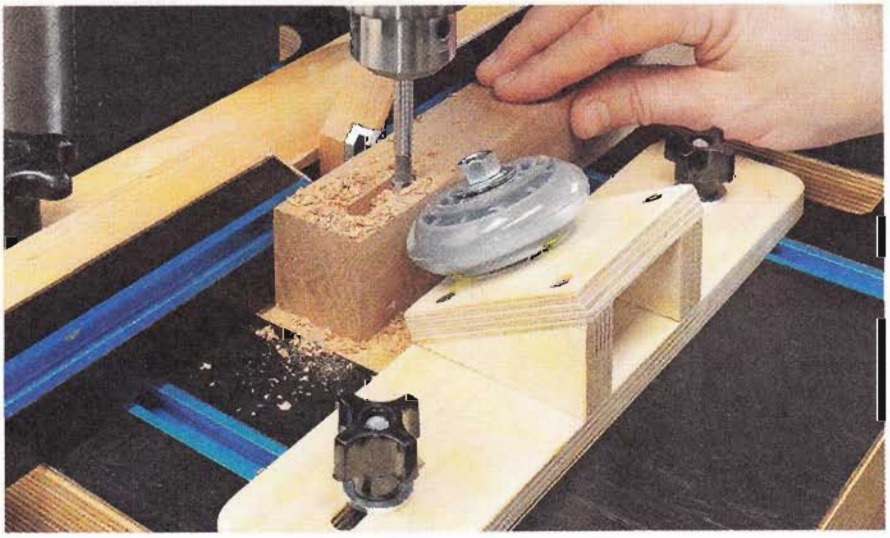
Skate Wheel Hold-Down

Holding a workpiece against the table and fence when drilling out a mortise at the drill press can be a hassle. I solved the problem with this hold-down jig made from an inline skate wheel bought at a sports store.

Size the base to fit your drill press table. A bolt serves as the "axle" and a series of washers keeps the wheel centered on the bolt and spinning freely. Just snug the hold-down against the workpiece before drilling.

Phil Huber
Urbandale, Iowa





Submit Your Tips

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

ShopNotes.com
and click on the link
SUBMIT A TIP

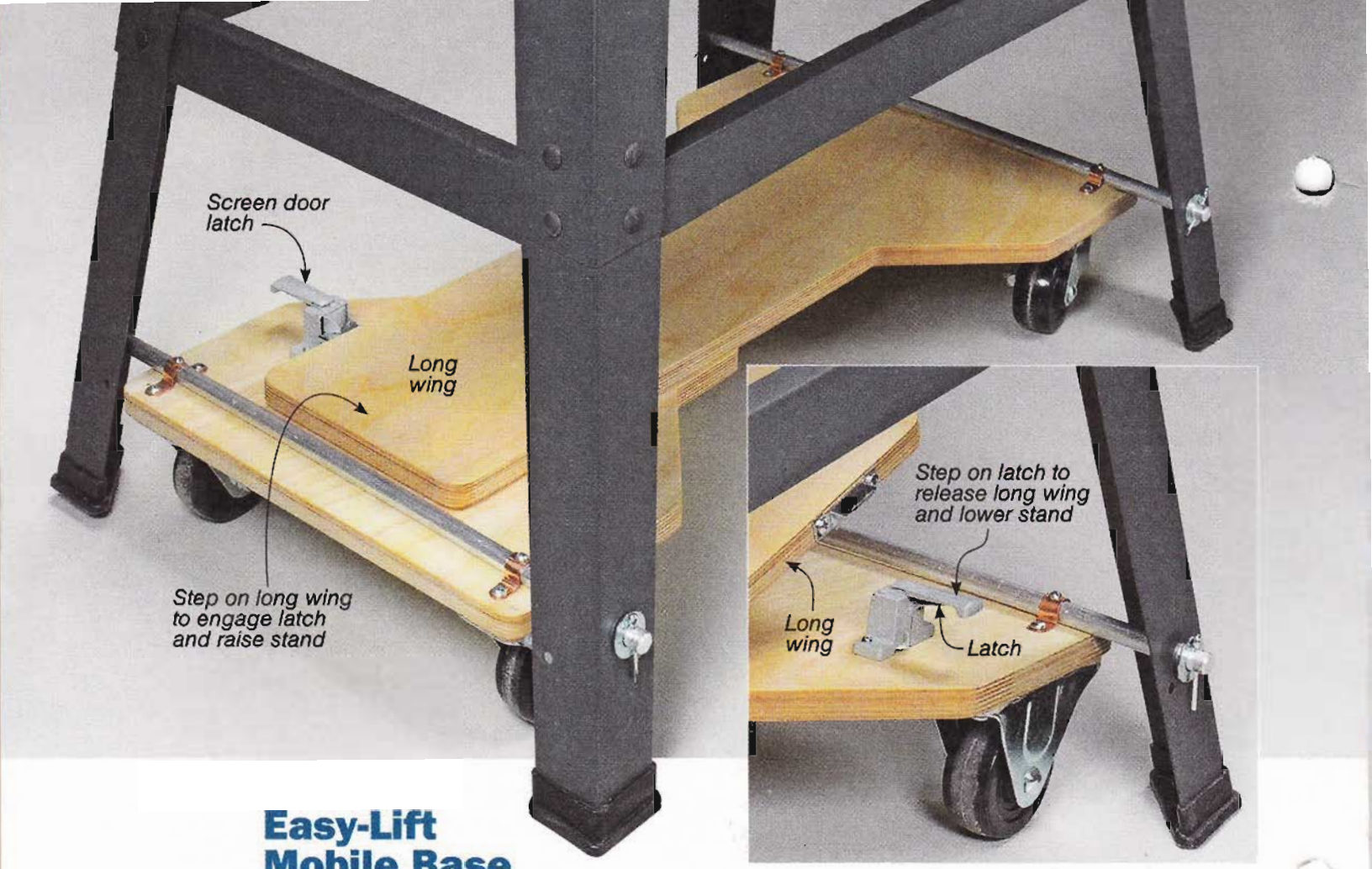
There, you'll be able to describe your tip in detail and upload photos or drawings. Or you can mail your tip to the editorial address shown in the right margin. We will pay up to $200 if we publish your tip. And if your tip is selected as the top tip, you'll also receive the *Bosch Impactor* shown on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

ShopNotes

Issue 115 Jan./Feb. 2011

ShopNotes® (ISSN 1062-4686) is published bimonthly by August Home Publishing, 2200 Grand Ave., Des Moines, IA 50312
ShopNotes® is a registered trademark of August Home Publishing

Single copy: $4.95 U.S. / $6.95 CDN
Canada Post Agreement Number 40038201.
Send change of address information and blocks of undeliverable copies to
P.O. Box 881, Station Main
Markham, ON L3P 8M6
Canada BN 84597 5473 RT
Periodicals Postage Paid at Des Moines, IA and at additional mailing offices.
Postmaster: Send change of address to:
ShopNotes, P.O. Box 37106, Boone, IA 50037-0106



Easy-Lift Mobile Base

THE WINNER!

My shop is small, so mobile bases for my tools are a must. But the problem with most commercial bases is that the casters are outside of the tool stand and it's easy to trip over them.

The compact, shop-made version you see here places the casters on the inside of the stand (photo above). And what's more, the design is easy to operate with light foot pressure. Plus, it uses common, inexpensive hardware.

As you can see below, the two overlapping, T-shaped "wings" hinge on ½"-dia. steel rods. The wings are sized to fit inside the legs of the stand. When the wings are in the flat, or "down" position, the legs of the tool stand should be lifted off the floor about ⅛".

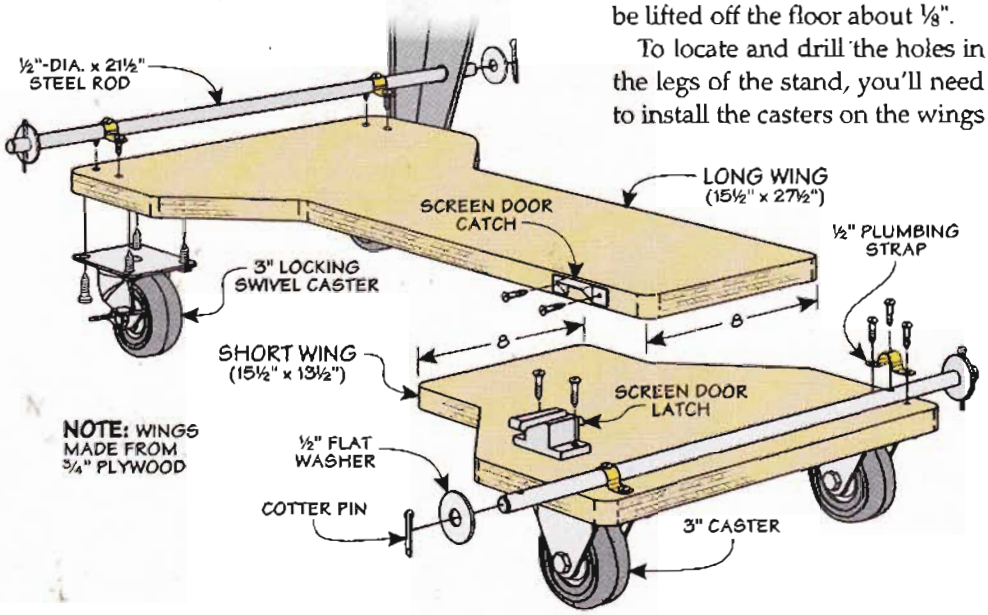
To locate and drill the holes in the legs of the stand, you'll need to install the casters on the wings and temporarily clamp the wings together. To take into account the ¼" radius of the steel rod plus the ⅛" the stand will be lifted off of the floor, I placed ⅜"-thick spacers under the legs of the stand.

All you do is slide the wing assembly under the stand and mark the legs using the top of the wings as a reference for the hole centers. Then, cut and drill the steel rods and install them, securing them with washers and cotter pins, as shown at left.

With the rods in place, you can attach each wing to the rod with a pair of straps. I drilled and installed a screw through the straps to keep the wings from slipping side-to-side.

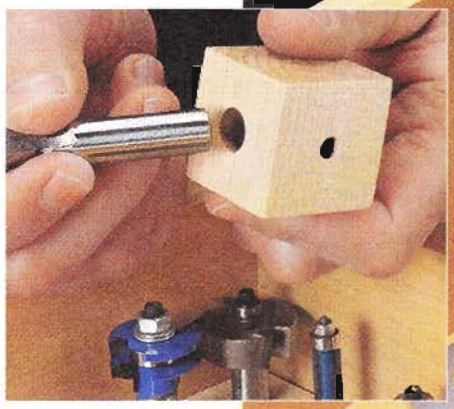
Finally, I installed a screen door latch to secure the wings in the "mobile" position when moving the tool. Simply tapping the latch with your toe releases the wings to lower the stand to the floor.

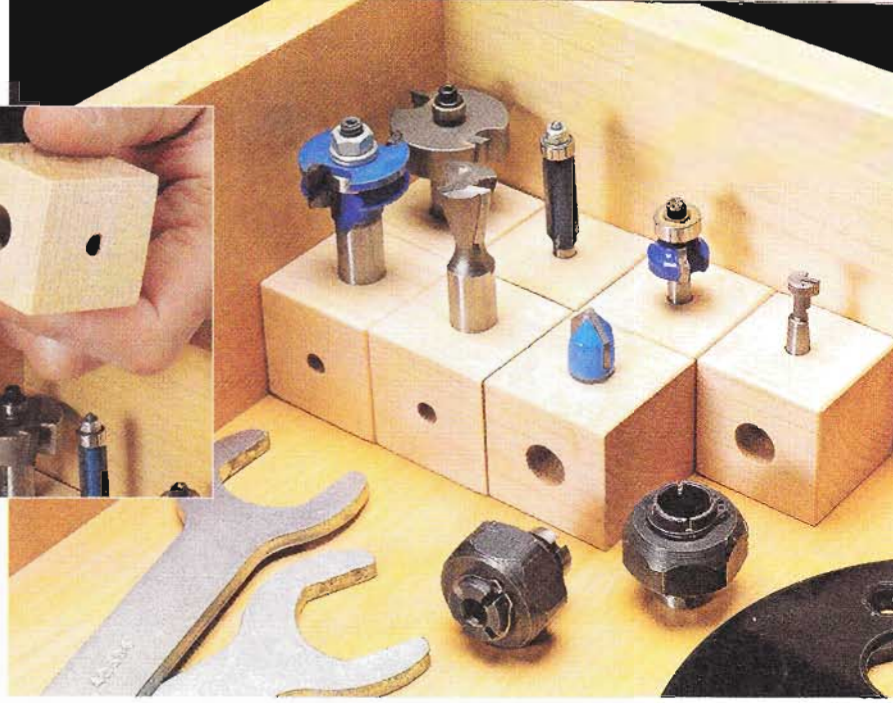
Carl Wubben
Dubuque, Iowa



Bit Cubes

I've always liked to use small blocks of wood to store router bits. I took it a step further and cut some cubes from 1½"-thick stock. This way, you can drill two holes of different diameters (½" and ¼") in each cube to match the shank sizes of router bits. The photos on the right show how this works.

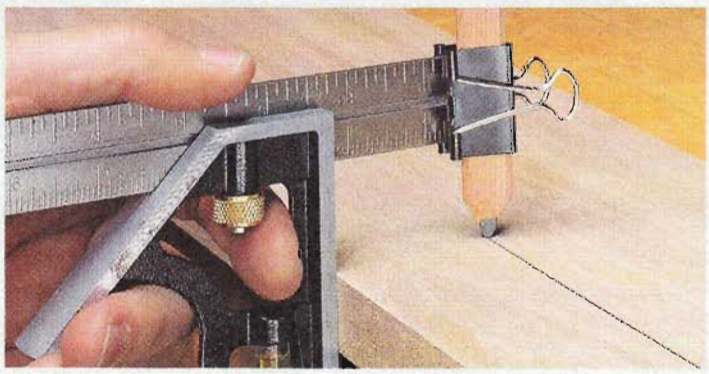




All you need to do is arrange the cubes in a drawer or on a shelf. You can use double-sided tape on the bottoms to keep them from sliding around.

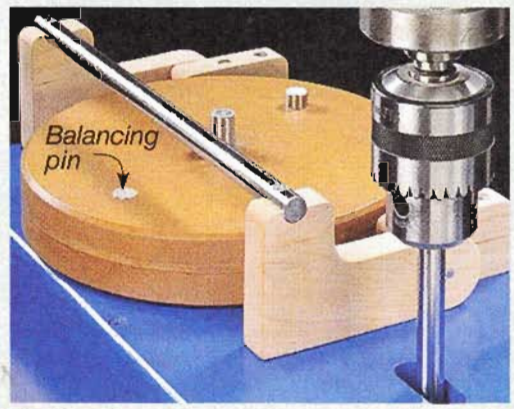
Robert Tindall
Littleton, Colorado

Quick Tips



▲ ***Alejandro Balbis*** *of Longueuil, Quebec figured out a simple way to make a small panel gauge, as in the photo above. He uses a binder clip to attach a carpenter's pencil to the end of his combination square. With this setup, it's an easy task to mark rough layout lines parallel to the edge of a workpiece.*

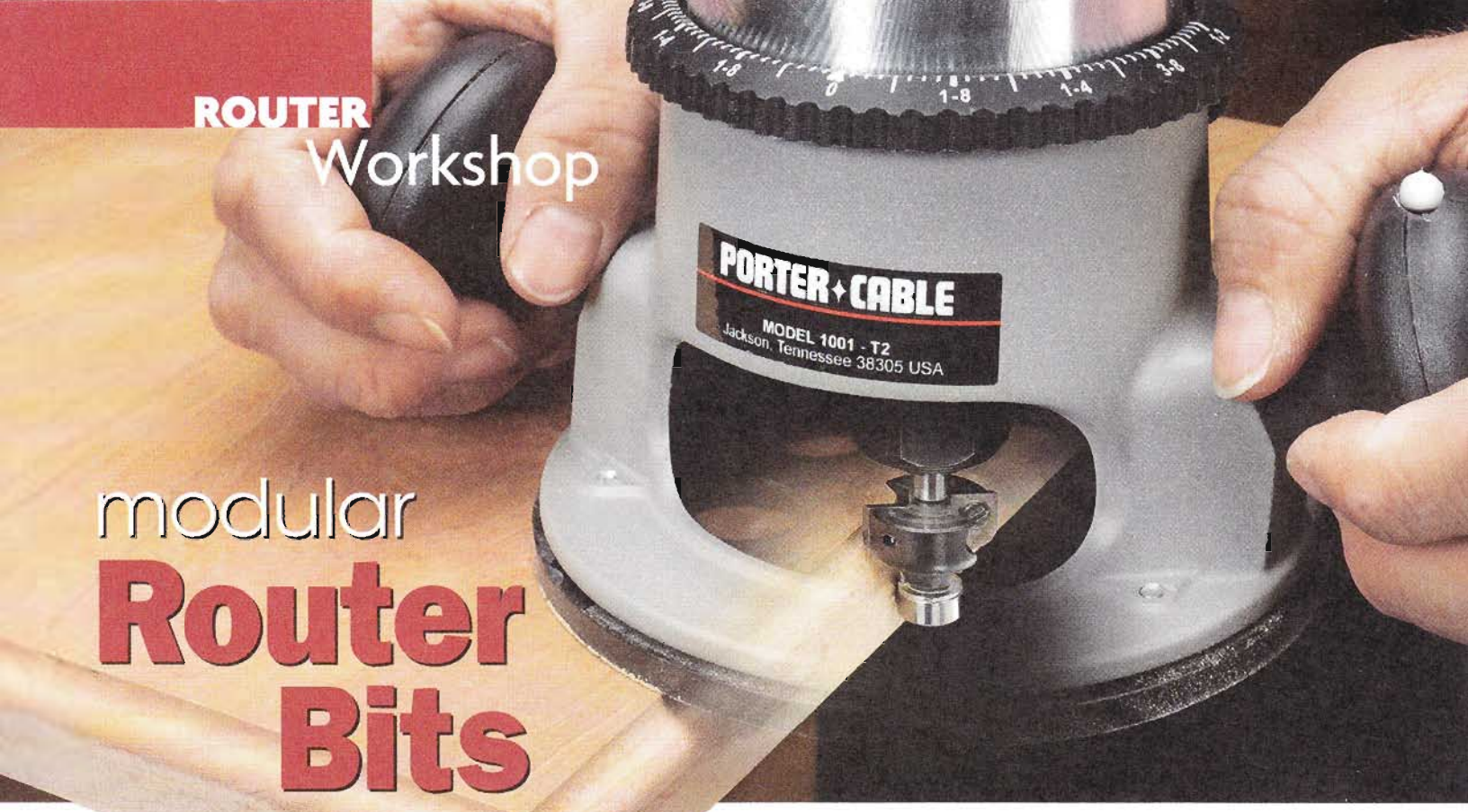
▲ *Over time, router collets can get packed with sawdust and grime.* ***Richard Peterson*** *of Clinton, Iowa found that brushes designed for cleaning guns are also great for cleaning router collets. Use the .25-caliber size for ¼" collets and the .50-caliber size for ½" collets.*



▲ ***Allan Wylie*** *of South Stafford, Vermont tamed the vibration of the sharpening station in ShopNotes No. 107 by adding a short length of steel rod to counterbalance the index pin in the platen.*

▲ *The ultimate idea in portable, multi-use tools come from* ***Charles Mak*** *of Calgary, Alberta. He uses a plastic card (like a credit card) as a square when assembling small projects.*

modular Router Bits

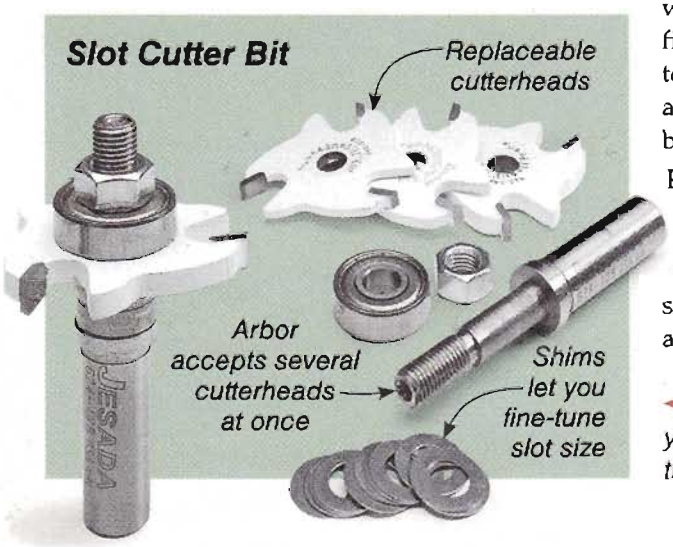


These router bits save you money by letting you replace dull or damaged cutting edges.

When a typical router bit gets dull, it's all too easy to just throw it away. That's unfortunate though since the only parts of the bit that are worn are the cutting edges. Most of the time, the shank, body, and bearing (if there is one) are in good shape. Wouldn't it be great if you could just get new cutting edges instead of a whole new bit?

That's the idea behind several types of "modular" router bits that are now available for woodworkers. Here's how it works. When cutting edges get dull or chipped, you simply unscrew them from the bit and attach a sharp new set. Best of all, the cutters cost far less than a new bit.

There are two approaches to making a modular router bit with replaceable cutters. The first features a "disposable" cutterhead assembly. In the second approach, small individual carbide inserts are screwed to a one-piece bit body.



◀ **Slot Cutter.** *This set allows you to stack several cutters on the arbor for custom-size slots.*

CUTTERHEADS

On a typical router bit, the shank and body are ground from a single piece of steel. The carbide cutting edges are then brazed permanently in place. But not all bits are made this way. On some, the bit is made in two parts so the cutting edges are replaceable. A cutterhead that includes the bit body and cutting edges screw onto a reusable arbor.

Slot Cutters. You're probably already familiar with this kind of router bit. Many slot cutters are designed this way, as you can see in the lower left photo. The arbor and cutters are sold separately. This saves money since, with a single, inexpensive arbor, you can "build" different bits.

Amana E-Z Change. One company has taken the concept to a whole new level. The photos on the top of the opposite page show how these bits work.

Amana's E-Z Change line is made up of a variety of bearing-guided bits. The cutterhead attaches to the arbor in one of two ways.

The cutterheads on bits with a shank-mounted bearing thread directly onto the arbor (near right photo). The bits that have a bearing on the end have cutterheads that are attached with an Allen-head screw (far right photo).

No matter the style, replacement cutterheads come in a convenient three pack. So you can always have a sharp cutterhead on hand.

INSERT CUTTERS

The other approach to make longer-lasting bits is shown in the photos on the bottom of this page. Instead of a removable cutterhead, these bits employ a one-piece body and shank design. Rather than being brazed to the body, the solid carbide cutting inserts are attached with screws.

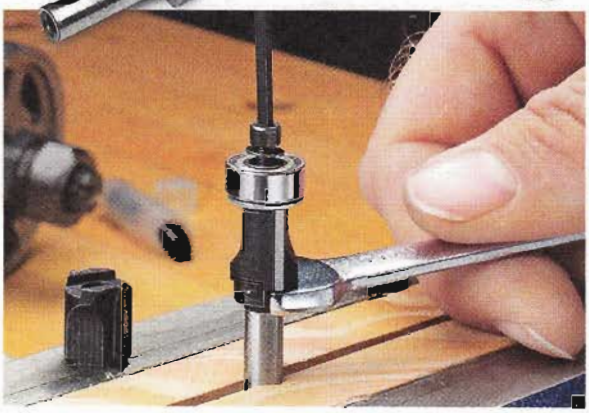
Several router bit manufacturers make replaceable insert bits for home woodworkers. For the most part, the profiles available are limited. Most often, you'll find bits with straight cutting edges like flush-trim, pattern, and rabbeting bits. And a few companies make bits with basic, commonly used edge profiles.

Borrowed Technology. The concept isn't new. In fact, replaceable insert bits like this are common in industrial and large-scale production applications. Now the idea has been scaled down in size and cost for the smaller routers woodworkers use.

Besides saving money, these bits have a couple other advantages. The first has to do with the type of carbide used. Because the inserts are screwed in place, bit manufacturers can use higher-quality, longer-lasting carbide that isn't suitable for brazing like the kind used on a typical router bit.

Multiple Edges. The other benefit is that inserts for common straight profiles often have two or four usable cutting edges each. This means that when one edge gets dull or chipped, you can simply turn the insert to get a new, sharp edge (lower right photo).

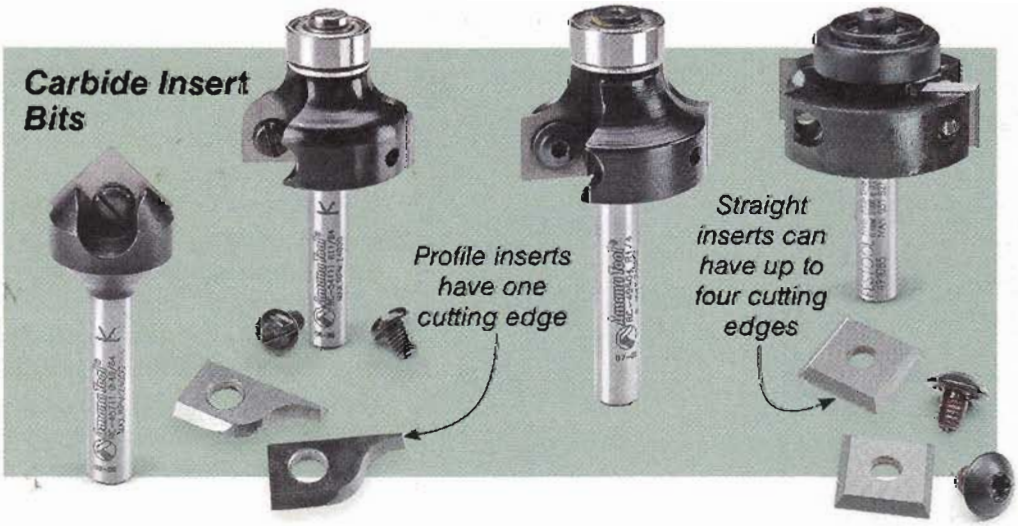
One thing I was concerned about was keeping the inserts aligned when changing them. The mounting holes are oversized and the inserts could end up offset if you're not careful. But the bits come with some installation tips for indexing the inserts for a perfect match.

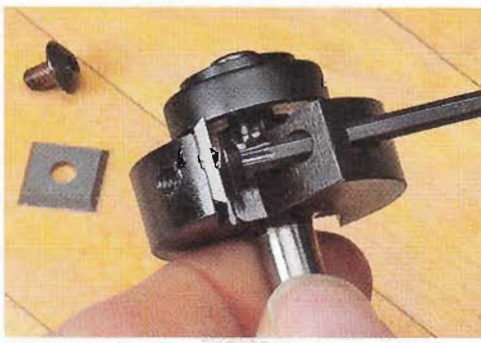


▲ ***Like New.*** *Two tools are required to change the cutterhead on this style of bit.*

Sticker Shock. You might be surprised by the initial higher cost of a modular router bit. Keep in mind, though, that the cost savings really kicks in when you start replacing dull or damaged cutterheads or inserts. It's also important to note that straight-edged cutters are less expensive than more complex profiles.

My advice is to consider the bits you use most often as the best candidates for replacement with a modular design. I think you'll be happy with both the results and money you save.





▲ ***Carbide Inserts.*** *You can quickly install a fresh, sharp cutting edge with insert bits.*

cordless Circular Saws

Find out how to choose the right battery-powered saw for your shop.

It's not unusual to think of a circular saw as a construction tool. But as a woodworker, I rely on one for a variety of shop tasks. The most common is breaking down sheets of plywood into smaller pieces so they're easier to handle on the table saw.

Recently, I began using a cordless circular saw and I think it's an ideal addition to a woodworking shop. Two benefits stand out for me. The first is convenience. Using it is as simple as grabbing it off the shelf — no more untangling an extension cord and keeping it out of the way as you work. In fact, it reminds me of making the switch to a cordless drill.

The other advantage is that many cordless saws are smaller and lighter than a corded saw. This translates into a tool that's easier to control and less tiring to use.

Cordless saws come in a range of sizes with a variety of features. So choosing one that perfectly suits the work you do can be a challenge. The information detailed here will help you make the right determination.

I want to mention up front that a cordless circular saw is more expensive, in most cases, than a corded version. However, the box on the opposite page shows one way to save a lot of money.

Sizes. *You can find everything from full-size cordless saws to small one-hand trim saws.*

RANGE OF SIZES

BATTERY BASICS

A cordless saw is categorized by a combination of its blade size and battery. Understanding how these two issues relate will help you choose a particular model. And since the battery is the most obvious difference between a standard circular saw and a cordless circular saw, it's a good place to start the discussion.

Battery Size. There are actually two factors to consider regarding batteries. The first is the voltage capacity. And the second is the chemical composition of the battery used to store the electricity.

BATTERY BASICS

In general, saws with larger blades have larger, higher voltage batteries. The batteries are available from 9.6-volts to 36-volts. The most common battery is 18-volts. Higher voltage batteries provide longer running time. So if you expect to use the saw for long periods of time, then you may want to consider a larger saw.

Battery Chemistry. The chemicals used to make the batteries play a big role in both weight and performance. Batteries store electricity using one of three types of materials. Inexpensive nickel cadmium (NiCad) batteries are the heaviest and tend to drop off in power as you use them.

A nickel metal-hydride (NiMh) battery provides more consistent power delivery. Plus, you'll be able to recharge it more times (cycles) than a NiCad battery before it needs to be replaced.

The third type of battery is the newest. Lithium-ion batteries are much lighter in weight for the same voltage compared to the other types. These batteries deliver full power right up to full discharge. And they hold a charge for up to 18 months. This can be real handy for a tool that doesn't get used every day.

The size and type of battery also adds weight and can affect the balance of the saw in use. Most batteries mount to the main handle, while the battery in the saw shown in the upper right photo attaches to the side.

BLADE SIZE

For the most part, corded saws have a one-size-fits-all 7¼" blade. Cordless tools on the other hand, give you a lot more choices, as you can see in the lower photo on the opposite page. Saws are available with blades ranging from a full-size 7¼" down to a compact 3⅜" blade (right margin photo).

Even with a battery, a 7¼" cordless saw is about the same size and weight of a corded saw. So its primary advantage is not being tied to an extension cord. It's a good choice if you mostly use a circular saw to make cuts in thick construction lumber.

Since I use my saw mostly for cutting sheet goods, a smaller saw makes more sense. And I think this is where a cordless saw really stands out.

Most cordless circular saws have either a 6½" or 5½" blade. You wouldn't think that reducing the blade size would make much difference in the size of the saw. But the reality is these saws are much smaller and lighter. That provides me with a greater sense of comfort and control — especially one handed.

On the next couple of pages, you'll find the other features to look for when choosing a saw.

▲ **Battery Location.** *The battery on this saw is mounted on the side in an effort to center the weight and reduce the footprint.*

▲ **Blades.** *You'll find cordless saws with blades from 3⅜" up to 7¼".*

money-saving Tool Kits

It's a mystery I'll never quite understand. For the price of a standalone saw (with a battery and charger), you can get a kit that includes a saw, a drill, some other handy tools, and an extra battery. So if you're looking to upgrade your cordless drill, it's definitely worth a look.

DEPTH OF CUT

▲ ***Bevels.*** *A 6½"-dia. blade can crosscut "two-by" lumber at 45°.*

Blade size and battery are the two most obvious features of cordless circular saws. But I think it's the features and capabilities of the saw that will make or break your decision. In any case, before you buy a saw, it's a good idea to try it for yourself to see how it feels.

MORE ABOUT BLADES

Although I've talked about how the blade size affects the overall size of the saw, there are some other blade-related items that need to be mentioned.

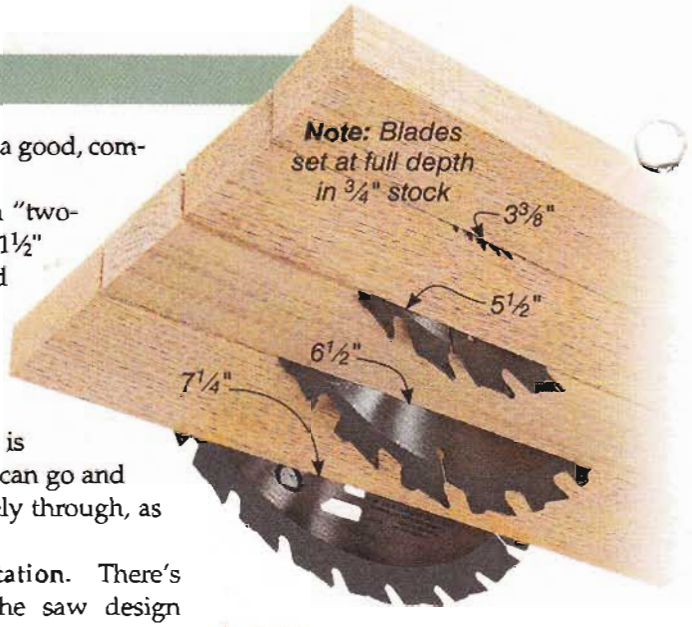
Depth of Cut. While a smaller blade results in a smaller saw, the depth of cut is reduced as well. You can see this in the upper right photo. For example, the 3⅜" blade just makes it through ¾"-thick material. But if all you do is make occasional cuts in sheet stock, this can be a good, compact choice.

To cut through "two-by" lumber (1½" thick), you need a saw with at least a 5½"-dia. blade. If you plan to make 45° cuts, a 6½" is the smallest you can go and still cut completely through, as in the left photo.

Blade Orientation. There's one aspect of the saw design that's important to consider. And that's the side of the saw the blade is located on. You can find saws with the blades mounted on either the left or right side. This doesn't necessarily mean one is suited better for left- or right-handed users. Choose the arrangement that gives you the best view of the cut depending on how you hold the saw.

Blade Changing. Finally, you'll want to look at how easy (or difficult) changing the blade is on any saw you're considering. For starters, make sure the saw has an arbor lock. It makes blade changes safer since you don't have to wedge the blade in place.

Most blades are secured with an Allen-head screw, as shown in the lower left photo. The wrench



▲ ***Capacity.*** *You can choose a saw based on the thickness of material you cut most often.*

is stored conveniently on the saw so it's always close at hand.

Using an Allen wrench isn't the only way to remove a blade. Some saws use a tool-less system. The lower right photo shows how this works. A sliding toggle on the arbor bolt acts as the wrench handle to secure the bolt.

BASEPLATES

One area of a circular saw that's often overlooked is the baseplate. The baseplate of a saw can be made from a piece of stamped steel or cast from aluminum or magnesium, as shown in the photos on the top of the next page.

No matter what the baseplate is made of, there are two qualities it should have. First, it shouldn't flex in use. Either type can be rigid, so give any saw you're looking at a check. You can see how well the baseplate resists flexing by pushing down on the saw handles.

Second, the baseplate should also be smooth so it doesn't mar a workpiece. Any saw that could mar an expensive piece of veneered plywood isn't worth a second look. I prefer a cast baseplate. To me, it's a sign of a higher-quality tool that will last longer.

CHANGING THE BLADE

▲ ***Use a Wrench.*** *To remove the blade on most saws there's an Allen wrench included.*

▲ ***No Tool Necessary.*** *A toggle on the arbor bolt of this saw slides out to give you the leverage necessary to tighten or loosen the blade.*

BASEPLATES, HANDLES & KNOBS

COMFORT & CONTROL

The other features I look at in a saw have to do with comfort. Every saw I looked at (except the 3⅜") came equipped with two handles. There's the main handle that contains the power switch and a front-mounted handle for increased control.

Main Handle. At first glance, it may not seem like there's much difference in any of the handles. However, if you take a look at the photos on this page, you can see how they differ. What I look for is whether the angle of the handle results in a comfortable grip when the saw is set for the material thickness I use most often.

Front Handle. The front handle on most saws is in line with the main handle. This way you can use either hand to grab it. Some saws have an offset front handle. So depending on how you usually hold the saw, you could end up with an uncomfortable grip.

For me, the lower the front handle the better. I find I have better leverage and control to keep a saw firmly against a cutting guide. Once again, trying the saw in person is the best way to see if a particular saw will work for you.

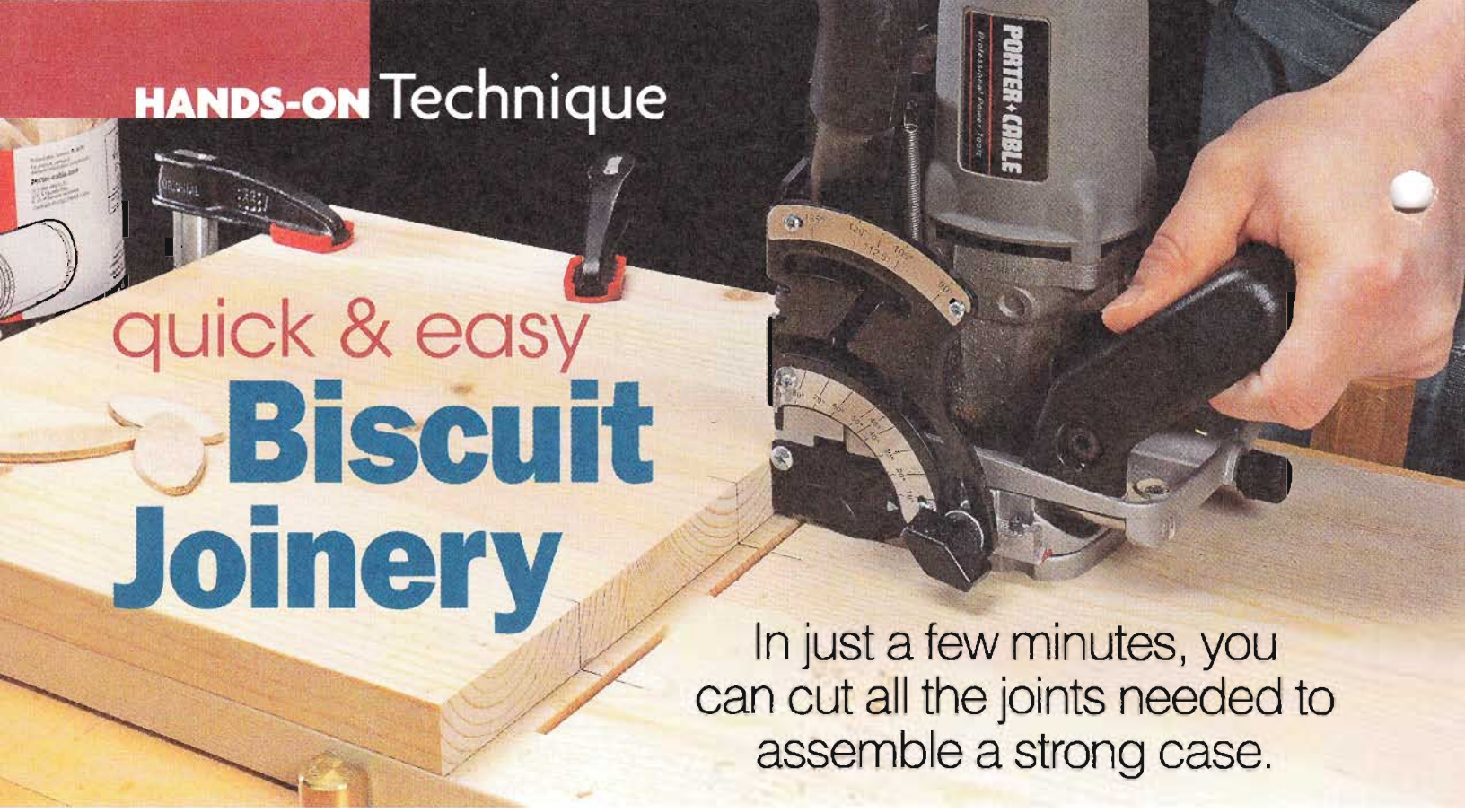
Knobs & Levers. The last items I look at are the knobs and levers that control the blade depth and bevel angle. Although I don't change them all that often, they should still be easy to grab and operate. Some knobs can be difficult to reach and almost painful to lock in place.

There's a lot to consider, here. And it's a pretty personal decision. The folks in the shop all chose different favorites. But there was one thing everyone agreed on — getting a cordless saw was definitely high on their list.

HAND POSITION

▲ ***Horizontal Position.*** *When set for cutting ¾" plywood, this saw places the main handle in a comfortable position parallel to the baseplate.*

▲ ***Vertical Handle.*** *The handle on this saw is more vertical. It's comfortable for ¾"-thick material but less so when the saw is adjusted for a deeper cut.*

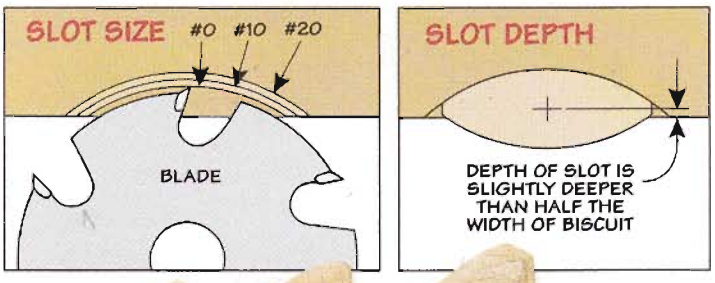


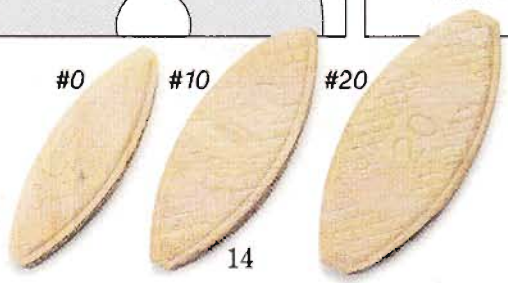
quick & easy Biscuit Joinery

In just a few minutes, you can cut all the joints needed to assemble a strong case.

The starting point for many woodworking projects is building a case. And building a strong and sturdy case requires a combination of the right materials and joinery. It also helps if it goes together quickly. One surefire approach is to assemble the case with biscuit joinery.

You can see how a biscuit joint works in the drawings below. The blade of a biscuit joiner cuts a shallow, curved slot in each mating piece. A football-shaped biscuit is glued into the slots creating a solid connection. Besides being fast, the joint makes aligning the parts a breeze.





◀ ***Three Sizes.*** *A biscuit joiner can cut slots for #0, #10, and #20 size biscuits to suit almost any application.*

Three Sizes. The blade of a biscuit joiner can cut slots for three different sizes of biscuits. You can see the full size of each biscuit in the photo at the bottom of the page. This feature gives you the versatility to work with parts in a range of widths and thicknesses. But I find that the large, #20 size works best in ¾"-thick material.

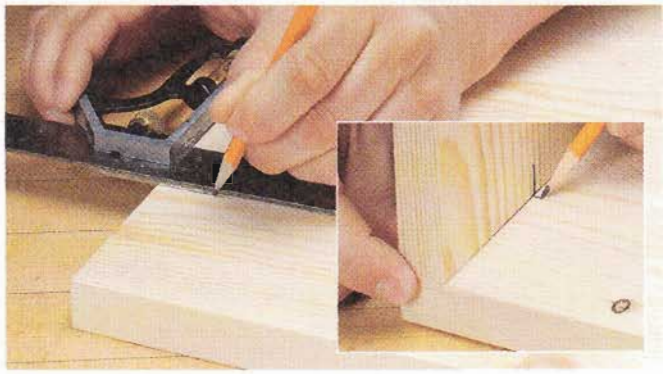
Using a biscuit joiner is about as simple as it gets. Just align the centerline of the joiner base on a layout mark and plunge the blade into the workpiece. That's it. But as you may guess, there are some tips and techniques that will give you the best results. I'll go over some of these using a simple case with a fixed divider as an example.

Layout. The first thing you need to do for just about any type of joinery is a little layout work. For biscuit joinery, you're really just marking the centerline location for each biscuit on the mating pieces. There are two things to keep in mind when doing this.

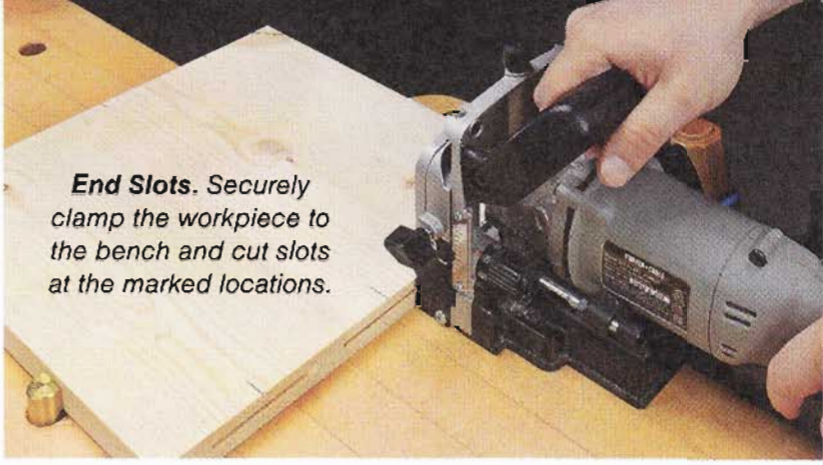
You don't want to cut the slot so close to the edge that it may weaken the grain or even be exposed. The other thing is to make sure to use enough biscuits to create a strong joint. As a rule, I try to space biscuits 4" to 6" apart across the full width of the joint.

The upper left photo on the next page shows how I make the layout marks. Begin by placing the two parts together in their assembled position (inset) and make a corresponding mark on each piece. Then use a square to extend the marks so they're easier to see when aligning the biscuit joiner.

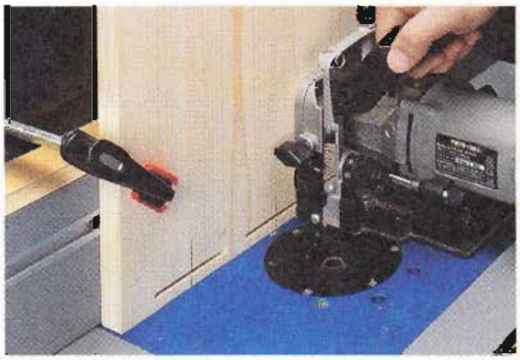
Reference Point. Before getting started on cutting joints, there's one other thing I want to mention. You have a choice of using either the fence of the joiner or its base as the reference surface for the workpiece. Either one guarantees that the slots are cut at a consistent location. However, switching



▲ **Easy Layout.** *Hold the parts in position (inset) and make a mark on each piece. Then, extend the lines.*



End Slots. *Securely clamp the workpiece to the bench and cut slots at the marked locations.*



► **Helping Hand.** *The router table fence holds the case side vertical for cutting slots in the face.*

Corner Joint

between the two in the same joint may cause parts to be misaligned. So it's a good idea to stick with one method for the entire process.

I prefer to use the base of the joiner. This provides the tool with a larger bearing surface since it can rest flat on my workbench.

Corner Joints. There are two main types of joints involved when building a case. One type is a joint where the ends of two pieces meet in a corner (upper margin photo). To create a biscuit joint here, you'll need to cut slots into the end of one piece and into the face of the other.

You can see both operations in the upper right photos. To cut the slots in the end of the top, I clamp it to my workbench (inside face up). Then it's just a matter of aligning the joiner with the marks and cutting the slots.

Cutting the mating slots in the side takes a different approach. That's because the tool needs to meet the workpiece at 90°. You can see my solution in the lower photo above. I clamped the workpiece to the fence of my router table. It holds the workpiece securely and the table supports the biscuit joiner.

T-Joints. The other type of case joint you'll need to make is a T-joint (lower right margin photo). This joint is commonly used for fixed shelves and dividers. The real challenge of this joint is cutting the slots into the face of the side. There's no obvious way to reference the base of the joiner.

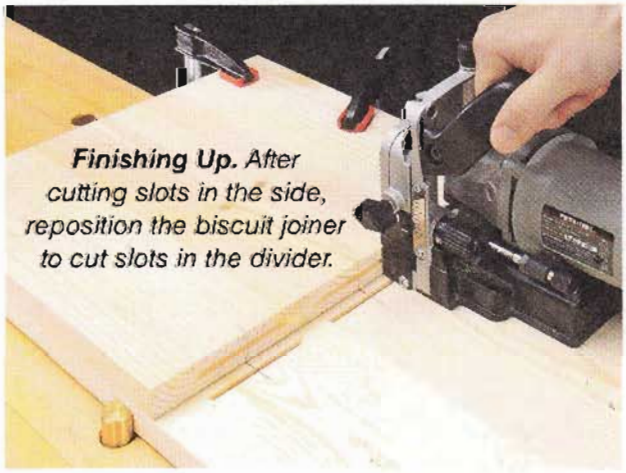
The answer is to create a reference surface with the mating workpiece (lower left photo). After marking the location of the divider's bottom edge on the side, I "folded" the piece down and clamped it in place.

Now cut the slot by holding the biscuit joiner vertically. The base of the tool registers against the divider for an accurate cut.

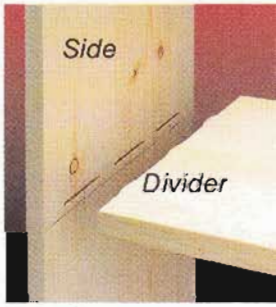
All that's left to complete the joint is to cut the slots in the divider. Best of all, you don't need to move anything. Just flip the joiner around and make the cuts, as in the lower right photo.

Following these simple steps make it easy to master case joinery. In no time you'll have all the slots cut and then you'll be ready to start assembly.

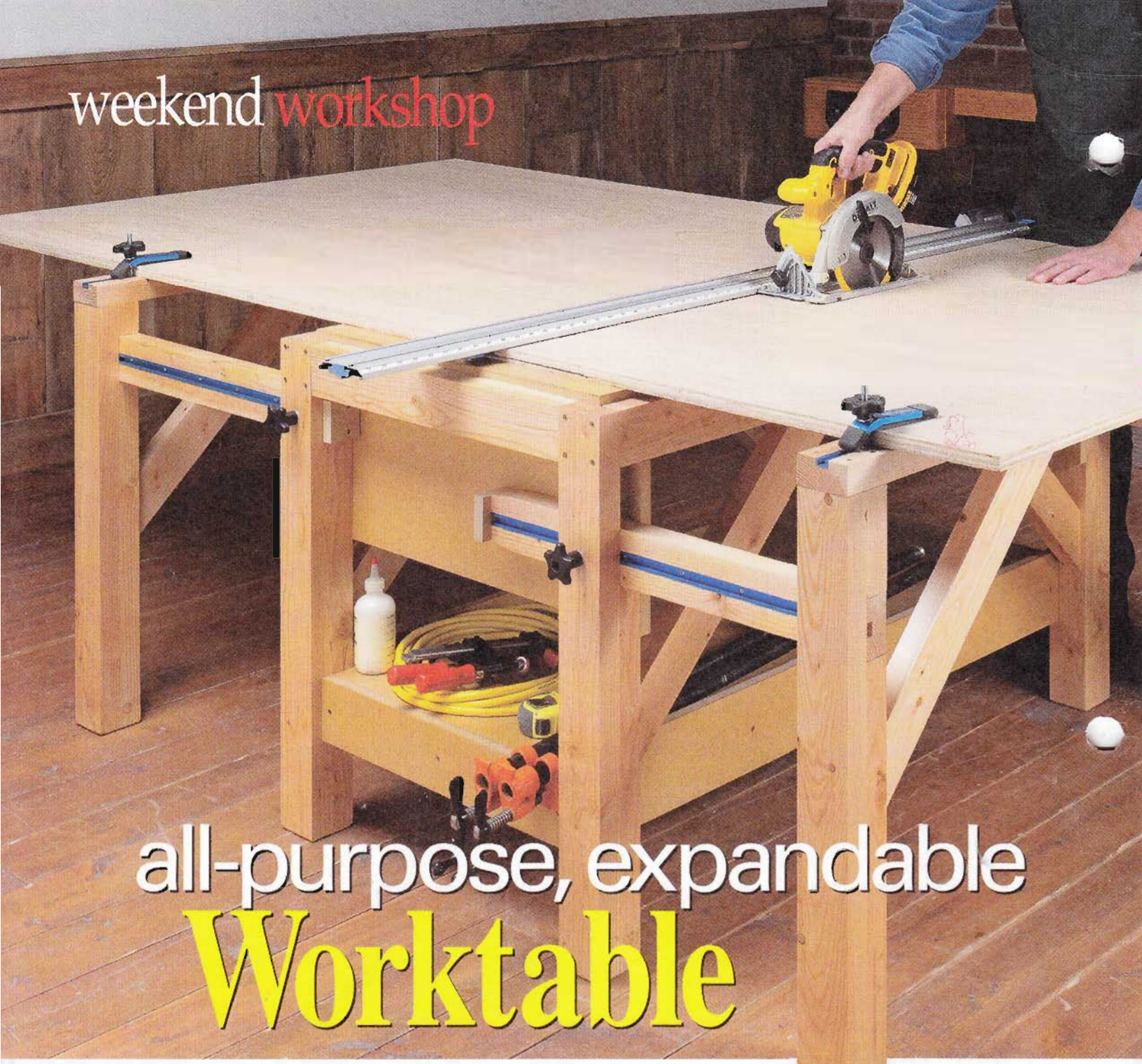
Support. *To cut the slots in the side, use the divider to locate the biscuit joiner.*



Finishing Up. *After cutting slots in the side, reposition the biscuit joiner to cut slots in the divider.*



T-Joint



all-purpose, expandable Worktable

This easy-to-build workstation quickly expands to support full sheets of plywood.

Versatility is a requirement for working in a small shop. Everything from tools to workstations needs to serve several roles to make the most of the space.

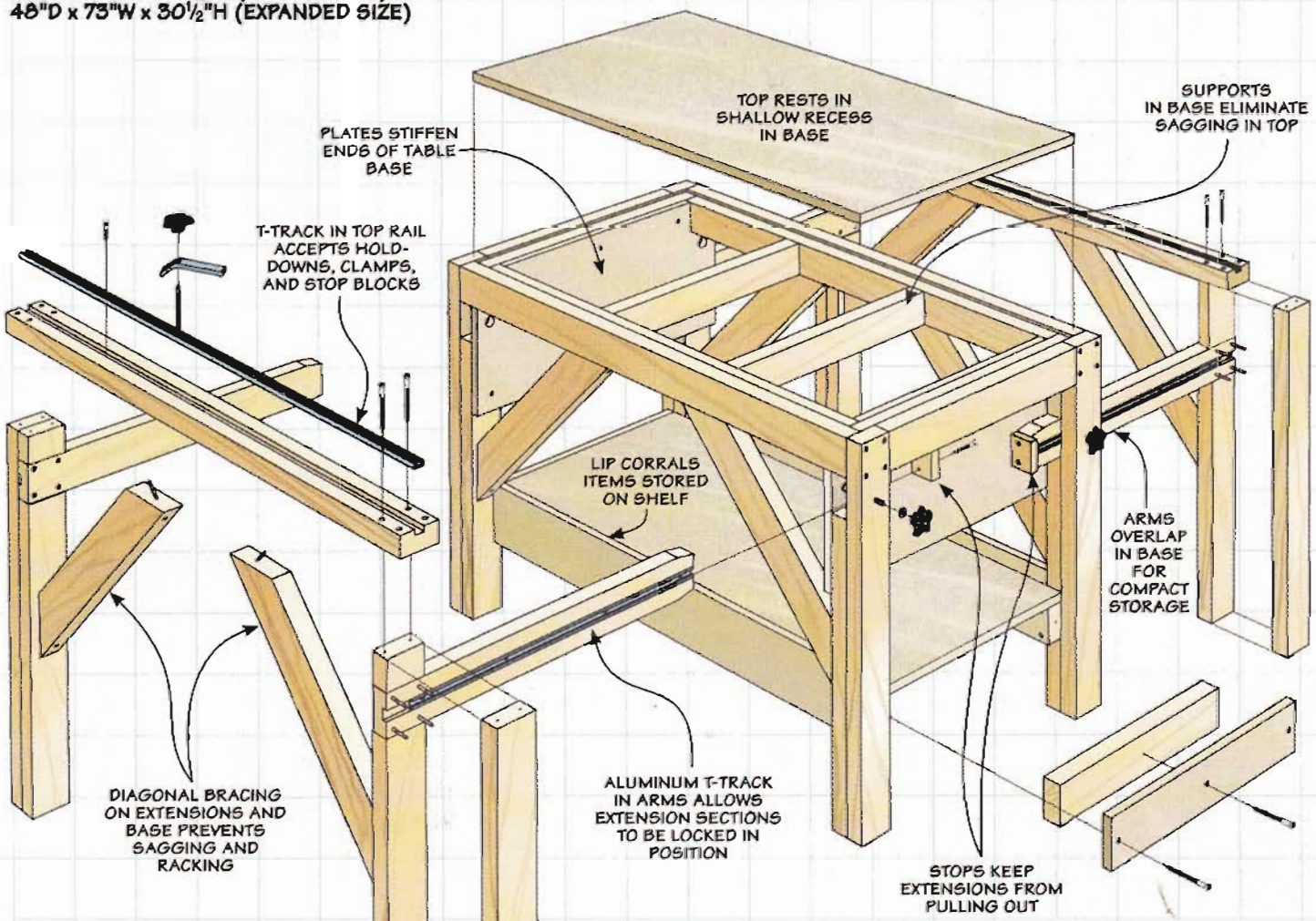
The small worktable shown here is a perfect example of this. Most of the time, it serves as a compact workbench for all kinds of tasks, as you can see in the photo on the facing page. But like a dining room table that expands to feed a crowd, this one features pull-out extensions. This is really handy when I'm working with plywood. Instead of trying to muscle a full sheet onto my table saw, I can use a circular saw to break the sheet down into more manageable pieces. The top is sacrificial and designed to be replaced as necessary.

There are a few other features worth mentioning. T-track on each extension provides clamping options and a shelf provides some valuable storage. Not bad for a project you can build in a weekend.

Exploded View Details

OVERALL DIMENSIONS:
48"D x 33"W x 30½"H (STORED SIZE)
48"D x 73"W x 30½"H (EXPANDED SIZE)

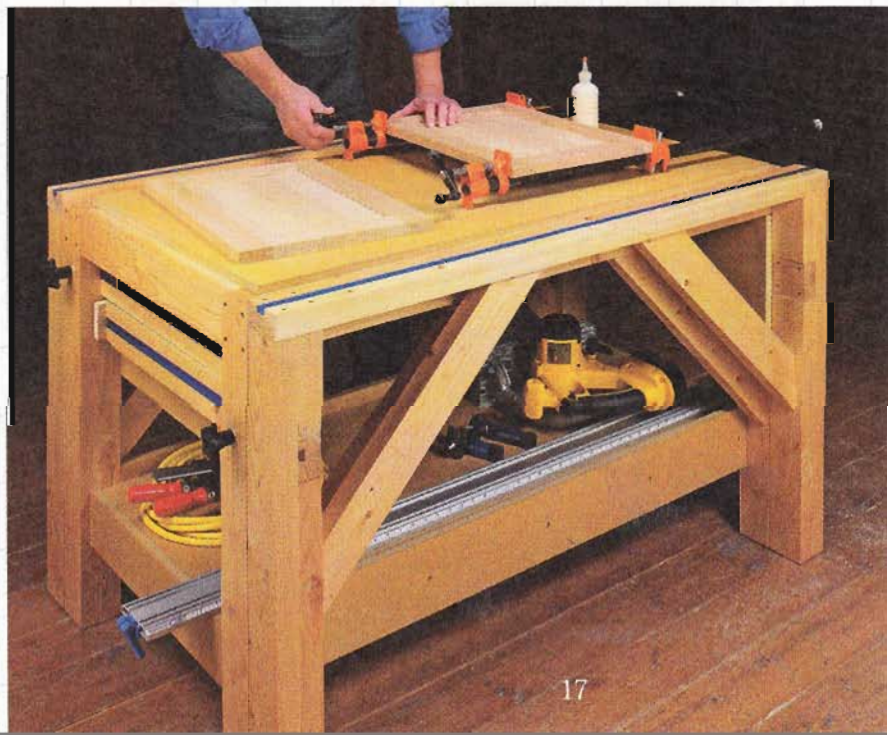
NOTE:
TOP CAN BE FLIPPED OVER TO CREATE A CLEAN, SMOOTH WORKSURFACE



NOTE: TABLE FRAME AND EXTENSIONS ARE ASSEMBLED WITH GLUE AND WOODSCREWS

NOTE: FOR HARDWARE SOURCES, TURN TO PAGE 51

NOTE: TABLE IS BUILT FROM ECONOMICAL, "TWO-BY" CONSTRUCTION LUMBER (16 - 8'-LONG 2x4s) AND ONE SHEET OF ¾" MDF

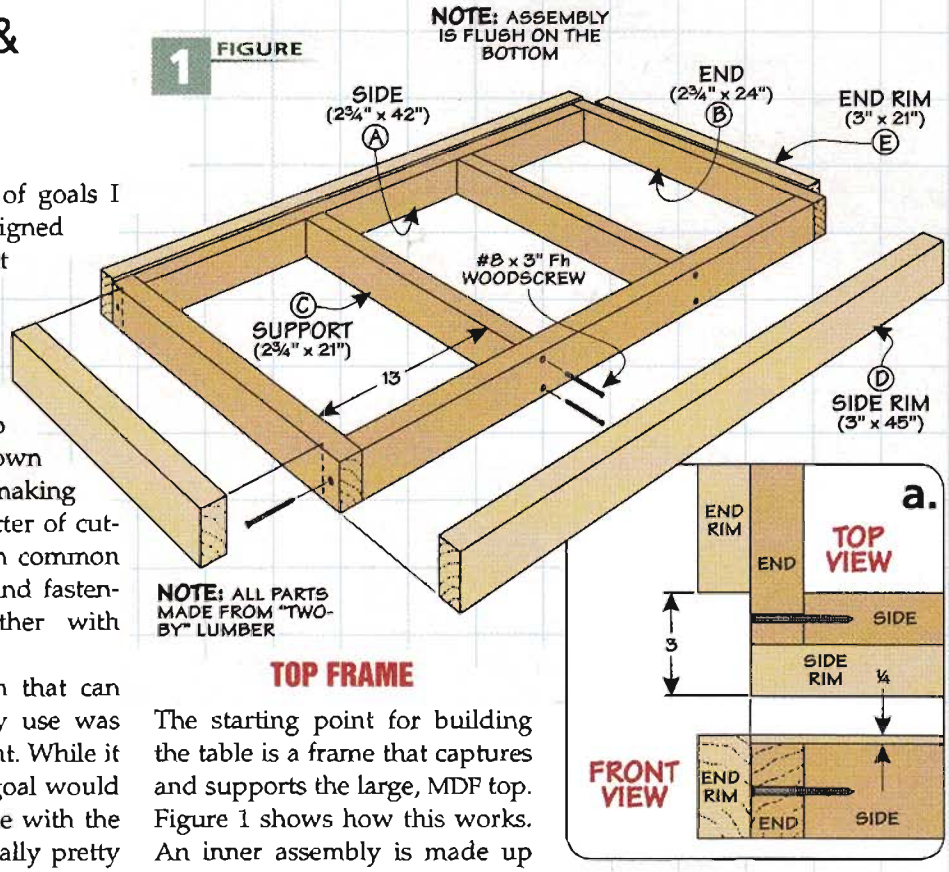


► ***Multipurpose.*** *With the extensions stored, the table still provides a generous extra worksurface and some valuable storage space, too.*

table base & Shelf

There were a couple of goals I kept in mind as I designed this table. The first one was simplicity. I didn't want to spend a lot of time fussing with joinery or complicated assemblies. So when it comes right down to it, you'll find that making this table is just a matter of cutting parts to size from common construction lumber and fastening everything together with glue and screws.

A solid workstation that can stand up to everyday use was the second requirement. While it might seem that this goal would be difficult to reconcile with the first, the two are actually pretty compatible. The key is layering the parts. As you add each piece, the overall strength increases. The result is a very sturdy table that will stand up to years of use, but is easily built in a weekend.



TOP FRAME

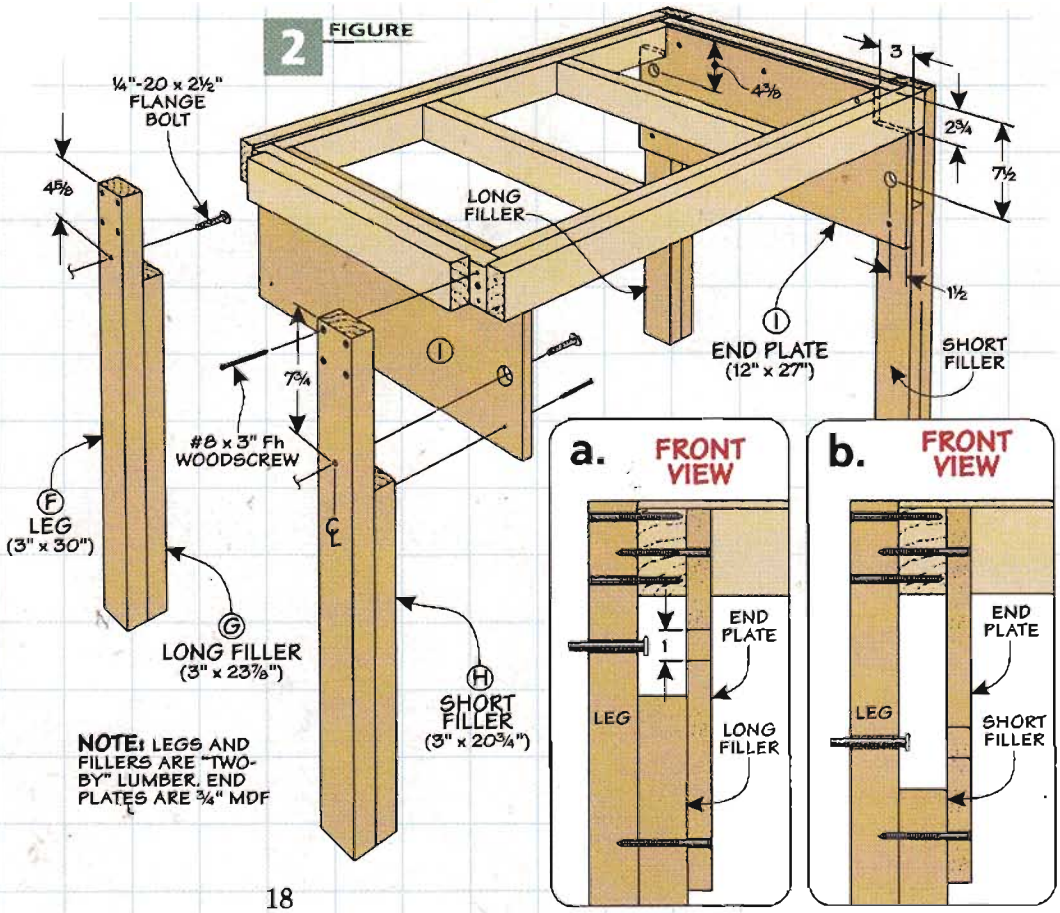
The starting point for building the table is a frame that captures and supports the large, MDF top. Figure 1 shows how this works. An inner assembly is made up of pairs of ends, sides, and inner supports. These provide solid backing for the worksurface. The outer rim pieces are added to trap the top so it can't move around. The benefit to this is that the top doesn't need to be attached with screws. So you don't need to worry about accidentally hitting a fastener when cutting or drilling into the tabletop.

Flat Assembly. As you build the frame, there are a few things to keep in mind. In order for the finished tabletop to lie flat, the supporting frame should be as flat as possible. That starts with selecting straight lumber. But it also means assembling the frame on a level surface, too.

Another detail to notice is the size of the parts for the outer rims. They're ¼" wider (taller) to create the lip for the top. The long, side rim pieces should match the assembled length of the inner layer. And the end rim pieces are 3" shorter. They're centered on the ends of the frame to create notches for the legs (Figure 1a).

LEGS

The legs on this work table do more than raise the top to a comfortable height. They also house the arms of the adjustable



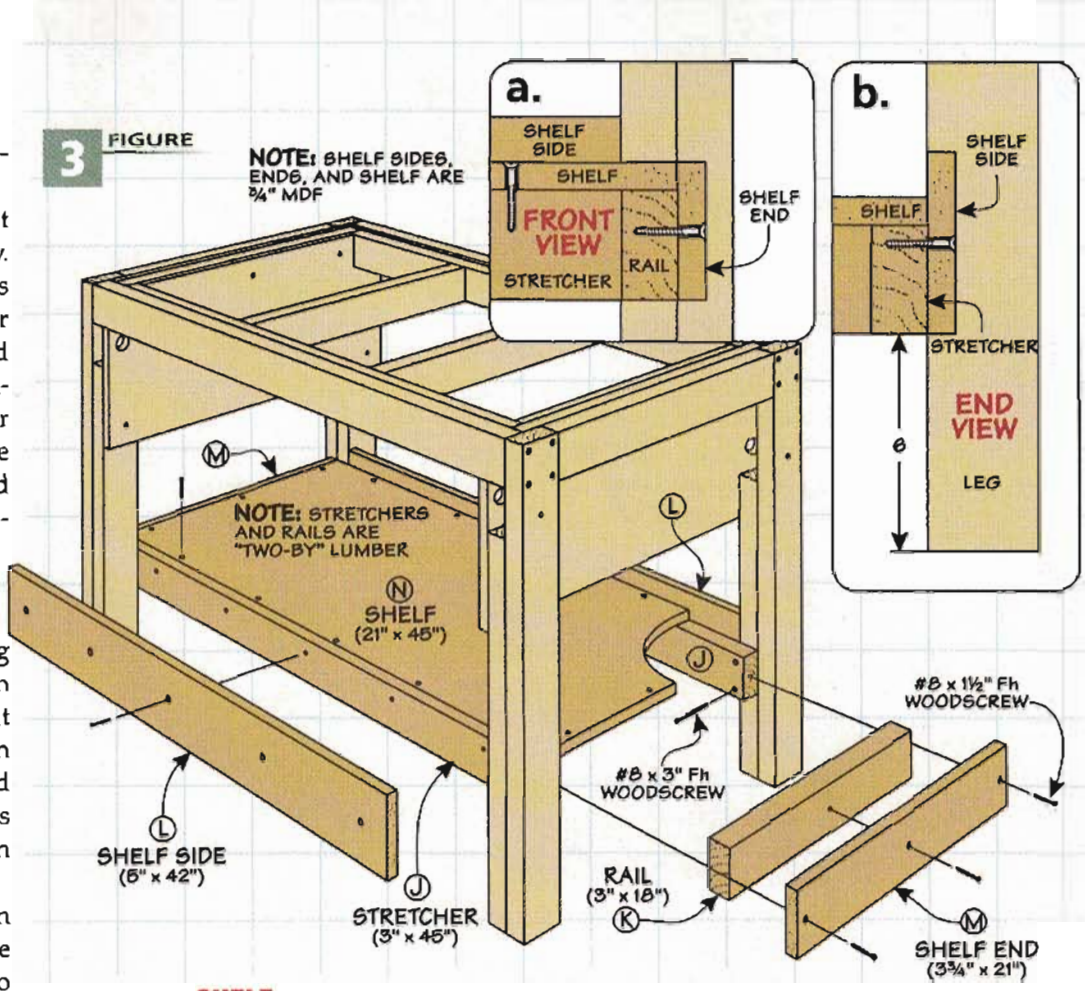
extensions that allow you to create a larger work area.

In Figure 2, you can see that each leg is a two-piece assembly. A long piece fits into the notches in the top frame. Then a shorter filler piece beefs up the leg and also forms a pocket to accommodate the extensions. The filler pieces on each end aren't the same length, as in Figures 2a and 2b. This creates space for the support arms of the extensions to slide past one another.

There's one more detail to note: I drilled a hole in each leg to accept a flange bolt, as shown in Figures 2a and 2b. The bolt mates with aluminum T-track in the extension arms. When paired with a washer and knob, it allows the extensions to be locked in place during use.

Reinforcements. Even though each leg is attached to the frame with four screws, I wanted to add extra stiffness to the assembly. The solution is the MDF end plates, as shown in Figure 2. The upper corners of each plate are notched to wrap around the inside of the frame. The plates keep the legs from flexing side to side. Additionally, the plates close off the pockets for the sliding arms on the extensions.

All that's left to complete the plates is to drill a pair of holes. They're located opposite the holes in the leg so you can install and remove the flange bolts, as illustrated in Figures 2a and 2b.



SHELF

No matter where I'm working, I like to keep tools and accessories close at hand. The space below the top frame is ideal for adding some storage to this project, as shown in Figure 3.

However, this shelf assembly does more than create a handy spot to set a few tools on. The stretchers and rails that support the shelf add another measure of strength to the table base. A pair of rails support the ends of the shelf. Like the top frame, the shelf is captured by a rim created by the shelf sides and ends. But this time, the sides and ends are made from ¾" MDF. Another difference is that the parts aren't the same width. Figure 3a shows that the shelf ends are sized to match the width of the rail plus the thickness of the shelf.

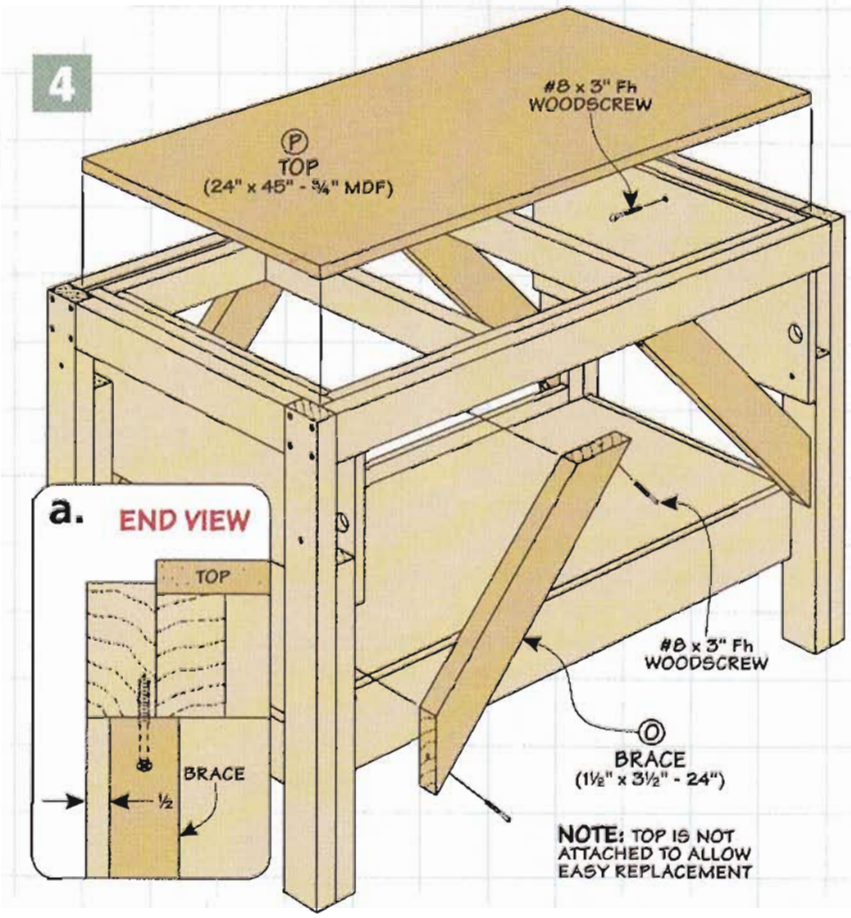
The shelf sides on the other hand are wider, as shown in Figure 3b. This creates a larger lip that keeps tools and supplies from falling off the sides of the shelf. Once these are in place, simply cut the shelf to fit, then glue and screw it into place.

Materials & Hardware

A	Sides (2)	1½ x 2¾ - 42
B	Ends (2)	1½ x 2¾ - 24
C	Supports (2)	1½ x 2¾ - 21
D	Side Rims (2)	1½ x 3 - 45
E	End Rims (2)	1½ x 3 - 21
F	Legs (4)	1½ x 3 -30
G	Long Fillers (4)	1½ x 3 - 23⅞
H	Short Fillers (4)	1½ x 3 - 20¾
I	End Plates (2)	12 x 27 - ¾ MDF
J	Stretchers (2)	1½ x 3 - 45
K	Rails (2)	1½ x 3 - 18
L	Shelf Sides (2)	5 x 42 - ¾ MDF
M	Shelf Ends (2)	3¾ x 21 - ¾ MDF
N	Shelf (1)	21 x 45 - ¾ MDF
O	Braces (8)	1½ x 3½ - 24
P	Top (1)	24 x 45 - ¾ MDF
Q	Extension Legs (4)	1½ x 3 - 29
R	Arms (4)	1⁷⁄₁₆ x 3 - 26
S	Small Blocks (2)	1½ x 3 - 2⅛
T	Large Blocks (2)	1½ x 3 - 5¼
U	Top Rails (2)	1½ x 3 - 48
V	Stops (4)	2½ x 2 - ¾ MDF

- (78) #8 x 3" Fh Woodscrews
- (4) ¼"-20 x 2½" Flange Bolts
- (32) #8 x 1½" Fh Woodscrews
- (4) 48" T-Tracks
- (48) #6 x ¾" Fh Woodscrews
- (4) ¼"-20 Star Knobs
- (4) ¼" Flat Washers
- (24) #8 x 2½" Fh Woodscrews
- (1 pr.) Aluminum Hold-Downs
- (2) ⅝"-18 x 3" Flange Bolts
- (2) ⅝" Flat Washers

tabletop & Extensions



For the most part, the "heavy" structural work on the table is complete. In fact, there are just a few more items left before the main table is done. From there, it's simply a matter of building a pair of matching extensions to wrap up the entire project.

Braces. The final pieces to add to the base of the table are a set of diagonal braces, as illustrated in Figure 4. These braces help counteract any end-to-end racking stress on the table.

The braces are simply mitered at each end. Then long screws are driven through the brace and into the frame at an angle. The braces are inset from the face of the legs, as shown in Figure 4a.

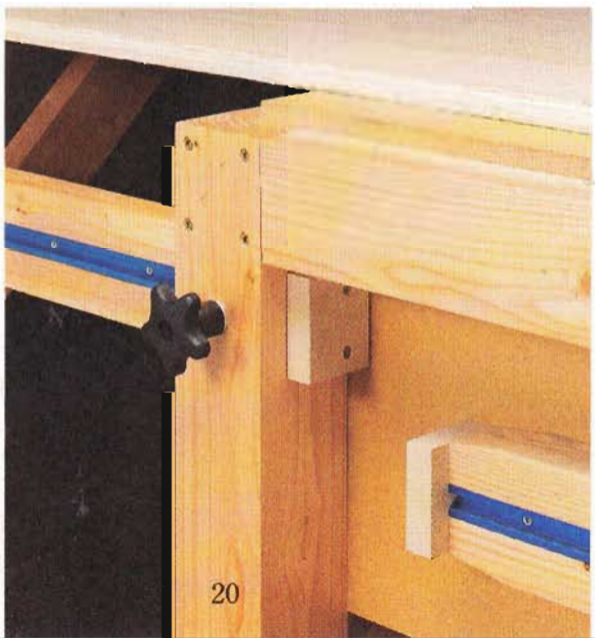
Top. The only piece left to add is the MDF worksurface. It isn't glued down or held in place with fasteners. Instead, it simply rests in the recess created by the top frame. As I mentioned before, the top is designed to be used as a sacrificial surface. So once it gets too many saw marks or holes, you can flip it over to reveal a clean surface. And when both faces get worn out, just cut another top to size.

It's not much work to make the top, as you can see in Figure 4. To keep it from shifting around in use, I sized it for a wiggle-free slip fit into the top frame.

PULL-OUT EXTENSIONS

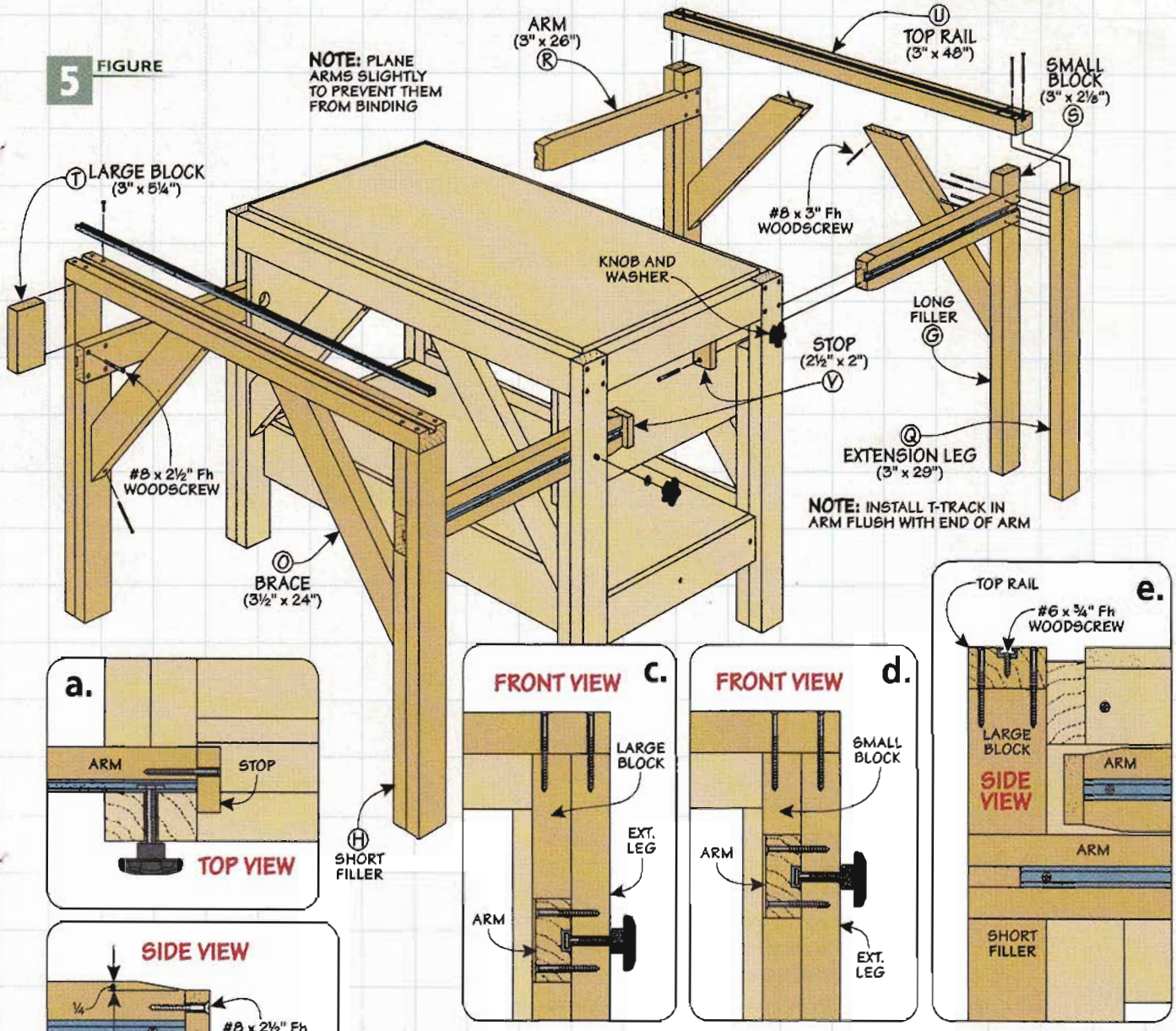
As you may recall, one of the goals for this table is simplicity. Well, designing the pull-out extensions is one place things could get challenging. To keep things simple, I used a straightforward approach. Each extension slides on a pair of arms that fit into the pockets on the ends of the table base. A length of T-track embedded in each arm engages a flange bolt in the base (Figure 5). This allows you to lock the extension in any position.

Pull-Out Assembly. When you think about it, the extensions act like built-in, adjustable sawhorses for the table. They have a narrow top rail to support a large workpiece and increase the effective size of the table. The extensions share some of the same construction as the table. This starts with the leg assembly, as



◄ ***Overlap.*** *The extension arms are set at different heights to allow compact storage.*

► ***Clamp.*** *T-track in each extension lets you quickly clamp a workpiece in place.*



you can see in Figure 5. Each leg consists of two layers. An outer, full-length leg and an inner filler piece. (These filler pieces are the same size as the ones used earlier on the table base.)

Arms. Resting on the filler piece is an arm that connects the extension to the table base. There are a few details to point out here. First, each arm has a centered groove cut in it to accept a length of T-track. Second, I tapered one end of the arms, as shown in Figure 5b. This prevents the arm from catching on the opposing arm as the extension is pushed in.

The other detail I want to mention is the thickness of the arm. The pockets are 1½" wide. So to prevent the arms from binding in use, I ran them through the planer to shave off 1/16".

To complete the inner part of the leg assembly, I cut a block to fit above the arm and flush with the top of the outer leg, as shown in Figures 5c and 5d.

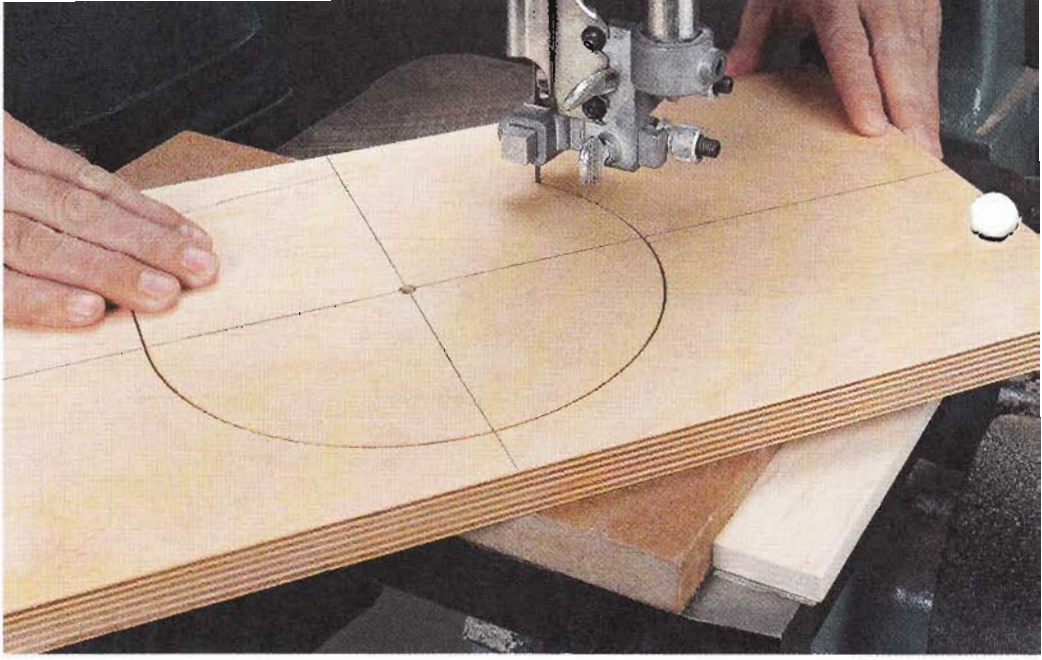
Top Rails. Capping each extension is a long rail. It's simply screwed to the top of the leg assembly, as illustrated in Figure 5e. The only addition is a centered groove cut along the top face to hold a length of T-track. You can use the track to attach hold-downs, clamps, or stop blocks to secure a workpiece.

More Braces. In use, the extensions need to support a lot of weight without flexing. The arms work to keep the extension from tipping. But you still need a way to keep the whole assembly rigid. Once again, the solution is a pair of diagonal braces. The braces are centered across the legs and top rail and are attached with screws.

Last Stop. At last, you're ready to install the extensions. To do this, line up the flange bolts with the T-track groove in the arms and slide them in place. Then to keep the extensions from getting pulled out entirely, I screwed a stop to the end of each arm, as in Figures 5a and 5b. Now you're ready to set up the table to suit almost any shop task.

TIPS FROM Our Shop

Shop Short Cuts



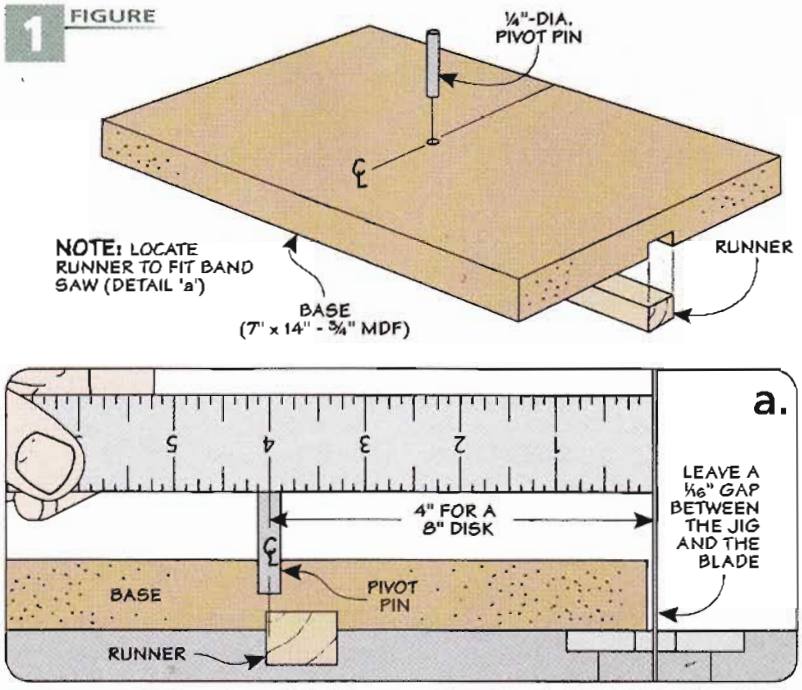
Cutting a Disk

I wanted a good, close fit between the turntable and fixed tables on the dozuki miter box (page 36). To make this easy, I cut out the turntable on the band saw using the simple jig you see here.

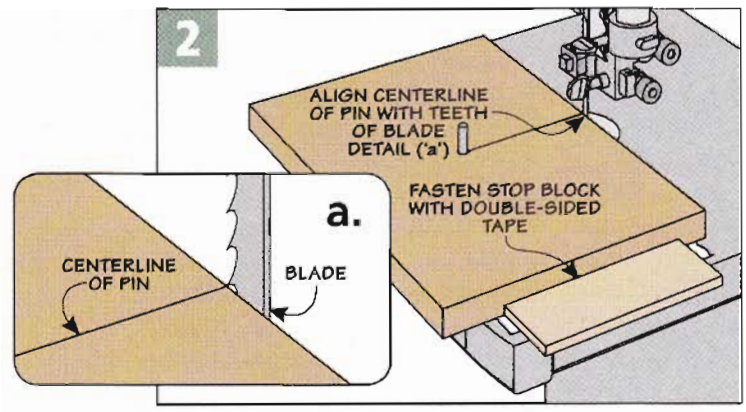
The jig starts with a rectangular base. Then you can cut a groove to attach a hardwood runner that fits the miter slot on your band saw. Finally, slide the jig onto the saw in order to locate the pivot pin. The pin's distance from the blade determines the radius of the circle. The size of pivot pin and hole depends on the size of the center hole of the finished part (¼" in my case).

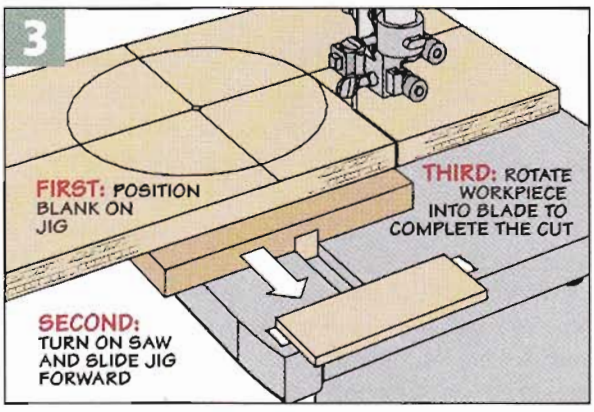
To use the jig, first slide it forward in the miter slot until the centerline of the pin is aligned with the front edge of the blade, as you can see in Figure 2. Then tape a simple stop in place.

FIGURE 1



Now you can fit the center hole of the workpiece over the pivot pin of the jig. With the workpiece and jig away from the blade, turn the saw on and slide the jig forward until it stops, as shown in Figure 3. Finally, you can slowly and steadily rotate the workpiece clockwise into the blade to complete the circle.





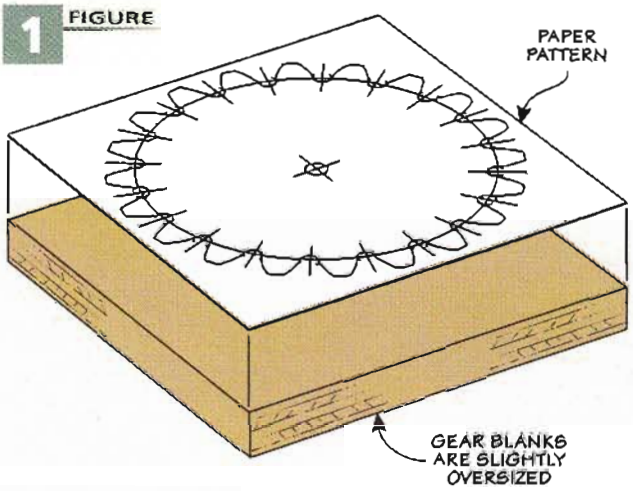
Making Gears

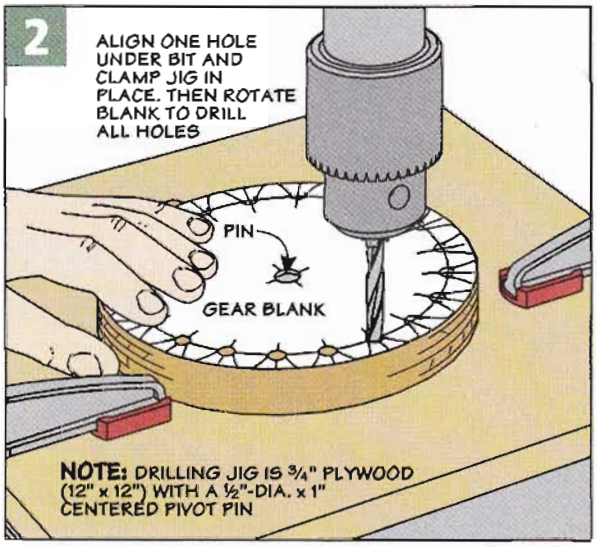
Creating the gears (and indexing wheel) for the router milling machine isn't difficult, just tedious. To ensure consistency, I used a set of patterns and an easy-to-build drilling jig for the drill press.

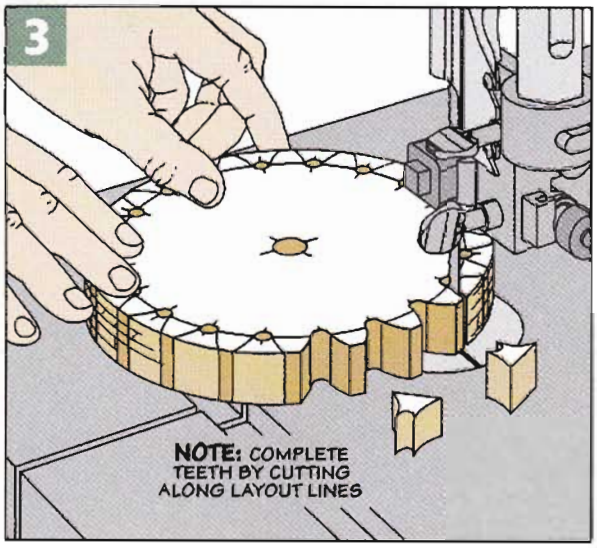
Each pattern is attached to an oversized blank (Figure 1). After drilling a hole at the center of the pattern, you can cut the blank to its circular shape. You can do this by hand at the band saw and simply follow the pattern, or use a modified version of the circle-cutting jig (opposite page).

The next step is to drill out the bottom of each tooth. I did this using the jig (Figure 2). Once you align one of the gear holes in the pattern under the bit, clamp the jig in place and start drilling using the layout lines as a guide.

Once all the holes are complete, you can head to the band saw and shape each tooth, as is shown in Figure 3.







File a Taper

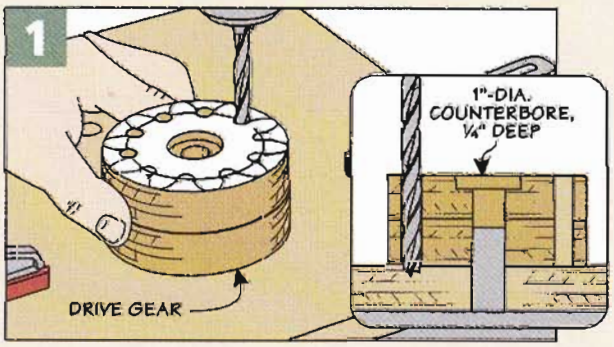
Tapered Pins. *To create the drive and tail pins for the router milling machine (page 24), chuck a length of steel rod in the drill press. At low speed, use a file to shape the tip of the pin.*

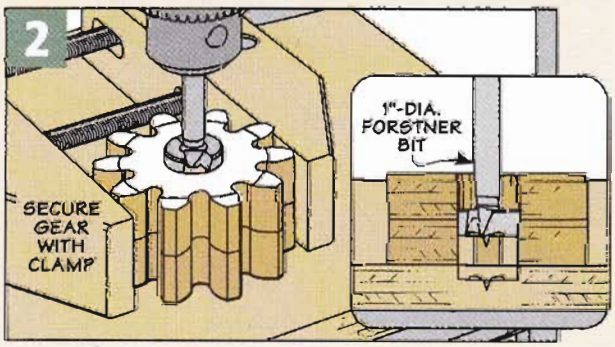
Counterbore Drilling Guide

The drive gear of the router milling machine (page 24) is the only gear with a different size center hole. It needs to be 1" in diameter to accept the carriage shaft.

The problem was I wanted to use the same jig I used for all the other gears to drill out the teeth. The solution was to first drill a shallow 1"-dia. counterbore in the drive gear blank after attaching the pattern. Then, using the same centerpoint, drill a ½"-dia. hole to match the pin on the drilling jig, as in Figure 1.

Once all the gear teeth are cut, reinstall the 1"-dia. Forstner bit in the drill press. This way, you can use the original counterbored hole as a guide to drill completely through the gear.





dream shop project

router Milling Machine

Shape table legs and add decorative details to other workpieces with this unique, shop-built router jig.

Materials & H/W

BASE

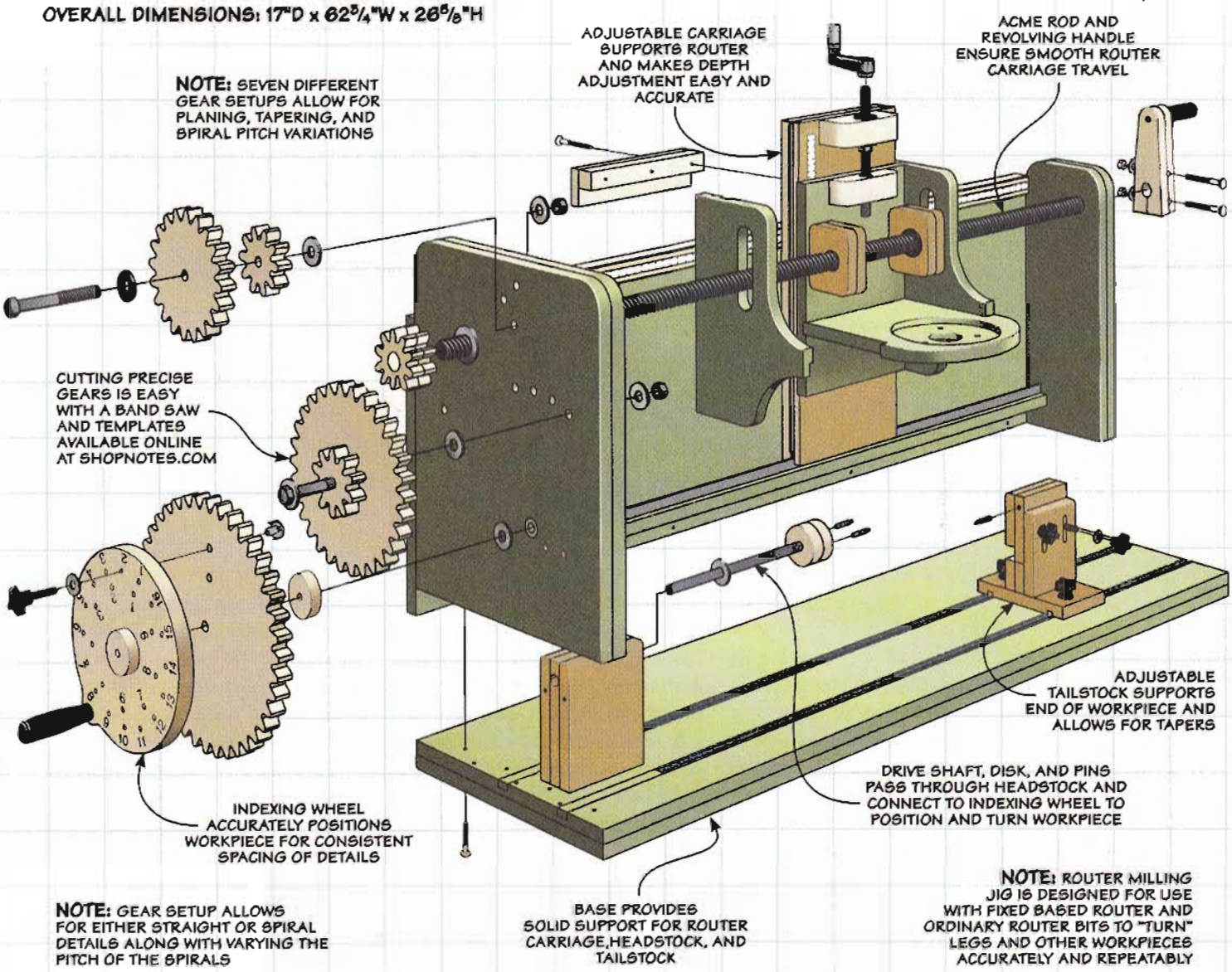
A	Bottom (1)	15¼ x 52 - 1½ MDF
B	Back (1)	16⅛ x 52 - ¾ MDF
C	Fillers (2)	¾ x 6½ - ⅜ MDF
D	Left Side (1)	15¼ x 19 - 1½ MDF
E	Right Side (1)	6¼ x 18 - 1½ MDF
F	Carriage Rail (1)	1¼ x 1¼ - 49
G	Guide Support (1)	1¾ x 49 - ¾ MDF
H	Carriage Rail (1)	1 x 49 - ⅛ Alum.

HEADSTOCK/TAILSTOCK

I	Base (1)	4 x 6¾ - ¾ MDF
J	Short Keys (2)	⅜ x 1 - ½
K	Long Keys (2)	⅜ x 2 - ½
L	Vertical Support (1)	4 x 5⅛ - ¾ MDF
M	Pin Block Support (1)	1⅞ x 4 - 1½ MDF
N	Pin Block (1)	3¼ x 4 - 1½ MDF
O	Tail Pin/Drive Pins (3)	¼-Dia. x 1⅜ - Steel
P	Headstock (1)	5 x 6½ - 2¼ MDF

Exploded View Details

OVERALL DIMENSIONS: 17"D x 62¾"W x 26⅝"H



GEARS/DRIVE ASSEMBLIES

Q	Carriage Shaft (1)	1-dia. x 55¼
R	Drive Gear (1)	3¼-dia. - 1½ Ply.
S	Main Gear (1)	11⅞-dia. - ¾ Ply.
T	Spacer (2)	2-dia. - ¾ Ply.
U	Indexing Wheel (1)	9 x 9¾ - ¾ Ply.
V	Drive Shaft (1)	½-Dia. x 11½
W	Drive Disk (1)	2¼-Dia. - 1½ Ply.
X	10-Tooth Gear (1)	3¼-Dia. - ¾ Ply.
Y	20-Tooth Gear (1)	6⅛-Dia. - ¾ Ply.
Z	30-Tooth Gear (1)	9-Dia. - ¾ Ply.
AA	40-Tooth Gear (1)	11⅞-Dia. - ¾ Ply.
BB	Lock (1)	3⅛ x 3⅞6 - 1½ Ply.

SLIDING SUPPORT/ROUTER CARRIAGE

CC	Back (1)	8½ x 21 - 1½ MDF
DD	Guide Bar (2)	1 x 20¼ - ⅛ Alum.
EE	Lift Block (1)	1½ x 2¼ - 5
FF	Spacer (1)	1¼ x 1¼ - 10
GG	Cleat (1)	¾ x 2½ - 10
HH	Sides (2)	8⅞ x 13 - ¾ MDF
II	Carriage Back (1)	9 x 13 - ¾ MDF
JJ	Router Base (1)	10 x 11¼ - ¾ MDF
KK	Carriage Block (1)	1½ x 1⅞6 - 5
LL	Traveler Block (1)	3¼ x 4 - 1½ MDF
MM	Crank Arm (1)	2 x 7 - 1½ Ply.

- (2) 1"-5 Acme Nuts
- (2) 1" Flanged Sleeve Bearings
- (2) 1" Flat Washers
- (2) ½" Flanged Sleeve Bearings
- (2) T-Track (48" Long)
- (16) #6 x ½" Fh Woodscrews
- (25) #8 x 1½" Fh Woodscrews
- (4) #8 x 2½" Fh Woodscrews
- (17) #10 x 3" Fh Woodscrews
- (1) Crank Handle
- (2) Revolving Handles
- (4) 5⁄16"-18 Thru-Hole Knobs
- (1) ¼"-20 x 1¼" Studded Knob
- (8) ½" Washers
- (2) ¼"-20 T-Nuts
- (3) ½"-13 Locknuts
- (3) ¼" Washers
- (2) 5⁄16"-18 x 1½" Flange Bolts
- (4) 5⁄16" Washers
- (2) 5⁄16"-18 x 3" Carriage Bolts
- (1) ½"-13 x 8" Threaded Rod
- (1) ½"-13 Coupling Nut
- (2) ½"-13 x 4" Hex Head Bolts
- (1) ¾" x 72" Self-Adhesive Measuring Tape
- (2) ¼"-20 x 2¾" Carriage Bolts
- (2) ¼"-20 Hex Nuts
- (2 Sets) Stick-On Numbers

building the Base

In order to create a wide range of designs, the router milling machine features a number of moving parts. And they all need to work together accurately.

For starters, the workpiece is supported by and spins around the headstock and tailstock assemblies. Another is the router carriage which moves side to side along the back of the jig. Finally, a set of gears at the left end controls how fast the workpiece and carriage move in relation to each other. I'll cover more about how all this works together later. Right now, it's time to start building a solid base to support everything.

START WITH THE BASE

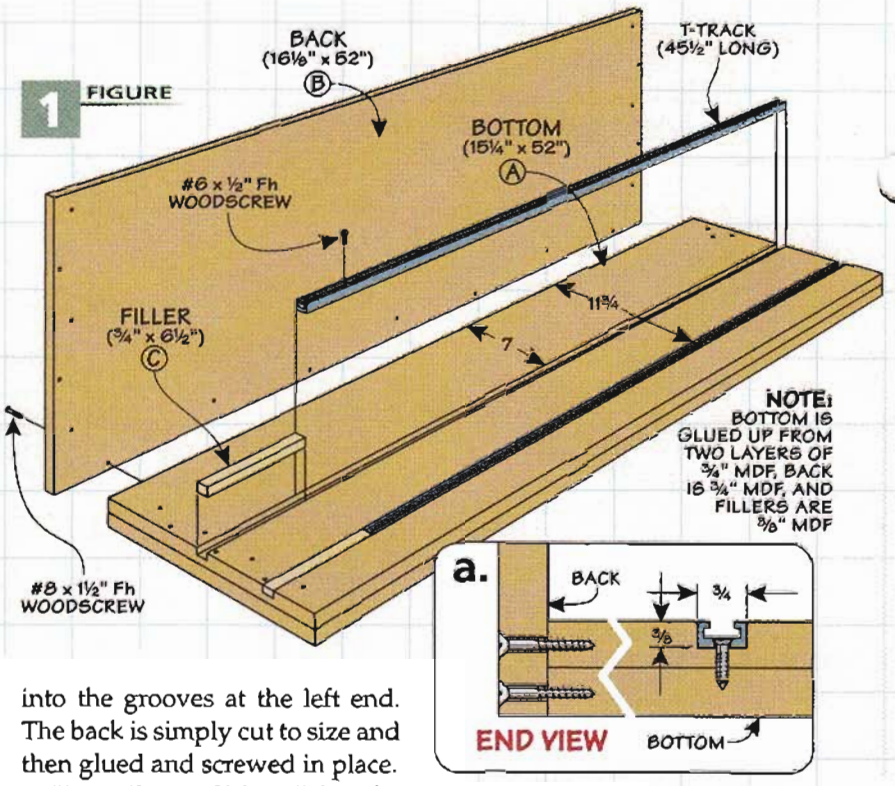
Work on the base starts with gluing up two pieces of ¾" MDF to make the bottom and then cutting it to size, as illustrated in Figure 1. Next, you'll need to cut a pair of grooves in the bottom to accept some T-track.

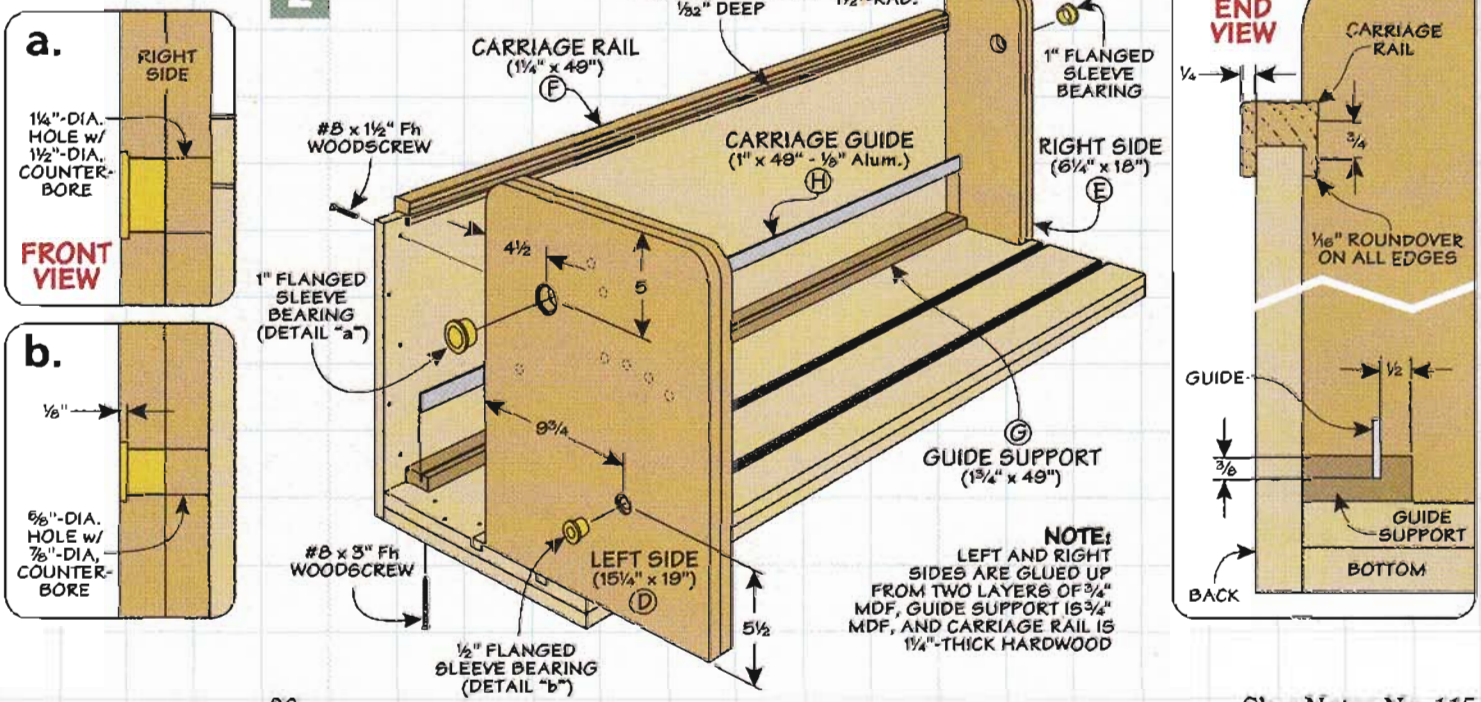
Because the T-track doesn't extend the full length of the groove, I cut some filler strips to size from MDF and glued them into the grooves at the left end. The back is simply cut to size and then glued and screwed in place.

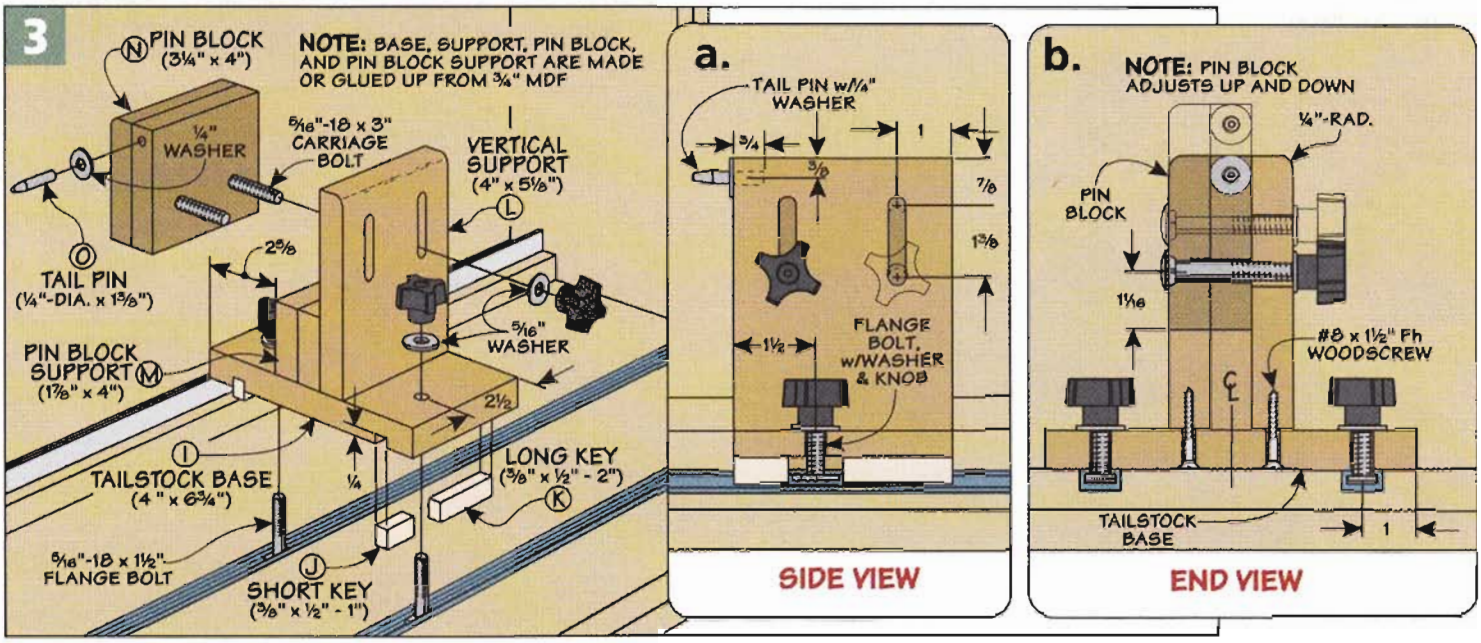
Heavy-Duty Sides. Like the bottom, the sides are glued up from two layers of MDF. As you can see, they extend above the top of the back to position the carriage shaft (added later) properly. You can trim them to final size and ease the upper corners using the dimensions detailed in Figure 2.

The sides serve as anchor points for several parts. So the next step is to drill a few counterbored holes for that purpose. A hole near the top edge of each side is sized for the flange bearings that support the shaft used to drive the router carriage. Another hole is located in the left side near the bottom and supports the headstock shaft.

The bearings are impregnated with oil to provide lubrication. To prevent the oil from leaching out into the MDF over time, I sealed the inside edges of the holes with a couple coats of finish.







There's one important point to mention here. While the right side can be glued and screwed in place, the left side is only attached with screws. This allows you to remove it later when you drill the mounting holes for the gears.

Guide Rails. With the sides installed, you can turn your attention to the rails used to guide the router carriage. Since the carriage hooks over and rides along the top of the back, I added a hardwood rail to provide a more durable surface (Figures 2 and 2c). A shallow groove (1/32") along the inside face provides clearance for a tape measure that's installed later.

The rail guides the top of the carriage. To guide the carriage at the bottom, I installed an MDF support that holds a ⅛"-thick piece of aluminum bar, like you see in Figures 2 and 2c.

Supporting the Workpiece. One of the keys to getting great results starts with rigid support of the workpiece. And that's the job of the headstock and tailstock.

I started with the tailstock since it's a little more involved (Figure 3). There are a couple of reasons for this. First, it needs to slide along the T-track in the base to adapt to the length of a workpiece. And second, it needs to adjust up and down to create tapered legs.

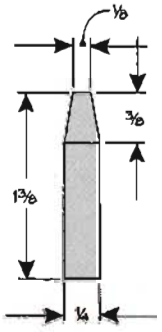
To travel along the T-track, the tailstock features a wide base with a pair of grooves and a set of hardwood keys. You can see how this works in Figure 3.

Vertical adjustment is handled by a support system (Figure 3). It consists of a vertical support and a pin block support. You'll need to cut a pair of slots in the vertical support to accept a pair of carriage bolts from the pin block that's added next. Then you can glue and screw them to the base.

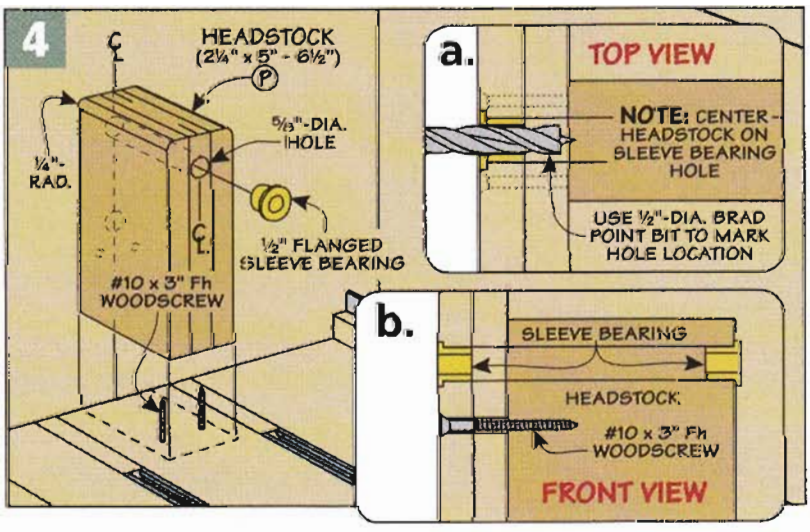
There's a hole in one end of the pin block for a steel pin used to support the workpiece in line with the headstock. The margin drawing provides the details and Shop Short Cuts on page 23 shows a quick way to taper the end.

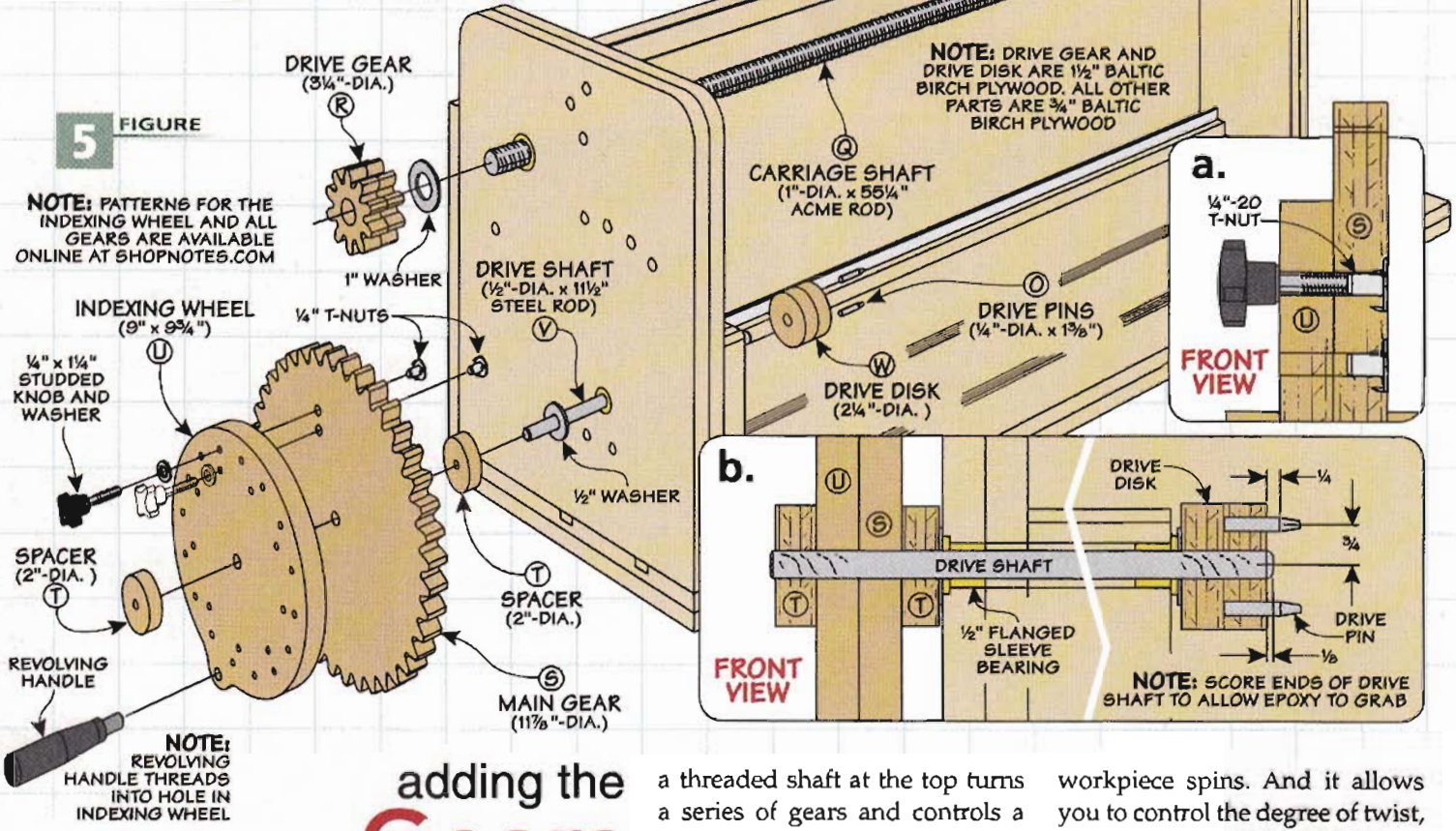
The Headstock. The headstock starts out as a glued up block of MDF (Figure 4). For the drive system that's added later to work properly, it's important to drill a hole through the block that matches up with the bearing. The hole is longer than most bits. So you'll need to drill in from both ends. To locate the hole at each end of the headstock, I matched up centerlines and marked them with a brad point bit (Figure 4a).

Here again, the headstock is simply screwed in place for now. To accurately align the block, I slipped a ½"-dia. rod through the two flange bearings.



TAIL/DRIVE PIN DETAIL





adding the Gears

With the base of the milling machine complete, the most interesting part of the construction starts — adding the gear system. These parts move the router carriage side to side while at the same time rotating the workpiece.

A quick look at Figures 5 and 6 will give you an idea how all this works. A drive gear connected to a threaded shaft at the top turns a series of gears and controls a workpiece drive system.

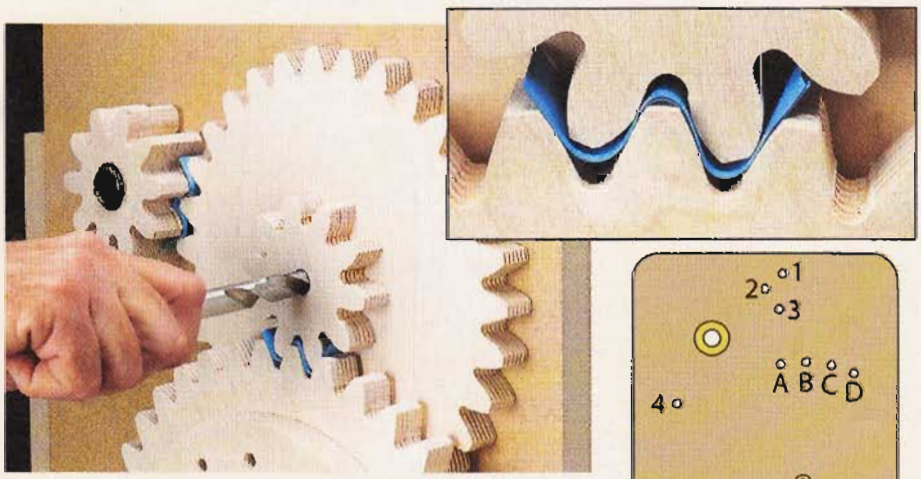
The rotation is transferred to a main gear that spins freely until it's connected to an indexing wheel with a studded knob. The indexing wheel allows you to accurately position the workpiece when you want to create straight or spiral details.

The arrangement and number of gears between the drive gear and main gear determines how fast the router travels while the workpiece spins. And it allows you to control the degree of twist, or pitch, of the spiral pattern.

Making the Gears. It's important to make the gears accurately. It's a simple, though repetitive, process using templates available at ShopNotes.com. You can read more about this in Shop Short Cuts on page 22.

Once you have the indexing wheel, gears, spacers, and drive disk completed, the next step is a little assembly. The indexing wheel and each gear is made up

Locating the Gear Holes



▲ **Gear Location.** *Using two layers of paper shims between the teeth, press the gear in place. Then use a brad point bit to locate the mounting hole.*

HOLE LOCATION	GEAR SETUP
A	10-20
B	10-30
C	10-40
D	LOCATE HOLE USING ANY GEAR AND SPACE SAME AS THE DISTANCE FROM HOLE B TO HOLE C
1	10-40 (D) & 10-30
2	10-40 (D) & 10-20
3	10-30 (D) & 10-20
4	10-20

of two parts, as you see in Figures 5 and 6. An easy way to glue the two parts together is shown in the photo below.

To complete the main gear, you'll need to add a couple of T-nuts (Figure 5). I temporarily joined the indexing wheel to the main gear with a bolt and then used a brad point bit to mark the T-nut locations. Use the inner and outer indexing holes directly opposite the handle.

Gear Mounting Holes. The next step is to use the gears to locate the mounting holes in the left end. To do this, you'll need to glue the drive gear to the carriage shaft with epoxy. Then, slip the shaft through the flange bearings in the ends of the base.

The box on the opposite page details which gears to use as you locate each hole. The first step is to locate holes A to D. Note: The 10-tooth gear always meshes with the main gear for holes A to D.

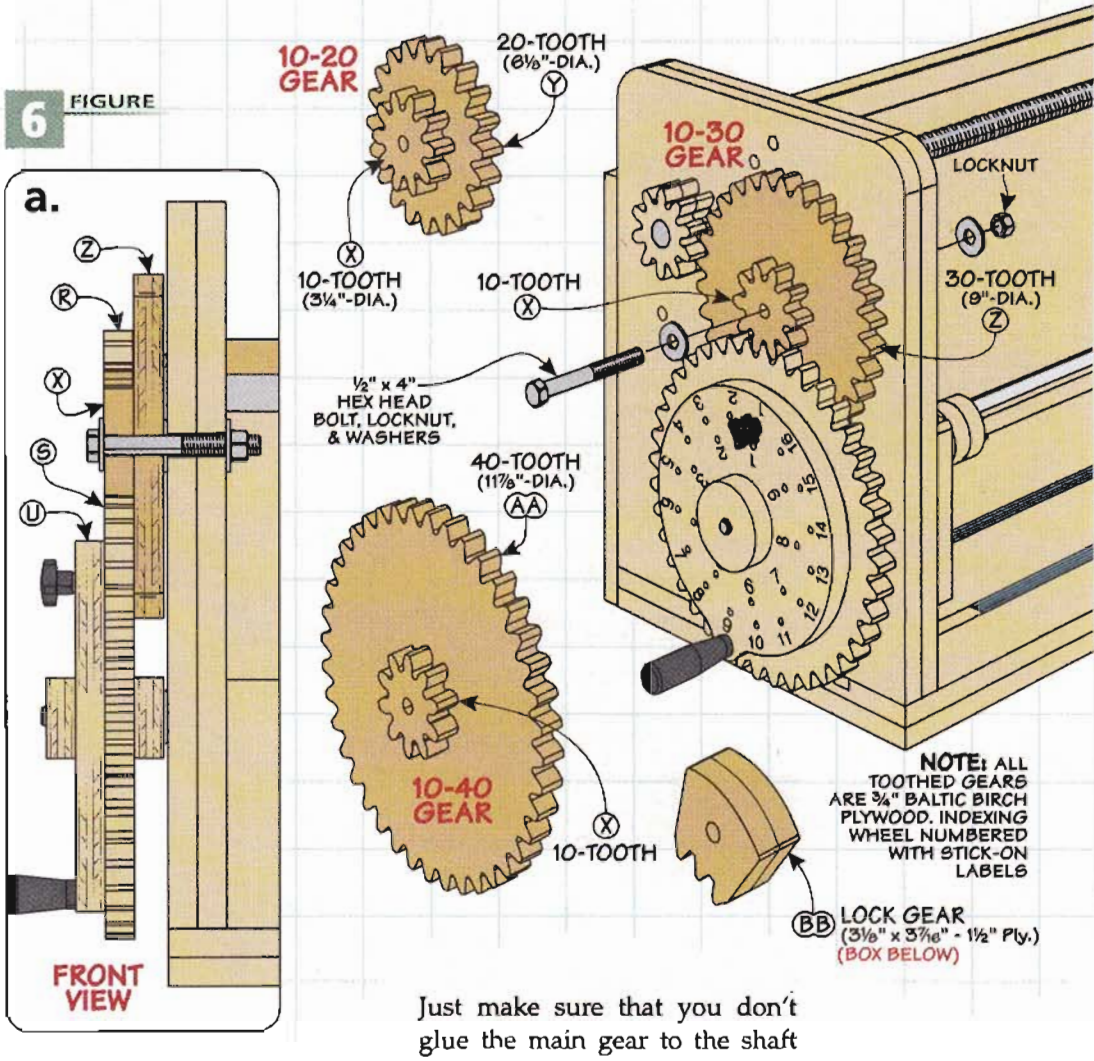
At this point, you'll need to remove the left side and head to the drill press to drill the holes. When that's completed, you can reinstall the left end.

The process for locating holes 1, 2, and 3 is just like before. Only this time, you'll need to install a gear in hole D per the chart. For hole 4, all you'll use here is the 10-20 gear. Here, the 20-tooth portion engages both the drive gear and main gear.

Final Assembly. Once these holes are drilled, you're ready for final assembly of the drive system. You can see how it goes together in Figure 5b. The drive disk has a pair of pins that engage holes in the top of the workpiece. Just make sure that you don't glue the main gear to the shaft since it needs to spin freely.

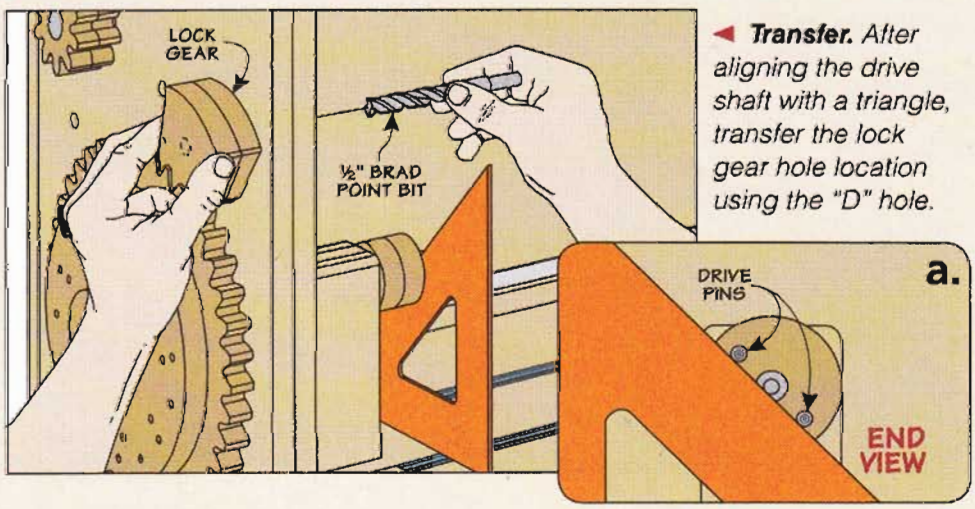
There's one final part to make — the lock gear. It's used to hold the workpiece stationary while you rout straight flutes or reeds for example. You can see how I located the mounting hole in the gear in the box below. Note: No paper shims are used for this.

FIGURE 6



▲ ***Gear Assembly.*** *To assemble the gears, apply glue and then bolt them tightly together. The alignment of the teeth on the two gears doesn't matter.*

Lock Gear Hole Location



◀ ***Transfer.*** *After aligning the drive shaft with a triangle, transfer the lock gear hole location using the "D" hole.*

router Carriage

With all the gears completed, you're ready to add two assemblies that support the router. The first assembly is a support that slides along the rail at the top of the base. The other assembly is an adjustable carriage. The router mounts to the carriage to allow you to precisely control the depth of cut in the workpiece.

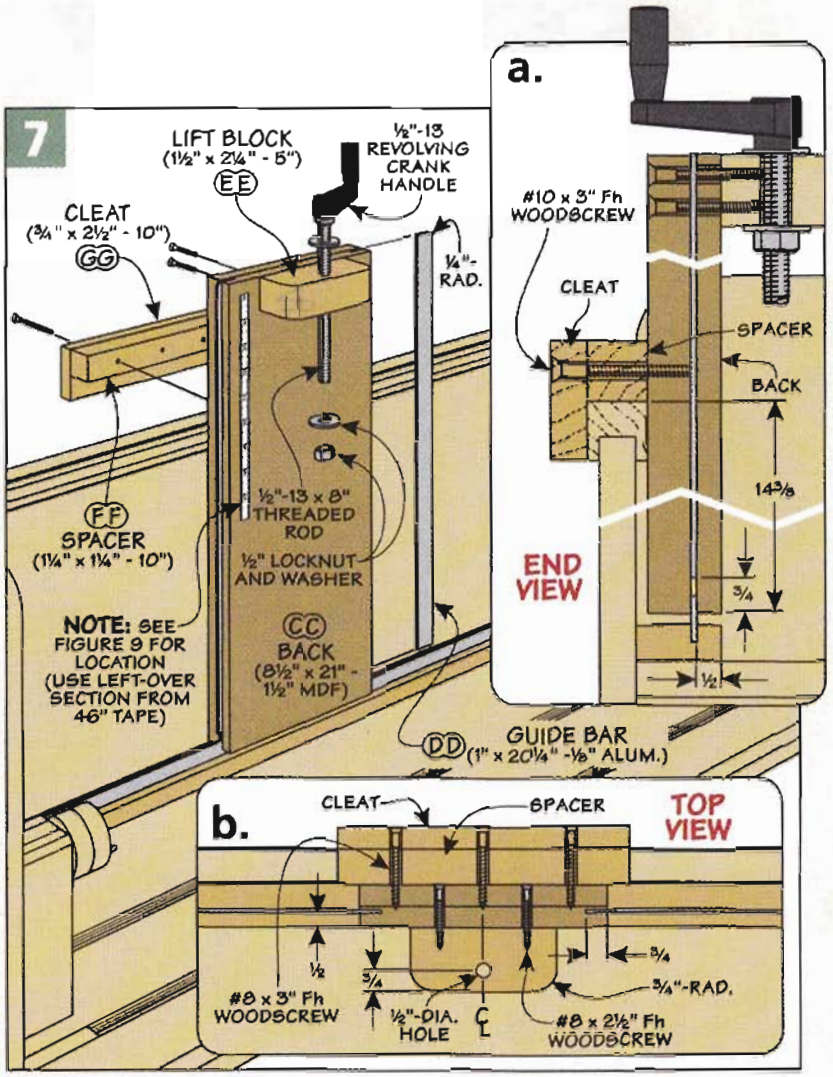
SLIDING SUPPORT

The sliding support you see in Figure 7 consists of an MDF back along with a spacer, a cleat, and a lift block made from hardwood.

Aluminum bars that fit into kerfs on each side of the back guide the router carriage. And a kerf along the bottom of the back fits over the guide in the base to stabilize the support.

To allow the support to move along the rail, I attached a cleat and spacer. The spacer and cleat are positioned so the bottom of the back rides just above the support, as you see in Figure 7a.

Finally, attached to the top front edge of the back is a lift block. After attaching a threaded rod to a handle, slip the shaft through the block and secure it with a washer and lock nut. The assembly should spin without any play.



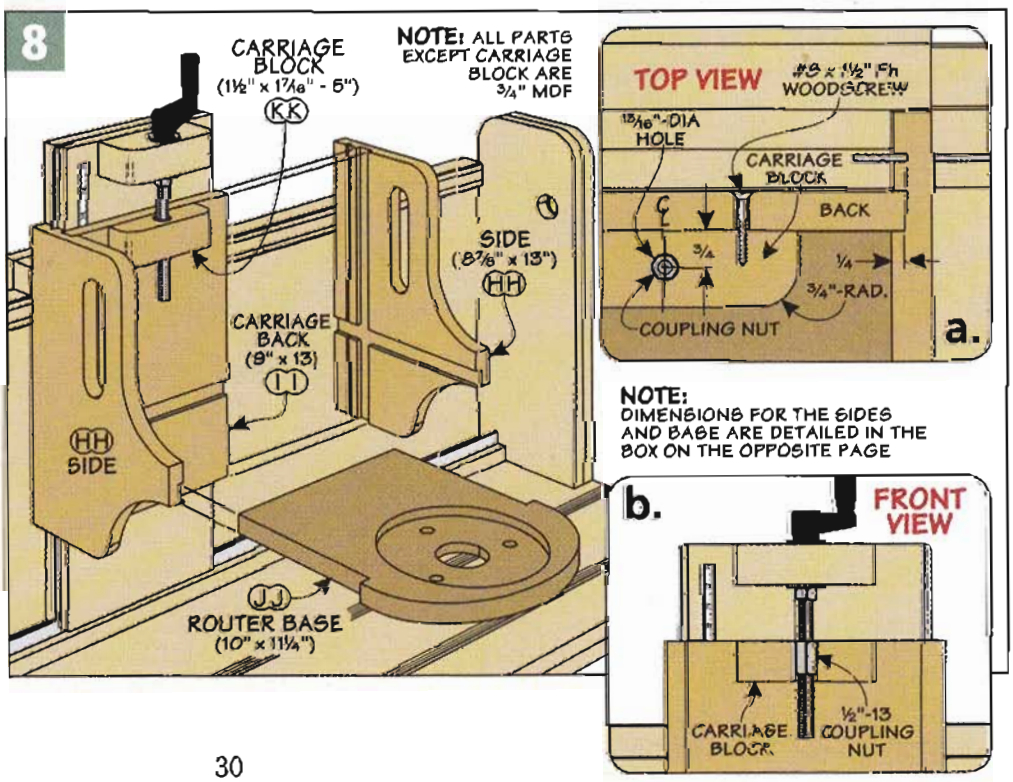
ROUTER CARRIAGE

Adding the carriage that the router mounts to is the next step (Figure 8). You'll find all the dimensions necessary to shape the sides, along with the bottom, in the box on the opposite page.

I found it easiest to first cut all the grooves and dadoes in a blank cut to final width and length. The narrow groove along the back edge is sized for a smooth, sliding fit with the aluminum bar installed in the sliding support.

You can turn your attention to the bottom of the carriage once the sides are shaped. I used the baseplate on my router to locate the mounting holes in the bottom. These holes are oversized to provides a little room for adjustment when you mount the router.

The last part to complete before assembling the carriage is the back and carriage block. A coupling nut in the carriage block



engages the threaded rod in the sliding support assembly. I used epoxy to secure the nut to the block after pressing it in place.

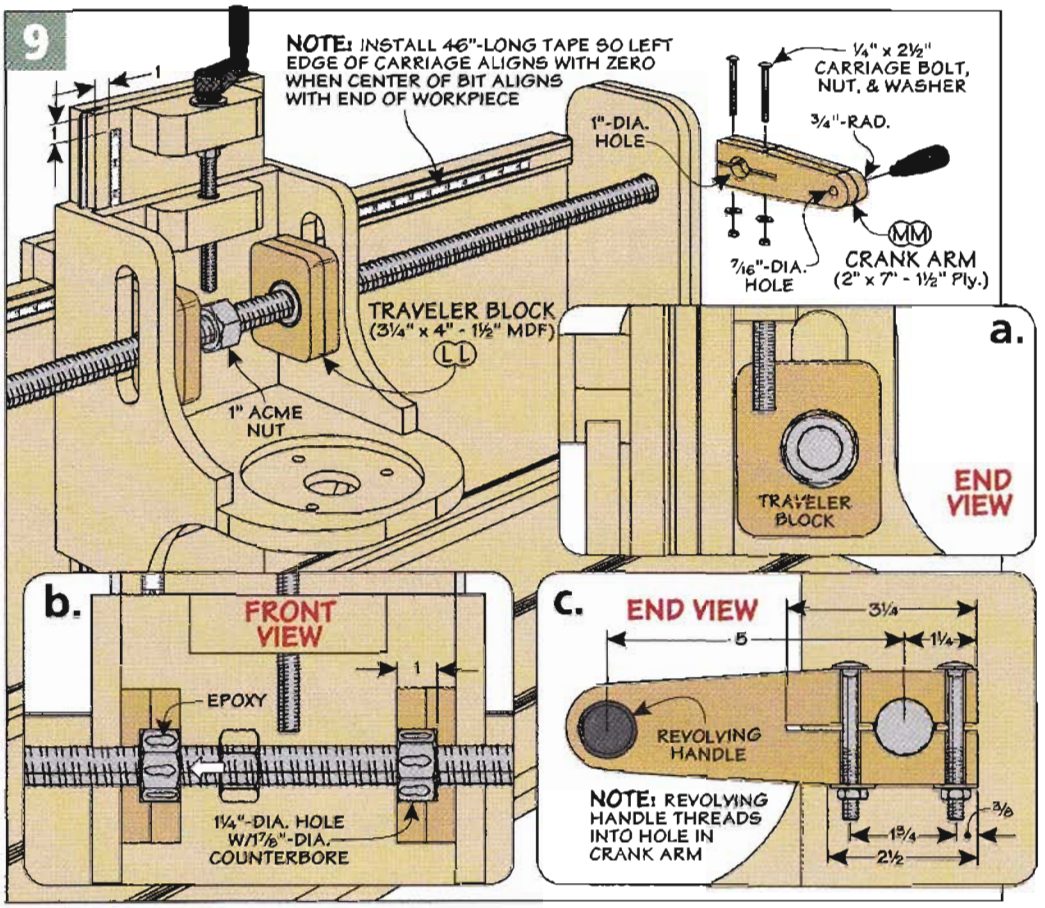
With the carriage completed, you can slip it into the guide bars of the sliding support. After threading the shaft into the coupling nut, hang the entire assembly in place on the back.

FINAL ASSEMBLY

At this point, completing the router milling machine is just a matter of installing the carriage shaft and handle along with a pair of traveler blocks that connect the router carriage to the shaft.

The traveler blocks fit against the inside faces of the router carriage, minimizing freeplay while still allowing the carriage to move up and down. After making the blocks, you'll need to drill a stopped hole on the inside face of each one to accept a nut for the shaft. I used epoxy to install a nut in just the right block for now.

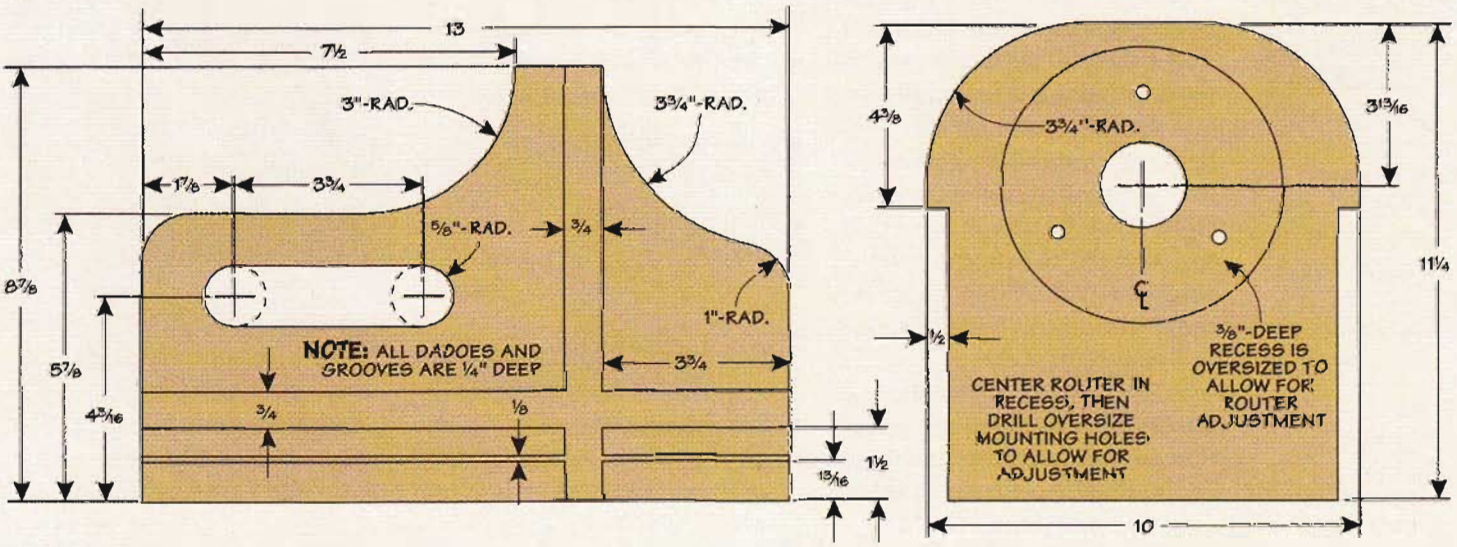
To begin the assembly, slip the carriage shaft through the left end and into the router carriage. As you do this, slip the left traveler block in place and add the loose nut. Continue feeding the shaft into the right traveler block and through the flange bearing on the right side.



Next, slide the router carriage against the right traveler block (Figure 9b). Then, slide the left traveler block against the opposite side and spin the nut into the traveler block until it bottoms out in the hole, removing any freeplay in the assembly. Finally, use epoxy to glue the nut in place.

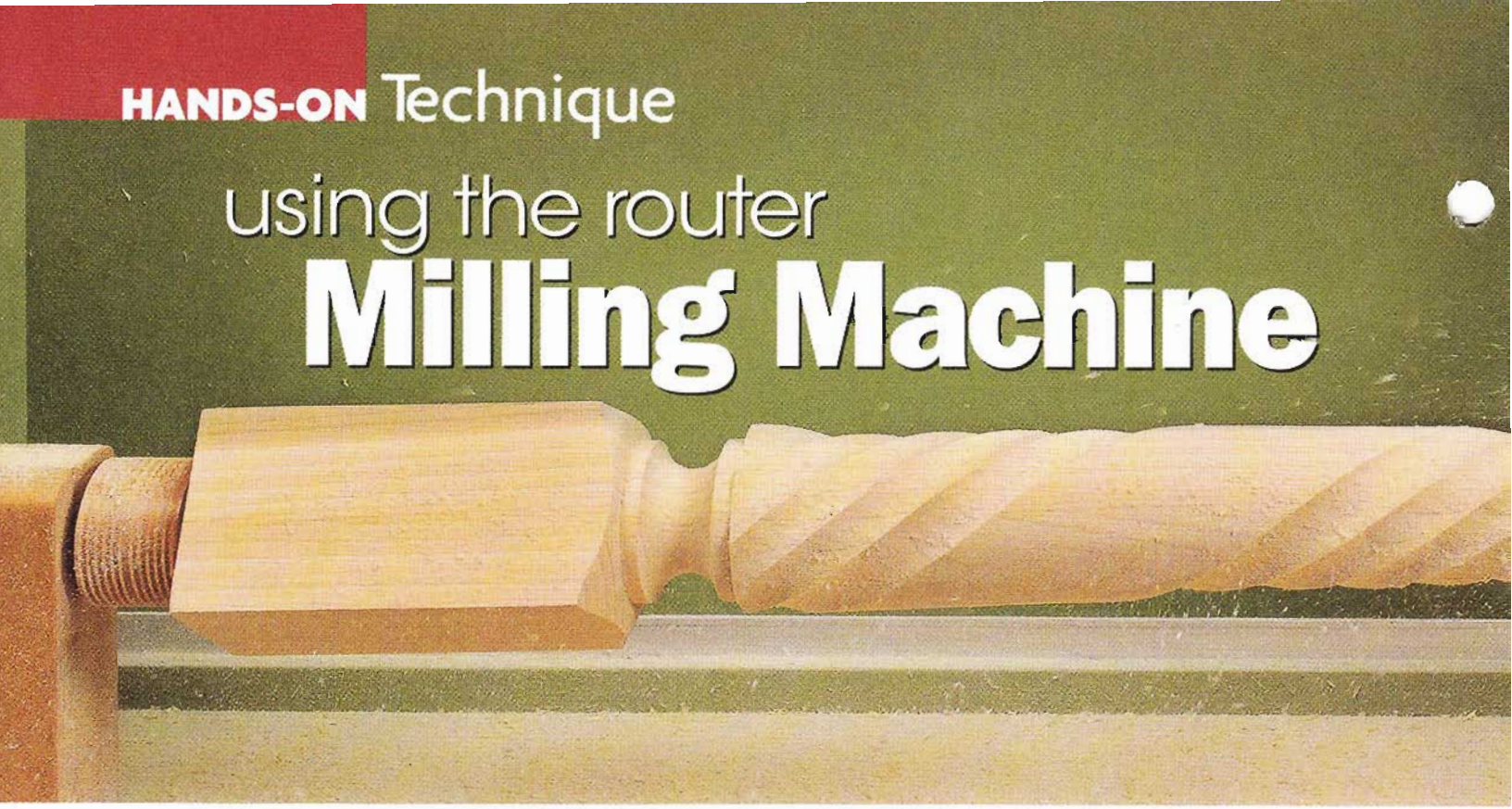
All that's left to do is add a crank arm and handle to the shaft (Figures 9 and 9c). Be sure to sandwich the arm snugly against the right side to take out any play. After mounting your router, you can start experimenting. The pages that follow will guide you through that process.

Side and Base Dimensions



HANDS-ON Technique

using the router Milling Machine



Using standard router bits, you can learn the step-by-step process to create uniquely designed legs.

Now that the router milling jig is completed, the next challenge is putting it to use. Here you'll learn a few ways to create your own unique designs.

Instead of presenting a specific design to duplicate, I'll offer detailed steps for specific operations, like tapering a table leg or simply adding straight flutes. You can use any single step or a combination to create your own unique design in any type of wood you choose.

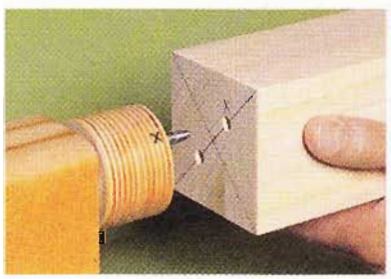
Experimenting is fun, but you can go through a lot of material quickly. To keep the cost down, I practiced on blanks glued up from inexpensive poplar. Once you have the design worked out, you're ready to duplicate it on your workpieces.

The Setup

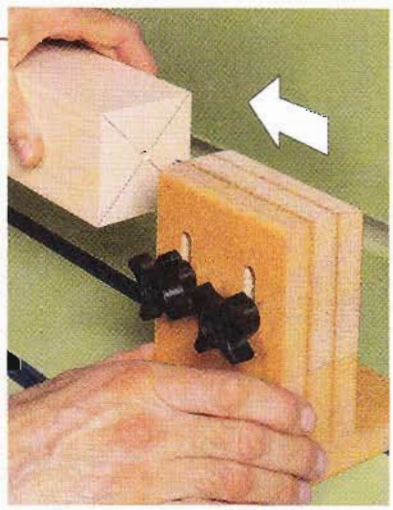
Creating a leg starts with supporting it between the headstock and tailstock. To do this, you'll need to drill some holes.

A pair of holes in the top of the leg are located along the diagonal, as you see in the photo at right. They're spaced to match up with the drive pins. And a single centered hole supports the bottom of the leg, as shown in the far right photo.

When you create a set of legs, you'll complete identical operations on each one before moving on. So it's important to reinstall them identically each time. The simplest way to do this is by marking an "X" on both the drive disk and leg (photo below).



▲ ***Headstock.*** *A pair of holes in the top of the leg mates with the drive pins in the headstock.*



▲ ***Tailstock.*** *The bottom of the leg is supported at the center by the tailstock pin.*

ShopNotes GO ONLINE EXTRAS

To view a video of the router milling jig in use and drawings of how to set up the gears for a desired result, go to: ShopNotes.com

Creating a Transition

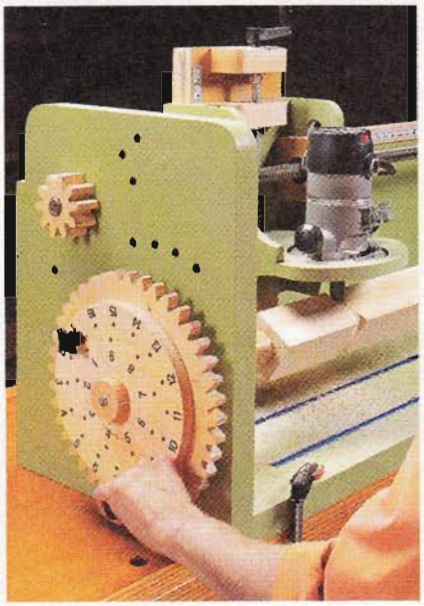
One of the most basic tasks in making a leg is creating a smooth transition from one area to the next. On a table leg, this would be an area between the square upper (where the apron rails attach) and the shaped lower portion of the leg.

Basic Router Bits. In the example you see here, two basic bits were used. A core box bit and a panel raising bit (far upper right photos). You'll start by installing the core box bit and lowering the carriage to make a shallow cut. As you turn the indexing wheel, you'll remove material just off the corners of the leg (photo at right).

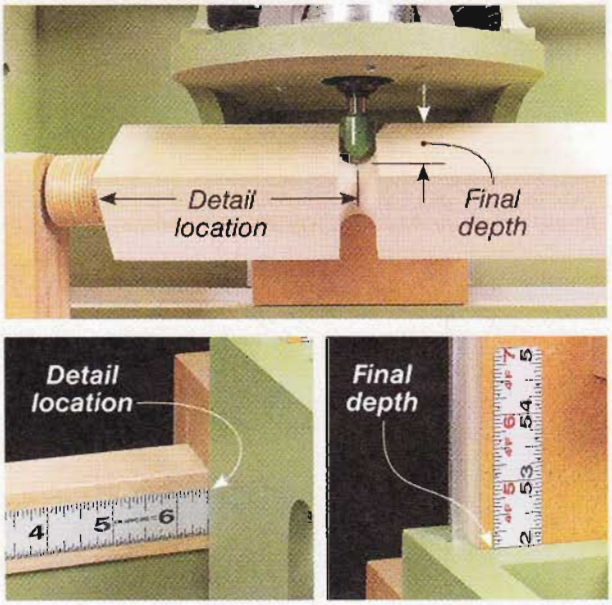
To complete the cove, make increasingly deeper cuts until you reach the desired depth (upper photo, far right). At this point, make a note of the vertical and horizontal position of the carriage (lower right photos). You'll use these measurements to duplicate the process on any other legs.

Adding Detail. A simple cove is a good starting point, but then to add a little more detail, I installed a vertical panel raising bit. It creates a much more interesting transition. Here again, record the final carriage location so you can repeat the cuts on another workpiece.

If you want to add details at another point on the leg, follow the same process. Note: For the best results, turn the leg so the bit is spinning into the material.



▲ ***A Simple Rotation.*** *To create the cove, turn the leg. Then, increase the depth of cut and repeat the process.*



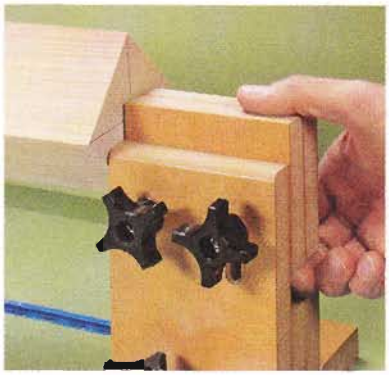
▲ ***Repeatability.*** *Once you reach final depth (top), record the two measurements that determine the position of the router carriage.*

Tapering a Leg

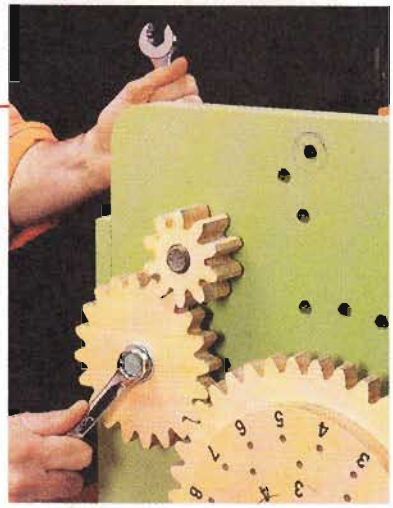
Once the transition is completed, you can begin to shape the lower portion of the leg. One option is to give the leg a lighter look by tapering it from top to bottom (margin at right).

Raise the Leg. To create the taper, you'll need to raise the bottom of the leg by adjusting the pin block (near right photo). Then, to connect the carriage shaft and drive shafts, you'll need to add a gear (far right photo). This way, as you turn the crank arm, the router carriage moves as the leg turns, making quick work of removing material.

Here again, it's best to make shallow passes (photo below) as you work from the top of the leg to the bottom. The last pass will completely round the leg at the transition (inset photo).



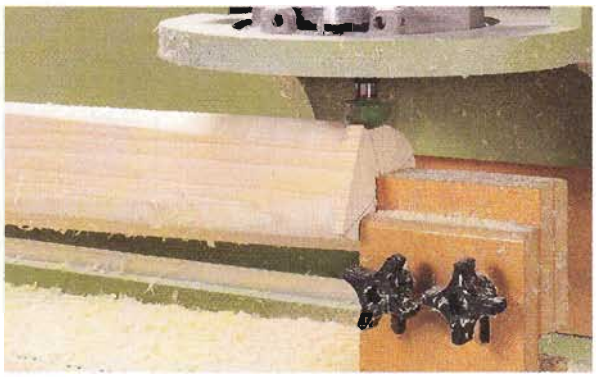
▲ ***Raise the Leg.*** *To form a taper, raise the pin block to the desired height and lock it in place.*



▲ ***Add a Gear.*** *To link the carriage and drive shafts together, install the 10-20 gear as shown.*

The surface may look a little rough after the tapering. So spend some time sanding the surface smooth (photo below).

▲ ***Tapering.*** *A flat-bottomed bowl bit removes material quickly to create a taper.*



▲ ***Taper the Leg.*** *Making progressively deeper cuts, taper the leg from left to right until you have a completely round leg at the transition (photo at right).*

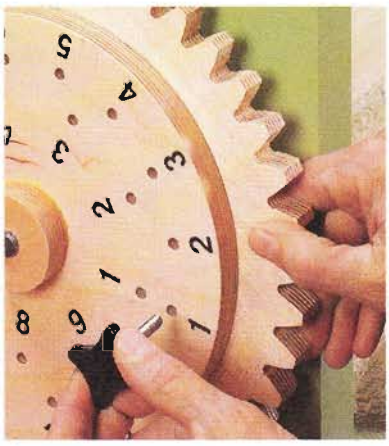
▲ ***Smoothing the Taper.*** *To remove the milling marks left by the bit, turn the workpiece by hand while sanding along the length of the leg.*

Adding Vertical Details

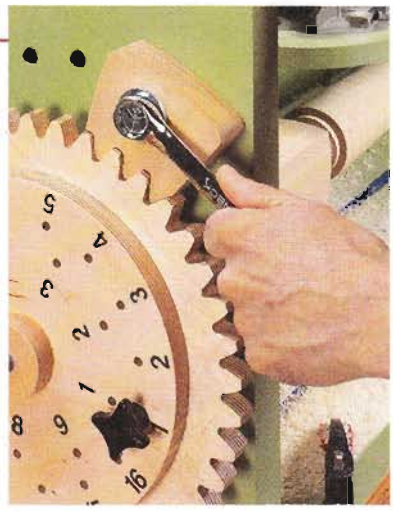
One eye-catching element you can add to a leg is a vertical detail, like the flutes on the leg in the margin. To do this, the leg needs to be locked in place while the router moves side-to-side.

Consistent Spacing. Start by pinning the indexing wheel to the main gear (near right photo). Using the outer ring of holes, sets of 2, 4, 8, or 16 evenly spaced details are possible. And the inner ring allows for sets of 3 or 9.

To keep the leg stationary, you'll need to add the lock gear, as shown in the far right photo.



▲ ***Accurate Reference.*** *Starting at the #1 position makes it easy to reference each flute.*



▲ ***Lock the Leg.*** *With the flat of the leg parallel to the base of the machine, add the lock gear.*

Adding Vertical Details (cont.)

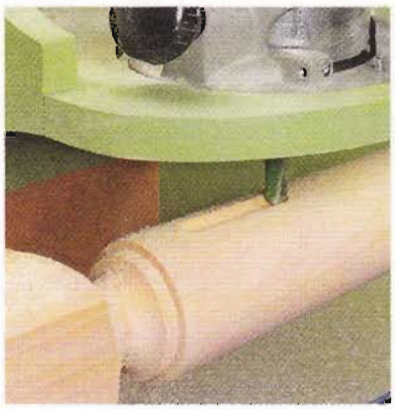
Starting Flat. For an odd number of details, where you start doesn't really matter. For an even number, it's looks best to start with the flat of the leg parallel to the base of the jig.

Creating the flutes shown requires a small core box bit (upper margin at right). The cut isn't deep, but to get the smoothest surface, I made two passes, removing most of the material during the first pass. For a final cleanup pass, lower the bit slightly and move the carriage back to the start.

Stops. To ensure that the end points of all the flutes were consistent, I could have used the scale on the rail. But if you have a lot to make, a block clamped at each end provides a positive stop and prevents you from routing too far.

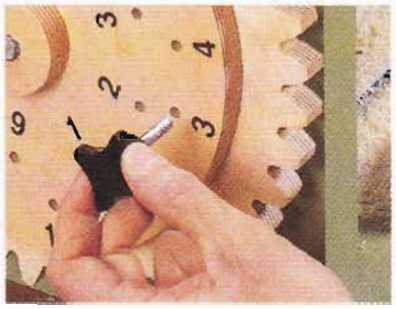
Relocating the indexing wheel repositions the leg for the next flute. I was creating eight flutes, so that meant skipping every other setting. For the second flute, I simply moved to position #3, as shown below. Then, just repeat the process to rout the flute.

▲ ***Fluting.*** *Adding evenly spaced flutes is a snap with a small diameter core box bit.*



▲ ***Start the Flute.*** *Lower the bit first, then turn the crank arm to move the carriage.*

▲ ***Positive Stops.*** *Clamping a stop at both ends ensures every flute is identical in length.*



▲ ***Adding Flutes.*** *To make the next flute, advance the index wheel to the next setting.*

Creating Spirals

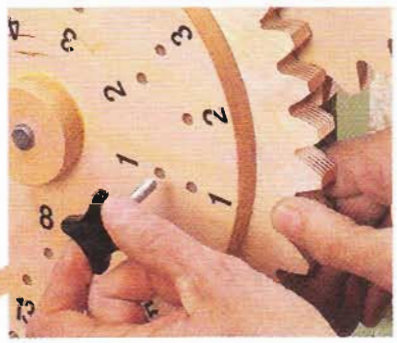
Up to this point, only a small amount of the capability of the router milling jig has been used. To take full advantage, you'll want to consider adding spiral details (lower margin photo).

To do this, you'll need to add a gear (or two) to connect the drive gear to the main gear (photo at the lower left). The arrangement and size of the gears determines the direction and pitch (spacing) of the spiral. You can see what the various patterns look like by visiting our website, *ShopNotes.com*.

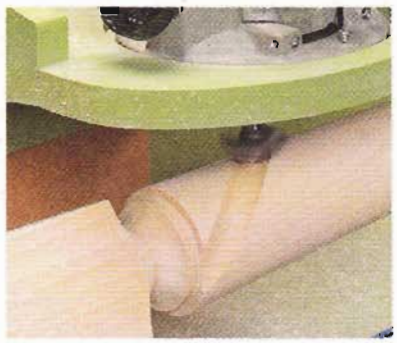
The process is similar to adding vertical details, the only difference is the gear setup. Like the other details, the look depends on the bit you use. For the shallow flutes shown, I used a small part of the bit shown in the margin.

So grab some bits and start experimenting. The possibilities for unique designs are unlimited. All it takes is a little imagination.

▲ ***Classic.*** *Just a portion of a bit adds eye-catching detail.*



▲ ***Spiral Gears.*** *Connecting the shafts with one or two gears results in a spiral effect. The inner indexing settings will create an odd number of spirals.*



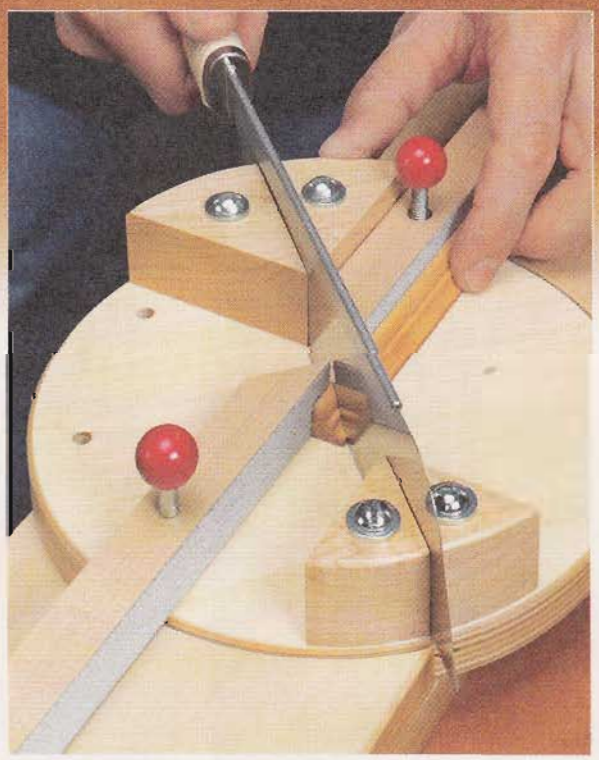
▲ ***Routing a Spiral.*** *As you turn the crank arm, the carriage and leg both move to create a spiral.*

pull saw Miter Box

Cut small parts safely and accurately with just a few strokes of your pull saw.

Cutting miters on small moldings at the table saw can be tricky. First of all, it can be difficult to safely control the workpiece. And it's not unusual for the saw blade to fling a small piece across the shop. This mitering jig lets you do the job without the risk.

The jig is designed around a Japanese dozuki (refer to page 42 for more about these saws). Its fine, ultra-sharp teeth and thin blade make for super-smooth cuts in small stock. Pairs of front and rear guide blocks sandwich the blade for making a perfectly straight, effortless cut while the workpiece is held firmly against the fence.

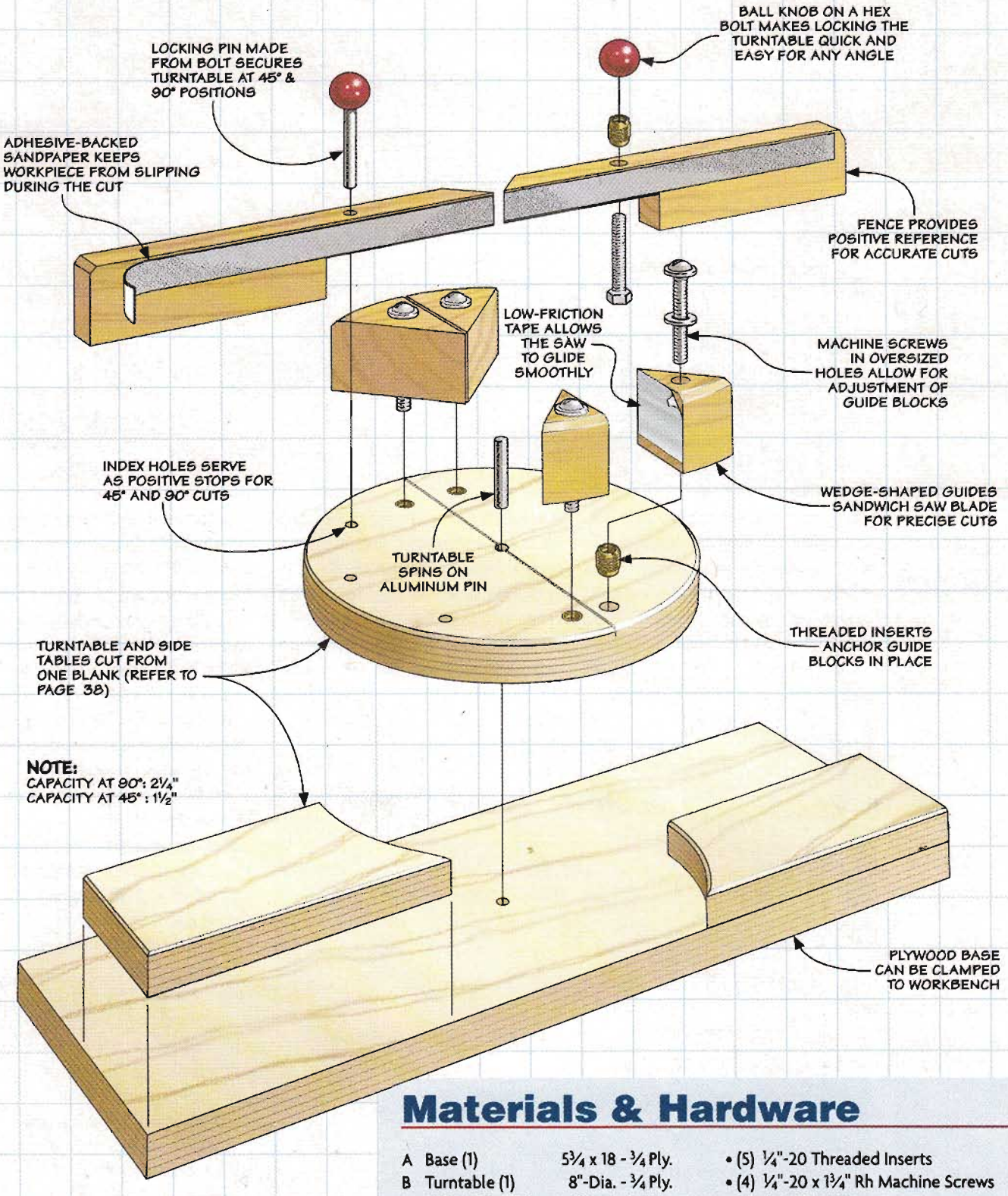


The adjustable "turntable" lets you make cuts at any angle. For 45° miter cuts and 90° crosscuts, the turntable locks in place with an index pin. For other angles, a simple, shop-made clamp does the job.

You're sure to find yourself reaching for this jig over and over again. And best of all, you can build it and start using it in just a weekend.

Exploded View Details

OVERALL DIMENSIONS: 8"D x 18"W x 3½"H



Materials & Hardware

A	Base (1)	5¾ x 18 - ¾ Ply.
B	Turntable (1)	8"-Dia. - ¾ Ply.
C	Side Tables (2)	2¾ - 7 - ¾ Ply.
D	Fence (1)	¾ x 1½ - 18
E	Rear Guides (2)	1¼ x 1½ - 1¾
F	Front Guides (2)	1¼ x 2 - 2 15/16

- (1) ¼" x 1⅛" Aluminum Rod
- (5) ¼"-20 Threaded Inserts
- (4) ¼"-20 x 1¾" Rh Machine Screws
- (4) ¼" Flat Washers
- (1) ¼"-20 x 1½" Full-Thread Hex Bolt
- (1) ¼"-20 x 3" Hex Bolt
- (2) ¾"-Dia. Ball Knobs w/¼"-20 Inserts
- (8) #8 x 1¼" Fh Woodscrews
- Low-Friction Tape

building up a Platform

The miter box is an easy build, but it's important to accurately lay out the parts. How well you do this up front affects the accuracy of your cuts in the end.

BASE ASSEMBLY

The first thing to do is cut the base to size, making sure the corners are square. This helps with the layout work.

Pivot Point. The location of the pivot pin for the turntable determines the location of the rest of the parts. Now you can get out a sharp pencil and your layout tools. As you can see in Figure 1, the hole for the pivot pin is centered on the base.

Oversized Blank. After carefully marking and drilling the ¼"-dia. through hole for the pin in the base, you can work on the turntable and side tables. These parts come from an oversized blank (Figure 1). As with the base, the location of the pivot pin on this blank is centered.

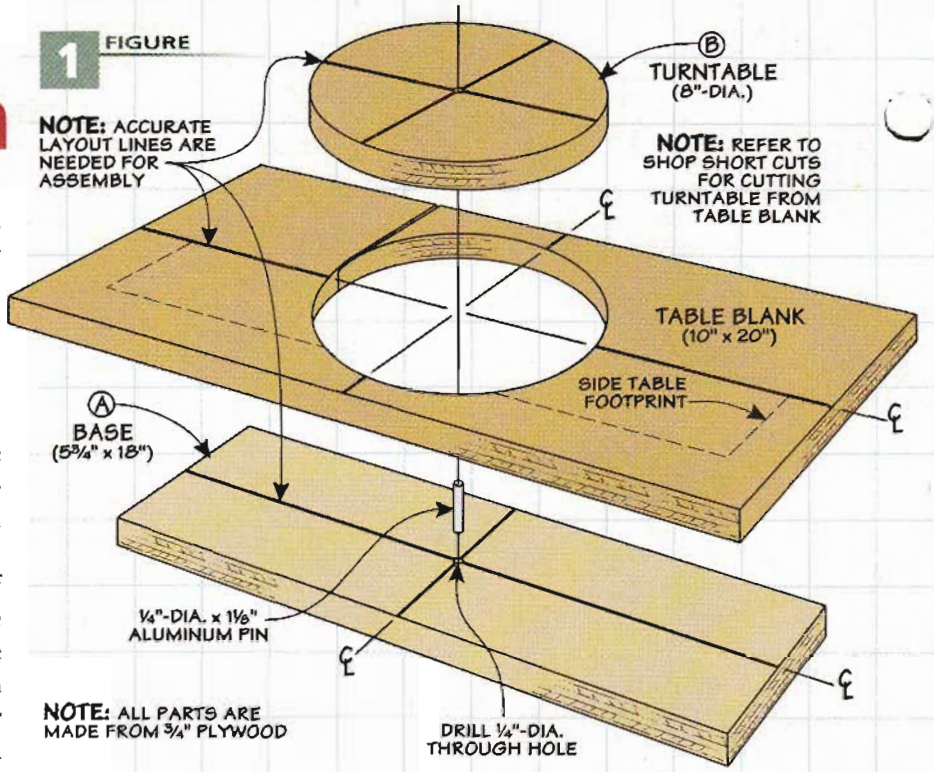
I made sure the two centerlines were crisp and neat. You'll rely on them when drilling the pivot hole and cutting out the parts. These lines will also help you later when adding the saw guides to the turntable. (One of the lines locates the kerf for the saw.)

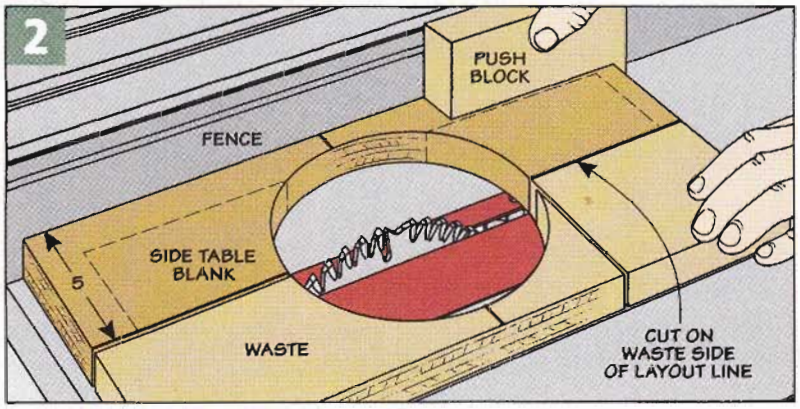
Cutting the Turntable. You can mark the centerpoint of the pivot hole with an awl to help locate the drill bit. After drilling the hole at the drill press, head over to the band saw to cut out the turntable. Shop Short Cuts on page 22 shows a simple jig you can use to do this.

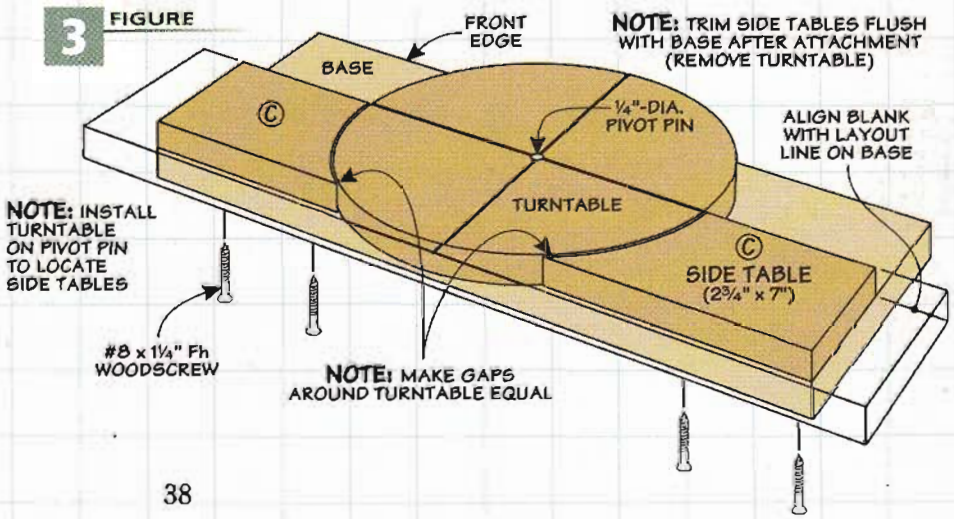
The oversized blank is also used for the two side tables, so you're going to keep one half of the blank. Figures 1 and 2 show what I mean. A little sanding will take care of any saw marks on the turntable and blank.

Side Tables. The next task is to make the pair of fixed side tables. The challenge here is sizing and fitting them properly. To make this easy, you'll want to make the pivot pin and temporarily install the turntable on the base. Figures 2 and 3 give you an overview of the process. It starts by using the blank left from cutting out the turntable at the band saw.

Remember those layout lines I talked about earlier? You'll use



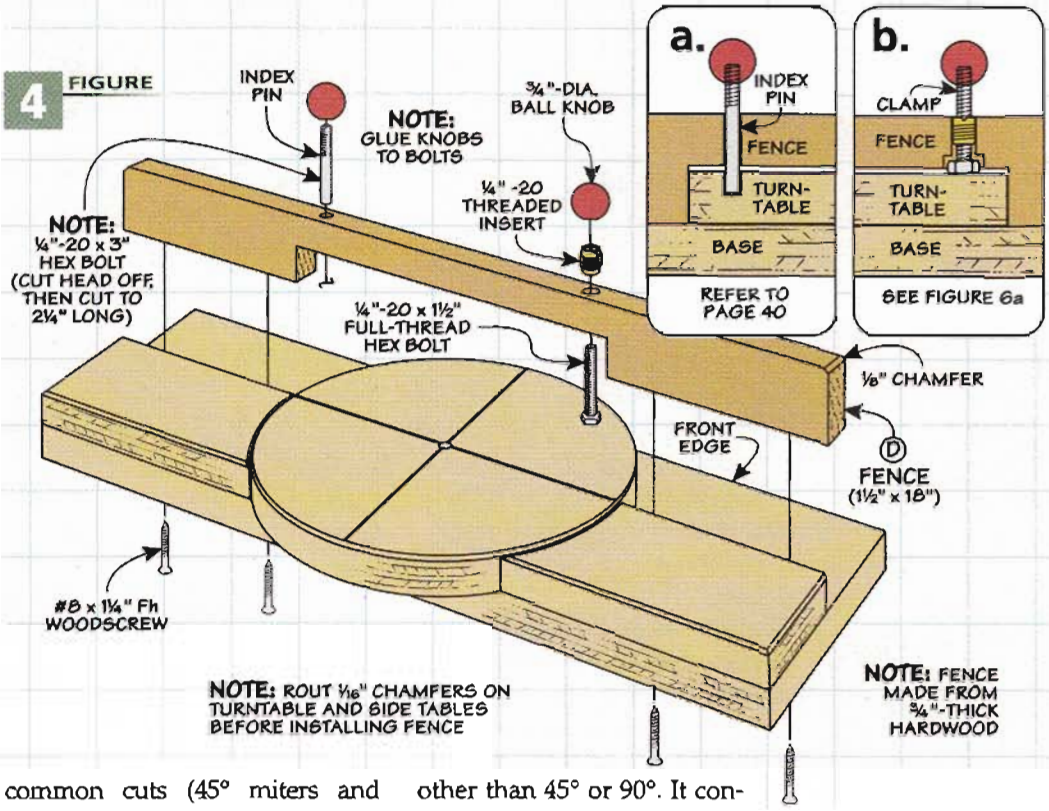




one of those lines as a guide to rip the blank for the two side tables from the larger table blank, as shown in Figure 2.

Table Positions. Here's where one of the layout lines you drew on the base comes into play. Place the table blank on the base, lining up the edge on the layout line on the base (Figure 3). Adjust the blank to create an even gap around the turntable while keeping the edge on the layout line.

Now you can fasten the blank to the base with screws from below. After removing the turntable, a quick trip to the table saw is all it takes to trim the blank flush with the base, creating the two side tables (Figure 3).



FENCE

The fence assembly you see in Figure 4 is a little unique. Not only does it reference the workpiece to the blade of the saw, it also has the job of locking the turntable in position. To make all this happen, there are a couple of things you need to do.

Create a Bridge. The first step is to cut the fence blank to size. The fence needs to span the turntable. So to create the needed clearance, I used a dado blade to cut a long notch. You can see how I did this in Figure 5.

A Pair of Holes. To lock the turntable in position for the most common cuts (45° miters and square cuts), I came up with a couple of simple, shop-made solutions — an index pin and clamp.

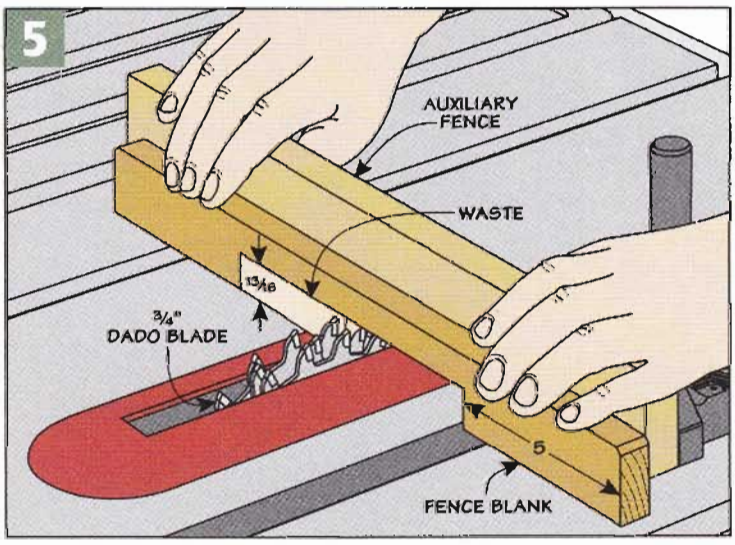
The pin and clamp are made from hex-head bolts. To install them, you'll need to drill a couple of holes in the fence (Figure 6). One of the holes is counterbored for the head of the clamp bolt.

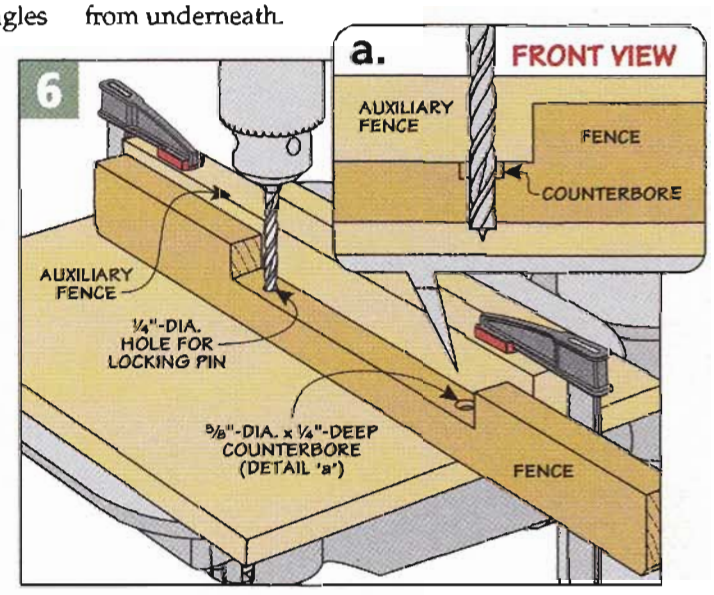
Index Pin. The index pin engages holes you'll drill into the turntable later when you set it up for use. To make the pin, I cut the head off a bolt and threaded a ball knob on the opposite end.

Locking Clamp. The clamp locks the turntable at angles other than 45° or 90°. It consists of an upside-down hex bolt with a knob on top installed in a threaded insert. To make the clamp, first grind or file the head of the bolt smooth. This helps prevent marring the surface of the turntable as you tighten it.

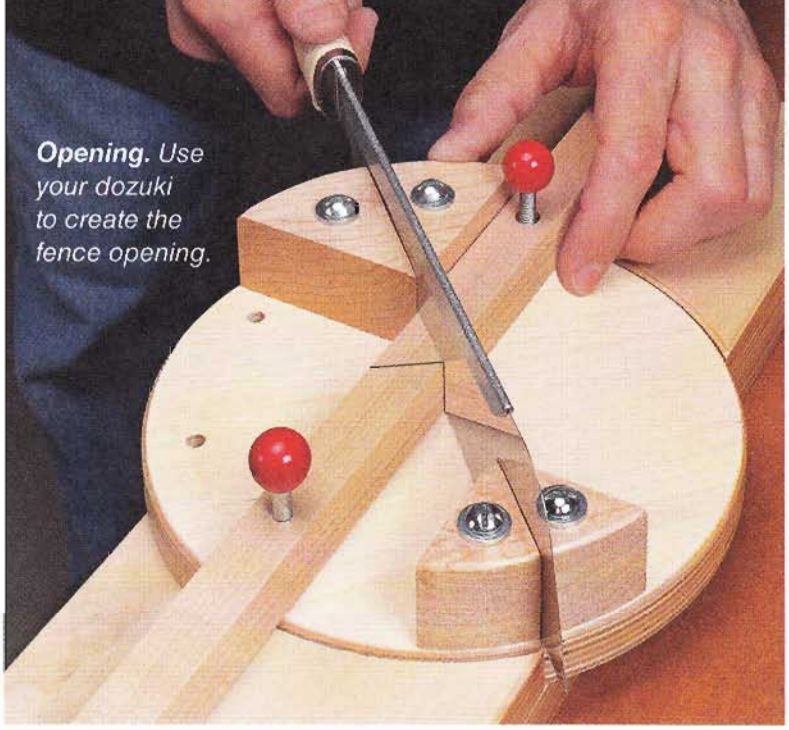
Now you can install the threaded insert into the fence. To assemble the clamp, thread the bolt all the way in from the underside of the fence before installing the knob.

Install Fence. Finally, you're ready to fasten the fence against the side tables with a few screws from underneath.





fine-tuning the Turntable



Opening. *Use your dozuki to create the fence opening.*

At this point, you have the main components of the jig complete and assembled. There are a few final details left to add. You'll drill the index holes that lock the turntable in position for 45° and 90° cuts. The last step will be to add a set of blocks that guide the saw blade during use.

INDEX HOLES

To eliminate the guesswork of setting the jig to make common 45° and 90° cuts, I drilled index holes in the turntable. These holes align with the index pin in the fence to keep the turntable from moving when cutting a workpiece.

Drafting Triangle. To accurately locate these index holes, I used an inexpensive drafting triangle. You'll use it to reference the fence from the original layout line on the turntable.

The box at the bottom of the page steps you through the process of drilling the three holes. It starts by butting the edge of the triangle against the fence. Rotate the turntable and slide the triangle along the fence until the layout line is aligned with the edge of the triangle. You can use the clamp to lock the turntable while drilling the hole ½" deep into the turntable. The hole in the fence (for the index pin) serves as a drilling guide. To drill the other two holes, simply repeat the process at the other locations.

GUIDES

You'll want to keep the drafting triangle handy for the next step — adding the two pairs of guides shown in Figure 8. They're made from thick stock to keep the blade of the saw square to the turntable and guide it accurately when cutting a workpiece.

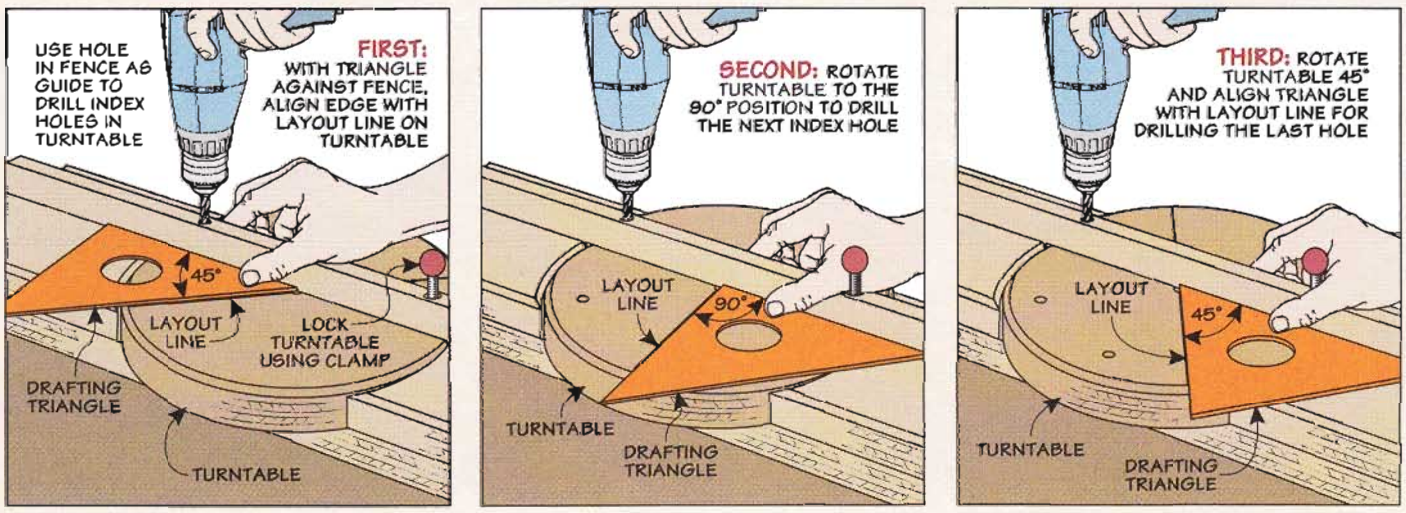
Making the Guides. The guides start out as triangular blocks. I used the pattern on the next page to lay them out on an extra-long blank.

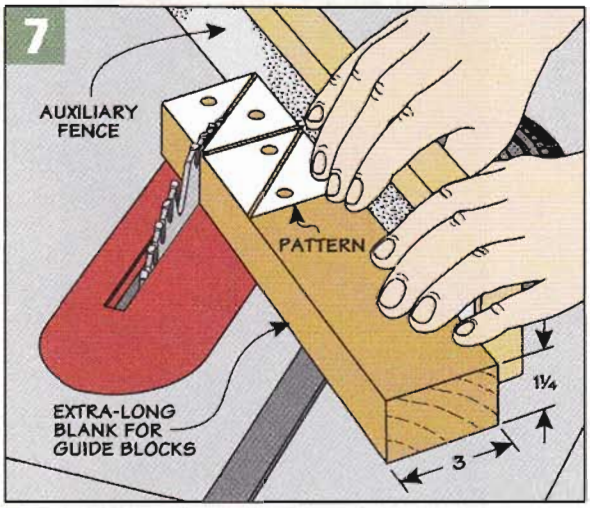
Each guide is mounted to the turntable with a machine screw and washer. To allow for adjustment and alignment with the saw blade, the mounting holes in the guides are oversized.

The pattern gives you the locations of the holes. I drilled the holes before heading over to the table saw to cut each block free, using the pattern as a guide, as detailed in Figure 7.

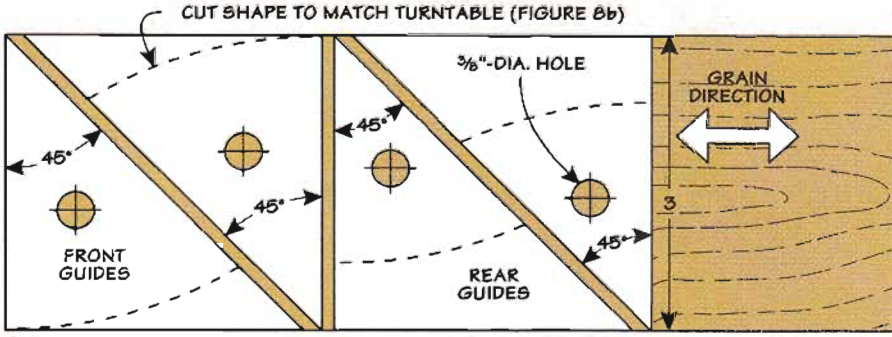
Position & Drill. With the blocks in hand, you can locate

Locating the Index Pin Holes





Pattern (shown 50% scale)



▲ **Guides.** *Use the pattern above to locate and drill the holes before cutting the guides free at the table saw, as illustrated in Figure 7.*

each of them on the turntable. Again, you're relying on the original layout line for initial positioning. Figure 8a shows you how far from the fence to locate each pair of guides.

The screws that fasten each guide are installed into threaded inserts in the turntable. With each block temporarily clamped to the turntable, use a brad point bit to mark the centerpoints for the threaded inserts.

Shaping. If you look at Figure 8, you can see that the back of each guide is shaped to match the curve of the turntable. While the blocks are clamped in place, you can trace the curve on the bottom of each one. It's an easy task to cut the shape at the band saw and sand it smooth.

Threaded Inserts. With the hole locations marked, it's a good idea to remove the turntable to install the threaded inserts. Accurate drilling is easier at the drill press. To remove the turntable, just tap out the pivot pin and slide the turntable out.

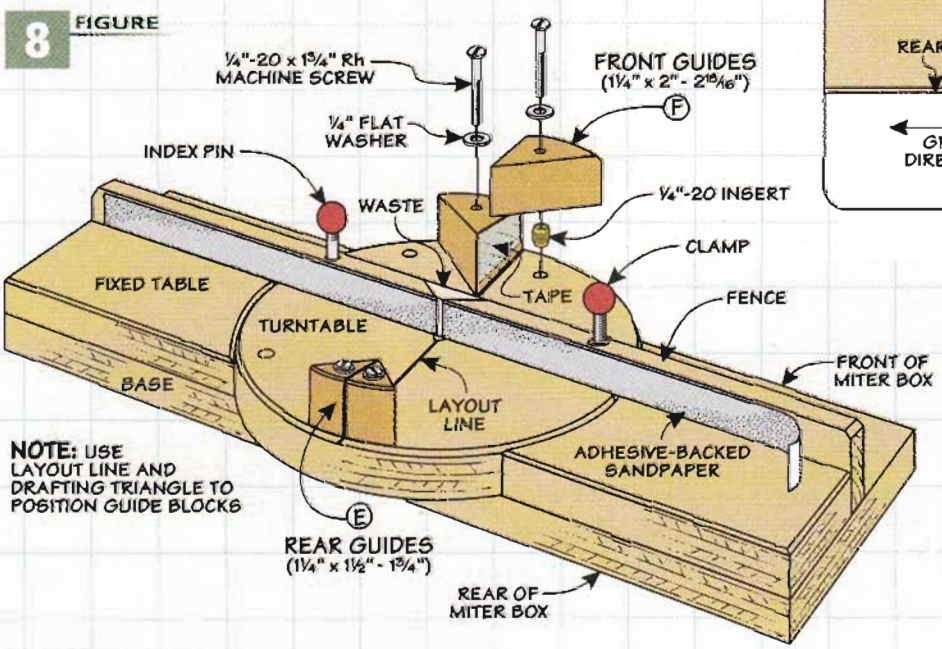
Slippery Tape. Now you can reinstall the turntable in the jig and set about installing the guides. The first step is to apply some low-friction tape to help make the saw slide smoothly between the guides. (For sources, turn to page 51.)

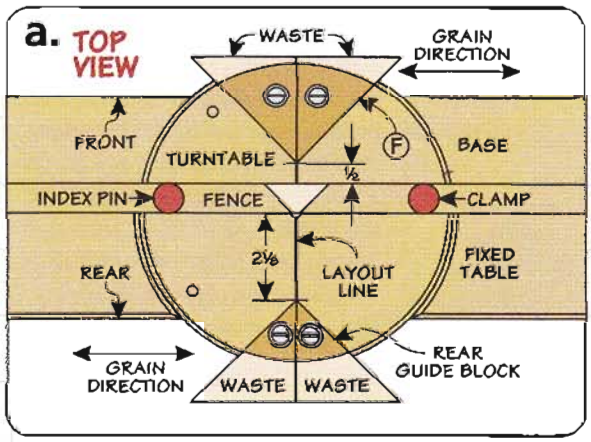
Install & Align. Now, you can use the triangle to help align the first pair of guides on one side of the layout line. Use the thickness of the saw blade to locate the other two guides.

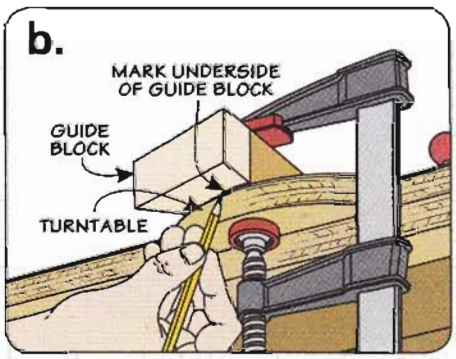
Fence Opening. Finally, you can cut through the fence at each 45° position to create the fence opening. Then I added adhesive-backed sandpaper to the faces.

For a final check, grab a small piece of stock and make a few cuts. You may need to make some minor adjustments to the guide blocks to keep the blade straight and sliding smoothly.

Once that's done, it won't take you long to discover that getting perfect crosscuts using your dozuki couldn't be easier.







using a japanese Dozuki

Here's what you need to know to make clean, accurate cuts for tight-fitting joinery.

When it comes to hand-cutting fine joinery and making quick cuts on smaller workpieces, I've learned to rely on a Japanese, dozuki-style pull saw. These saws have features that make precise cuts fast and accurate.

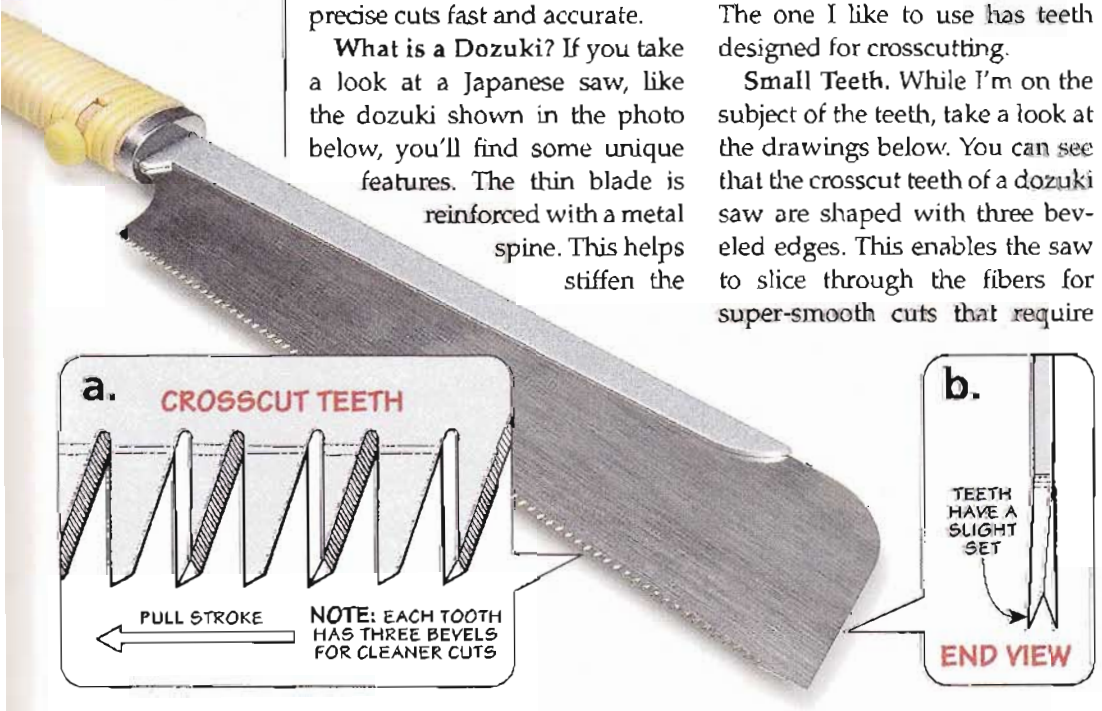
What is a Dozuki? If you take a look at a Japanese saw, like the dozuki shown in the photo below, you'll find some unique features. The thin blade is reinforced with a metal spine. This helps stiffen the blade and results in a hairline kerf (about 0.023") for precise cuts.

Modern dozuki saws are sometimes sold as "joinery" saws with crosscut teeth, though you can also find them with rip teeth. The one I like to use has teeth designed for crosscutting.

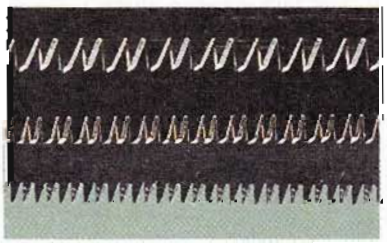
Small Teeth. While I'm on the subject of the teeth, take a look at the drawings below. You can see that the crosscut teeth of a dozuki saw are shaped with three beveled edges. This enables the saw to slice through the fibers for super-smooth cuts that require little cleanup. And you'll notice the teeth are quite small. The number of teeth range from 17 to 28 teeth per inch (photo below.)

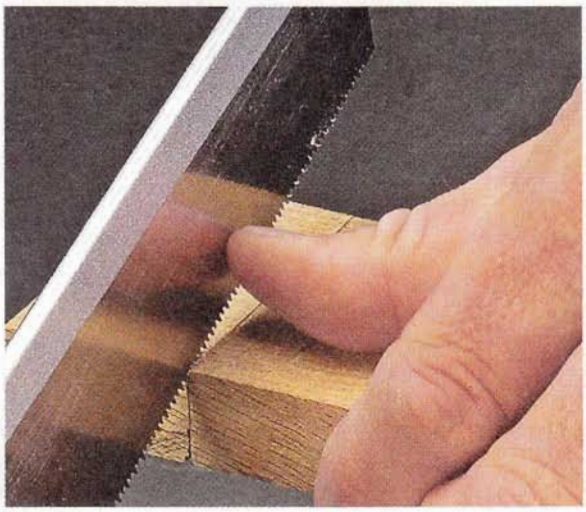
There's another feature you'll find on all Japanese saws. The teeth are angled toward the handle. This means the saw cuts on the pull stroke, putting the thin blade in tension for straight cuts.

Finally, you can see that the long handle is aligned with the blade. This gives you better control as you make a cut. But you still need the right technique to get the best results.



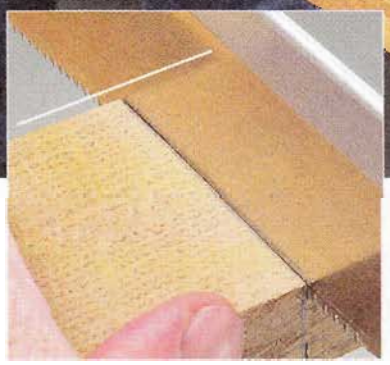
▼ ***Sharp Teeth.*** *The number of teeth per inch on a dozuki saw can vary greatly.*





▲ **Starting Out.** *Use your thumb as a guide to place the saw on the layout line. Start at the back of the workpiece and cut toward the front.*

One-Handed. *Make full strokes by pulling your elbow straight back to your side.*



◀ **Straight.** *The reflected line and the edge of the workpiece should be aligned.*

TECHNIQUE

Since you're pulling the saw to make a cut, you may find using a dozuki awkward at first. But with a little practice and a few pointers, you'll be using a dozuki for most of the hand-cut joinery in a lot of your projects.

Starting the Cut. Accurate cuts require precise layout lines. For these, I use a very sharp pencil or marking knife. Scoring the wood with a knife provides a good reference line for the saw blade.

As with any saw, you'll want to use the tip of your thumb to guide the blade during the first few short strokes. Start with the saw at the far edge of the workpiece and pull toward you, as you can see in the upper left photo.

One-Handed. Once you've started a kerf, you have a choice to make. And that's how to hold the saw to finish the cut. A one-handed approach is a natural option (upper right photo).

For this, you'll want to stand off to the side of the saw so that your arm can make a full stroke, pulling the saw straight back. It might take some practice to do this without swinging your elbow out and bending the blade toward the end of the stroke.

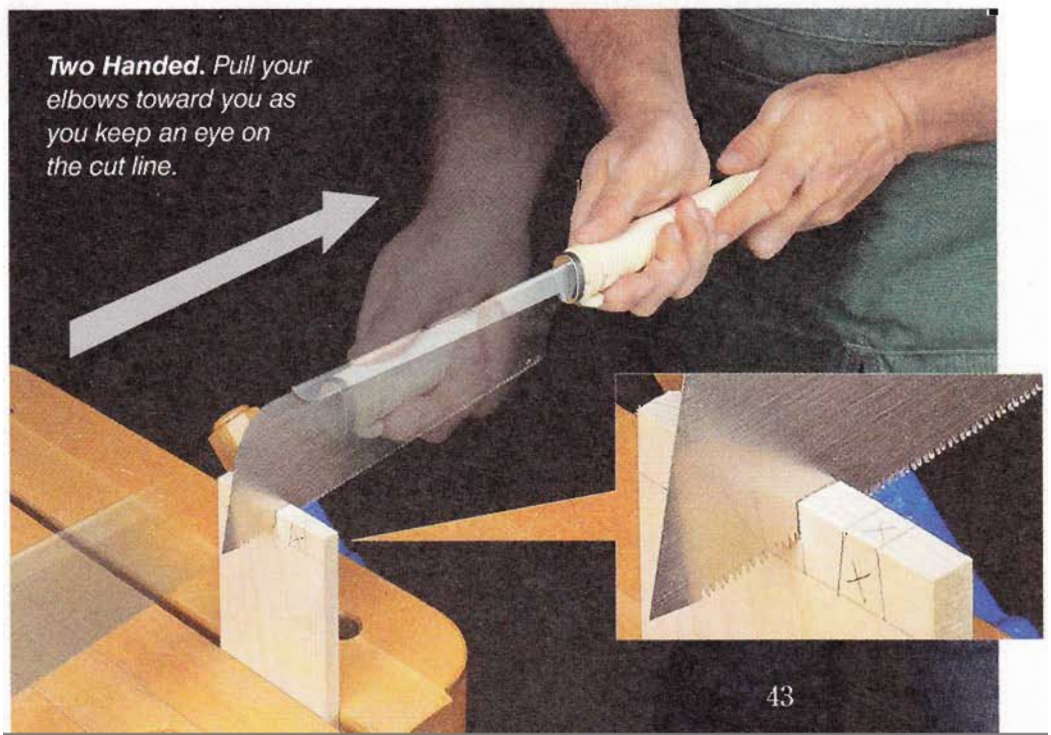
Long, smooth pull strokes are the key to accurate cuts. You can gauge the straightness of your cut using the reflection in the blade as you keep your eye on the cut line (inset photo at right).

Two-Handed. One technique you may want to try is a two-handed cut. I find it helps me stay on the cut line better (photo below). It looks a bit unconventional and may feel a little different at first, but it's worth a try if you find yourself struggling to get a straight cut.

For this technique, stand directly behind the cut line so you can keep an eye on both sides of the blade. Pull the saw toward you in one smooth stroke.

A Light Touch. Regardless of the technique you use, you'll want to let the teeth of the dozuki do the work. There's no need to apply a lot of pressure. On the return stroke, just guide the saw back through the kerf with a light touch before pulling the blade through on the next stroke.

After a bit of practice, I think you'll find the ease of cutting joints with a dozuki can make a big difference in your work.



Two Handed. *Pull your elbows toward you as you keep an eye on the cut line.*

commercial Lumber Racks

Store your lumber conveniently with any of these easy-to-install storage rack systems.

When I first started woodworking, I was surprised how fast lumber began to pile up around the shop. Whether it was new material or scraps left over from the last project, keeping it all organized was a challenge.

A quick and easy solution to the problem is a commercial lumber storage rack, like the ones you see on these pages. It's a great way to make the best use of the space you have in your shop. (For sources, turn to page 51.)

A La Carte. To get a storage setup that suits your needs exactly, check out the photos on this page. You buy the parts individually from a number of mail-order sources. This way, you can put together a system that works for you and the space you have. Plus, it's easy to modify or expand the setup if your needs change.

This starts with wall-mounted straps that come in two different lengths (24" and 55"). The straps accept brackets available in three different lengths (10", 14", and 18"). This kind of versatility makes customizing a snap.

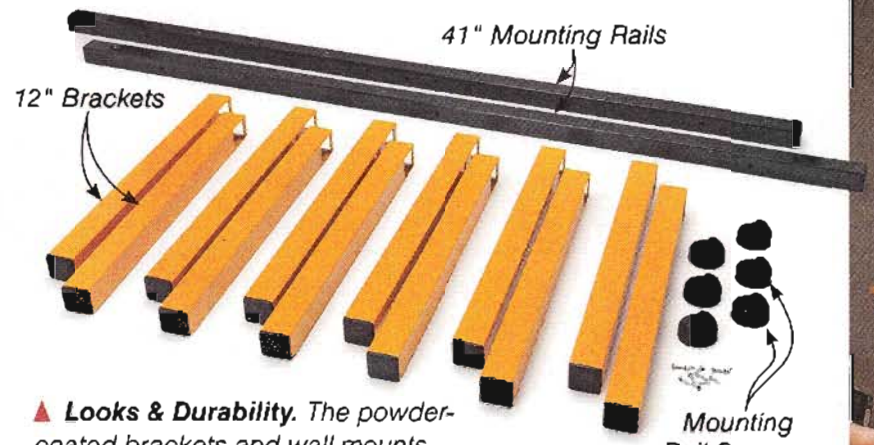
The two straps interlock (margin photo) to form a continuous mount for the brackets. And a tab at the end of the bracket fits into notches in the straps forming a secure lock (photo below). The notches are spaced 1½" apart for easy organization.

The parts are made from 3/16"-thick steel, providing plenty of strength for heavy loads.

◀ ***Interlocking Straps.*** *To increase storage capacity, a tab on the end of the 24" strap securely locks into the top of the long strap.*

Shelf Brackets

▲ ***Stout & Strong.*** *The heavy-duty shelf brackets fit securely into the straps and will support a heavy load with flexing.*



▲ **Looks & Durability.** *The powder-coated brackets and wall mounts create a durable, long-lasting surface.*

The long brackets are rated up to 300 lbs. at the tip. So it's important to securely mount the straps to the wall (box at the lower right.) To transfer some of the loading off the wall, the straps are designed to rest on the floor.

The setup shown in the main photo would run about $260. That might be a bit expensive when you're first starting out. A simpler solution is to purchase a kit. The two systems you see on this page fit that need.

The *Portamate*. The *Portamate* wood rack shown in the photo above comes with everything you need except for the fasteners used to mount the system to the wall. The 12"-long brackets are positioned by a single screw (inset photo at right). And each pair of brackets is limited to 110 lbs. — more than adequate for the lumber needs of most shops.

The downside is you can't easily adjust the spacing of each set of brackets without drilling new holes. But for only $80, it's a simple way to assemble and install a storage system in your shop in less than a half an hour.

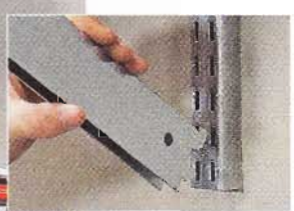
A Basic System. Another quick and easy lumber storage option is the system shown below. You can find hardware like this at some home centers and hardware stores. But if you can't find it locally, *Rockler* provides a kit with all the items shown for around $30.

▲ **Lighter Duty.** *A single screw acts as a stop to position each bracket. The brackets angle up slightly to ensure materials stay in place.*

The three pairs of 14" brackets are adjustable along the 24" twin-track shelf standards, so you can do a limited amount of customizing. As you can see in the photo at the lower left, it's a great system for creating small dedicated storage for a specific workspace.

The systems shown here are all great solutions for organizing your lumber safely and securely. This way, instead of spending time digging through a disorganized pile of lumber, you can spend it building your next project.

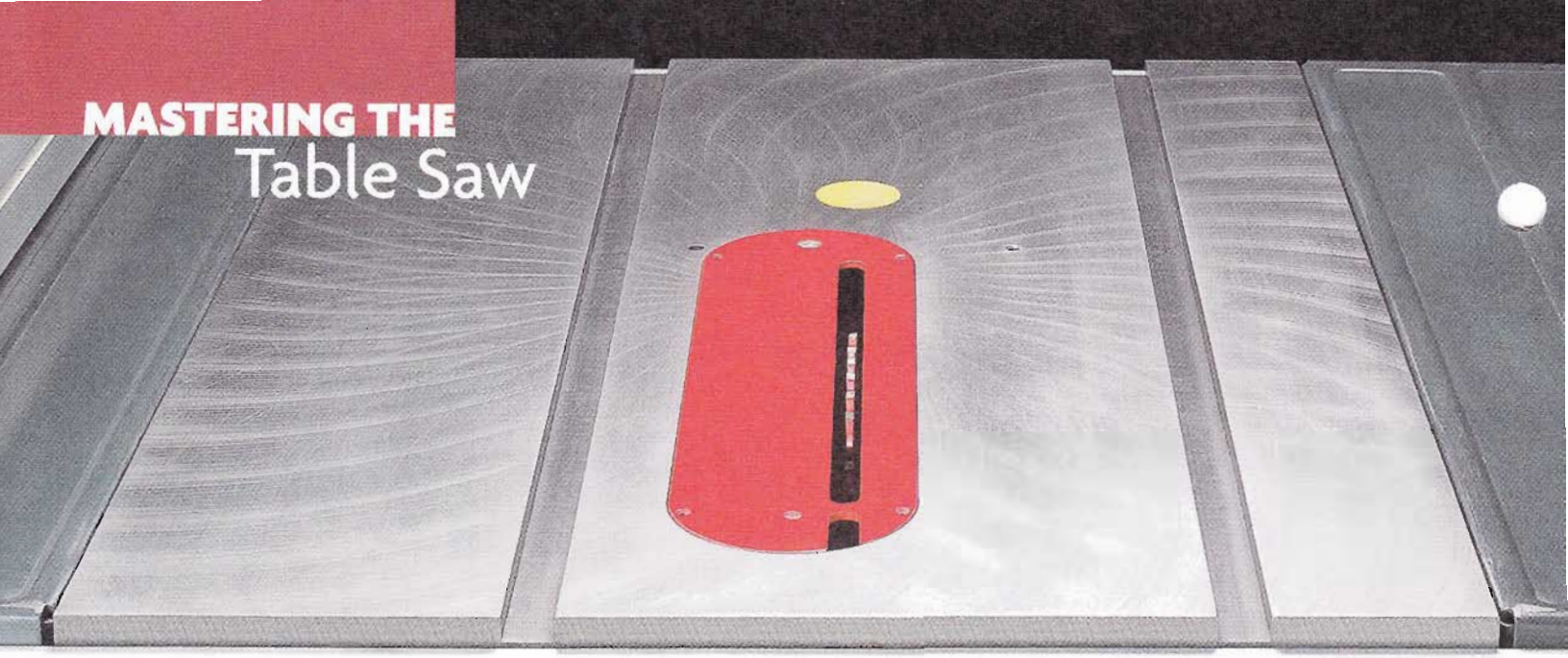
▲ **Simple.** *A pair of small tabs hooks into the standards for a rock-solid installation.*



mounting Hardware

Regardless of the type of lumber storage rack you buy, it's important to install it with the right hardware.

For most shops, this means fastening the system to the wall with either ¼" or ⅜" lag screws (top) driven into studs. If you have a concrete wall, your best bet is *Tapcon* screws (blue ones shown at right). They're available in different head styles to suit your needs, but you'll need an appropriately sized carbide-tipped drill bit to create a pilot hole for the threads.



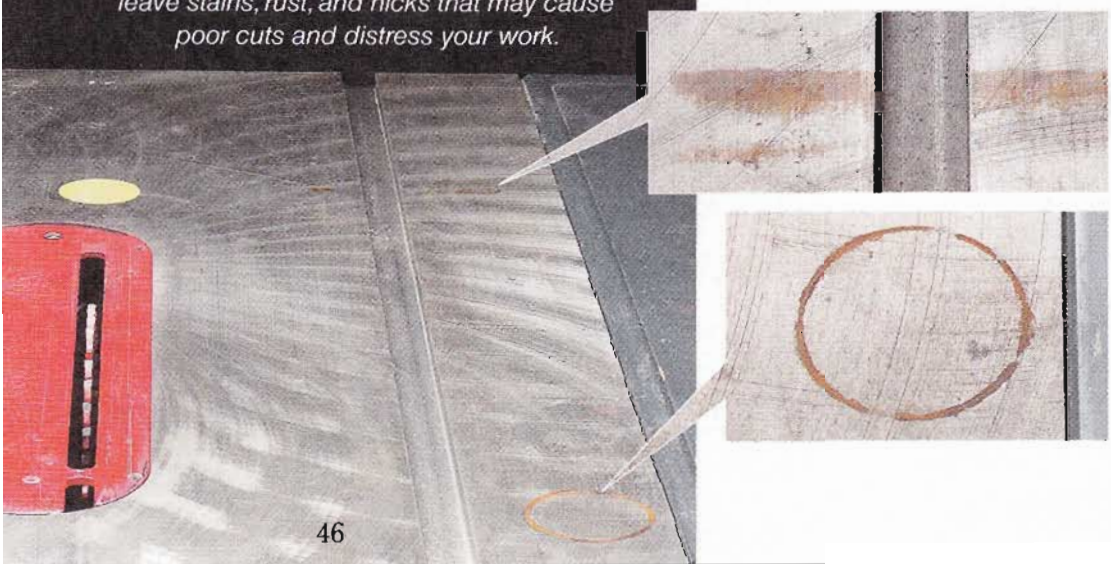
improve performance with a Table Saw Makeover

A smooth, clean surface on your table saw is more than just cosmetic, it's a key factor in better cuts.

The table saw in my shop gets a pretty good workout. But honestly, there are some days I use my table saw without ever turning it on. In a small shop like mine, the extra worksurface provided by the table is a big plus.

Depending on the task at hand, my saw table is often pressed into service as an assembly area, a sanding center, or even a finishing station. Unfortunately, this "moonlighting" has its consequences. The photo below reveals smeared glue and finish, scratches, and even some rust.

Hard Knocks. *Everyday wear and tear can leave stains, rust, and nicks that may cause poor cuts and distress your work.*



These are more than simply cosmetic blemishes. Rough spots on the table transfer "mystery" marks to the surface of a workpiece. And general grime prevents a board or jig from sliding smoothly. Besides making it harder to push, the added friction can lead to catches, noticeable blade marks, and inaccurate cuts. The cure is a little TLC. Here's an easy-to-follow process that I use to get my saw table looking as good as new — or even better.

File & Scrape. In this process, you'll work from coarse to fine, removing the largest blemishes first. So the first thing to do is go over the hard edges of the saw table with your fingers to find dings and burrs that could mar a workpiece. Be sure to include the blade opening and the miter

▲ **Scrape, First.** *A carbide scraper easily removes dried glue and finish from the cast iron top.*

▲ **Scrub the Rust.** *Rubber blocks with built-in abrasives scour away rust stains and grime.*

▲ **Sand It Smooth.** *Lubricate silicon carbide sandpaper with WD-40 to smooth out scratches.*

gauge slots, as well. You can soften the sharp edges with a few swipes of a file.

From there, turn your attention to the surface. The goal is to scrape away any spots of glue or finish. You can see a simple way of handling this in the upper left photo.

Eliminate Rust. If your shop is in an unheated garage or damp basement, you know it doesn't take much for rust to get a foothold. To scrub out rust spots, I like to use "rust erasers" impregnated with silicon-carbide abrasive grit, as you can see in the middle photo above. The blocks break down as you work exposing fresh abrasive. (For sources, turn to page 51.)

General Cleaning. With the big stuff taken care of, it's time to give the top a good cleaning. Use a degreasing cleaner to go over the entire surface. To break up any packed in grime in the nooks and crannies, use a brass brush or old toothbrush. A few blasts from a compressor (or canned air) helps knock the gunk out of the miter gauge slots.

Polish the Surface. By now, your saw table should be pretty clean. But it may not look that great. The next step is to smooth out and polish the table. This two-step task makes the surface look more uniform and it helps a workpiece to slide across the table smoothly, too.

The first step is to sand the top with a sanding block and some 220-grit wet-or-dry sandpaper. After lubricating the sandpaper with *WD-40*, go over the whole surface working front to back to remove deeper scratches, as in the upper right photo. You can wipe away the slurry with a rag to check your progress. Cast iron is tough on sandpaper, so change to a fresh piece often.

The second step polishes out the scratches left by the sandpaper to create a uniform, dull sheen. For this, I attach a fine abrasive pad to my finish sander and go over the surface again, as in the far left photo. Here again, it pays to replace the pad often.

When you're satisfied with the top's appearance, wipe it down with lacquer thinner. This will pick up stray metal particles and any traces of the *WD-40*.

Protect It. Finally, to preserve your hard work and keep the top looking and working well longer, it's a good idea to add a protective coating. A spray-on sealant (near left photo) is a good choice. It also reduces friction and prevents glue or finish from sticking.

I think you'll be amazed at how the top of the saw table looks and feels. But more importantly, this small investment some simple maintenance will help your saw work better, too.

▲ **Polish.** *An abrasive pad and power sander quickly make the surface smooth.*

▲ **Protect.** *A spray-on coating prevents rust, repels glue and finish, and makes the top slick.*

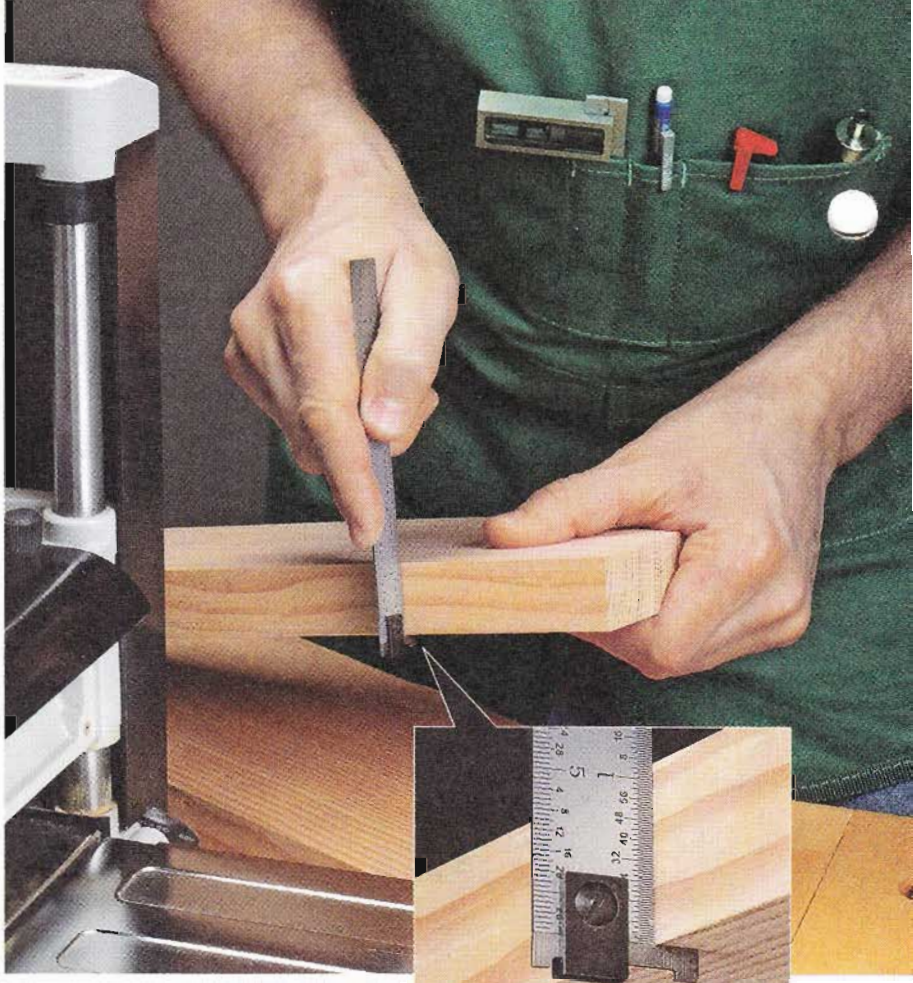
7 super Apron Tools

Always at hand, these pocket-sized tools provide big benefits.

Ever since I started woodworking, there are a few tools that I've always kept in my apron pockets — things like my tape measure, a 6" steel rule, and a No. 2 wood pencil. But lately, I've been adding a few other tools that come in handy for all sorts of everyday tasks around the shop. Here are a few of my favorites.

HOOK RULE

My 6" steel rule sees a lot of use for things like machine setup. But when it comes to checking the thickness of a workpiece, it's a challenge to get an accurate reading.



▲ **Hooked.** *An adjustable hook rule makes it easy to reference the edge of a workpiece.*

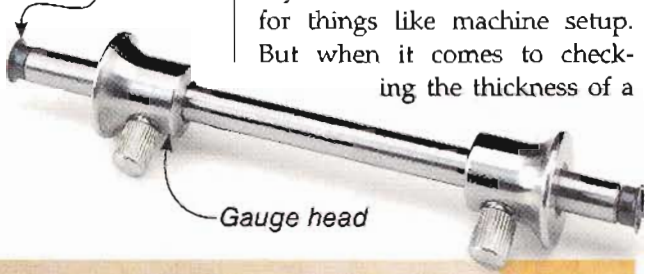
A rule with a sliding "hook" on the end is the solution. Have a look at the photos above to see what I mean. The metal hook extends past the measuring edge of the rule to provide a solid stop for an accurate reference.

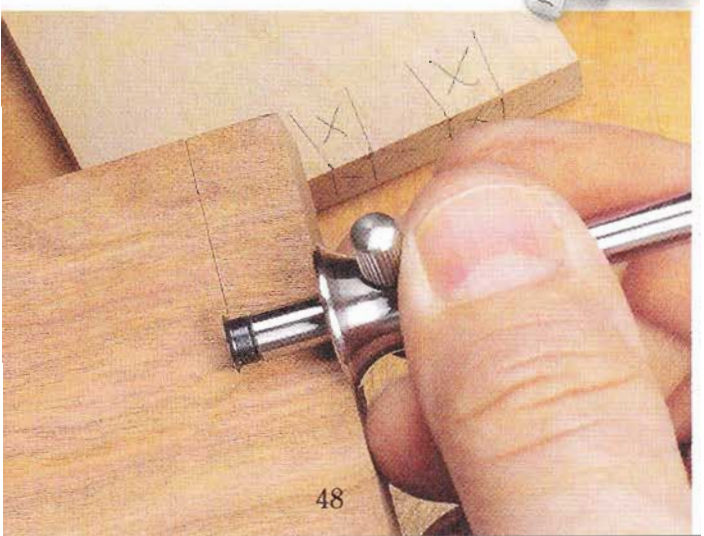
POCKET MARKING GAUGE

Over the years, I've used many marking gauges. These old-style gauges use a sharpened steel pin or blade to score a layout line. They work great, but their bulky size makes them a little unwieldy and they certainly don't fit well in an apron pocket.

The pocket marking gauge you see on the left comes from *Lee Valley* and fits handily in your apron. It's about 4½" long with a cutting wheel and gauge head at each end. The small size not only makes it more convenient to store and use, but with two gauge heads, it can serve double duty.

For example, when laying out the dovetail sockets on a drawer front, I can set one end to mark the length of the dovetails and the other end to mark the depth. When you're ready to store the gauge in your apron pocket, just slide each head to the end of the bar to nestle and protect the sharp cutting wheel.





◀ **Fine Lines.** *This pint-sized marking gauge makes precise layout lines for accurate joinery.*

DOUBLE SQUARE

One go-to tool I've always relied on is a 12" combination square. But the downside is it's too bulky to haul around in my apron. Instead, I find a small double square more useful.

The 4" size is as accurate as its larger cousins, so it's perfect for laying out most joinery. One common use is for establishing the location of a set of shelf pin

holes along an edge, as you see in the near right photo.

MECHANICAL PENCIL

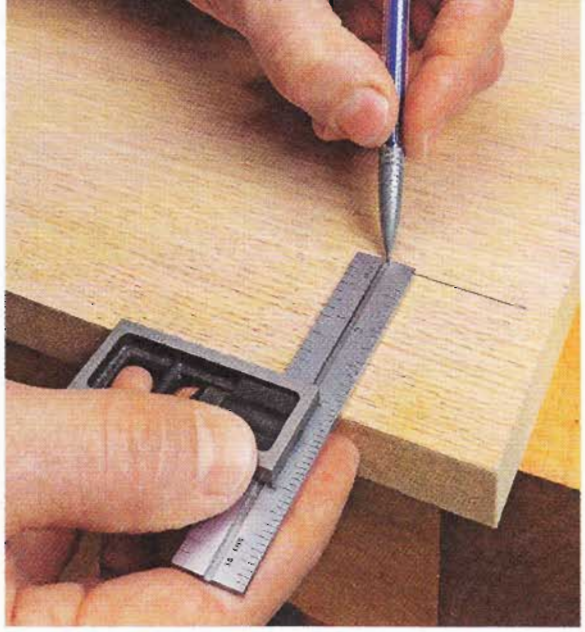
A No. 2 wood pencil is standard fare for layout work and making notes. But it's not the best tool for creating precise lines. The problem is, as the point becomes dull, the line gets wider.

Instead, I like to use the 0.5mm disposable mechanical pencils you can find in office supply stores. You can see one in the near photo at right. They're inexpensive and come in bulk packages. I've become a big fan and keep several scattered about the shop — including my apron pocket.

The best thing about these pencils is their consistency. Unlike a typical wood pencil, the line width never changes. This means your layout work is more accurate — and that translates into better-looking projects.

WHITE PLASTIC ERASER

While layout lines are important, at some point you want to remove them. Instead of sanding them off, I use a white plastic eraser (right photo above). It doesn't smudge the pencil lines like a rubber eraser typically does. This plastic eraser removes all traces of your pencil marks.



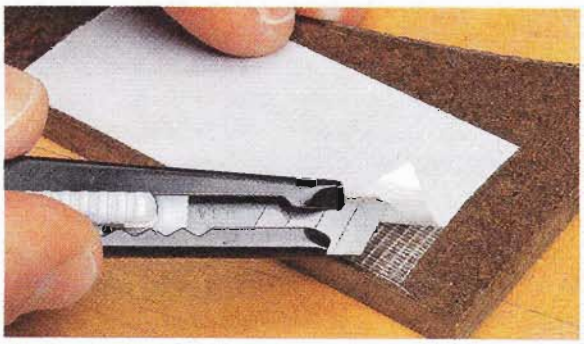
▲ ***Double Accuracy.*** *Team up a mechanical pencil with a 4" double square for creating crisp, precise layout lines that stand out.*

▲ ***No Residue.*** *A white plastic eraser is perfect for removing the last traces of layout lines.*

You'll find these erasers at art or office supply stores.

DISPOSABLE KNIFE

One other tool you'll find in my apron is a disposable knife like the one you see on the right. The one I use has a handy pocket clip. Available at your hardware store, these inexpensive knives are great tools for marking layout lines, cutting tape and cardboard, or picking the backing off of double-sided tape. And when the blade gets dull, all you need to do is snap off the end at the scored line to expose a fresh, sharp edge so you can get back to work.



▲ ***Cutting Edge Versatility.*** *Use a disposable knife for cutting tasks around the shop and for lifting off the backing of double-sided tape.*

TWEEZERS

There's one last item that's not really a woodworking "tool," but to me, it's just as important. It seems like every time I'm in the shop, I get snagged by a splinter. So a pair of tweezers is the other item you'll want to include in your apron arsenal. Check out the box on the left for a set that will stand up to the abuse of banging around in your pocket. These not only excel at removing splinters, but work great to remove specks of dust that sometimes end up in your freshly applied finish.

As you can see, there are handy additions you can make to your "stand-by" tools in your shop apron (refer to Sources, page 51). And one thing's for sure — they'll make your shop time a little more enjoyable and productive.

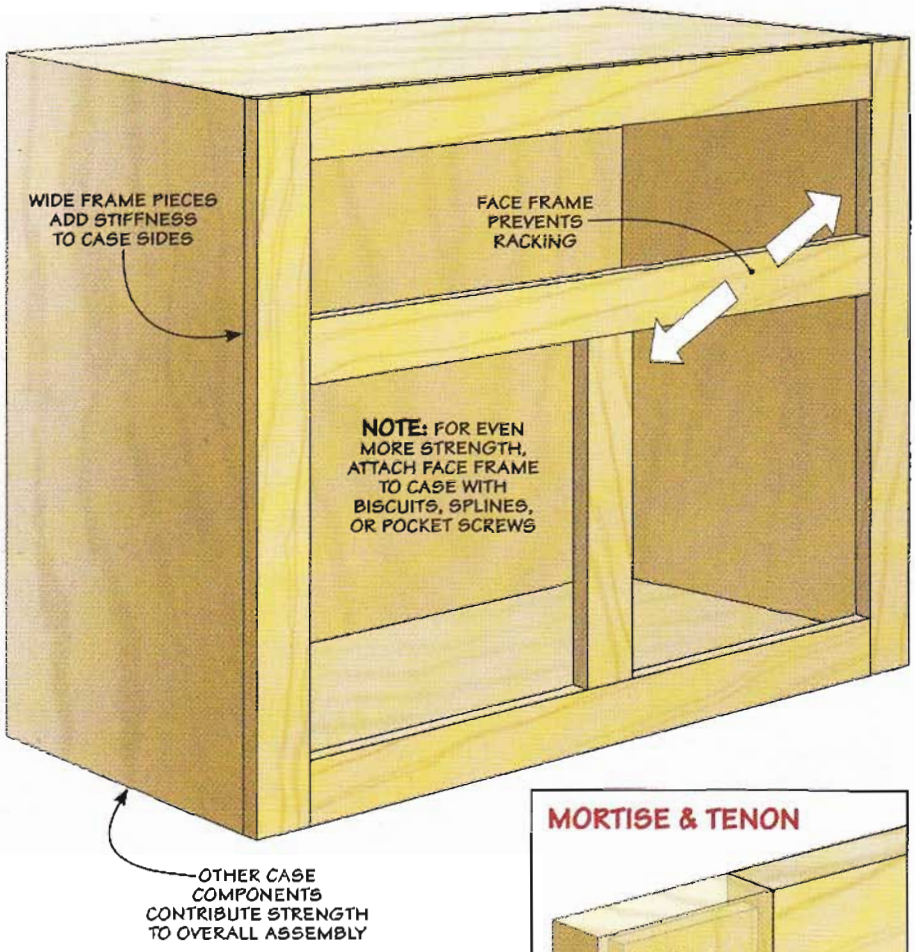
ultimate splinter removal
PockeTweez

First Aid. *Removing a splinter is not my idea of a productive use of shop time. These tweezers make it a quick task. Made from stainless steel, they grab the finest splinter without slipping. They're a modest investment at $25 and will last a lifetime.*

Q&A

questions from
Our Readers

Face Frame debate



I thought the purpose of a face frame was to strengthen a case. So why are the face frames of some projects assembled with mortise and tenon joinery and in other projects, the individual pieces are simply glued in place?

Pam Oslund
Cape Girardeau, Missouri

In traditional cabinet construction, the face frame is preassembled — usually with mortise and tenon joinery — before being fastened securely to the case, as shown in the drawing at right. The large amount of glue surface on the tenon cheeks and mortise walls turns a collection of parts into a rigid assembly. And the shoulders help the frame resist any corner-to-corner racking stress.

Other Uses. However, that's just one of the roles a face frame can play. For example, you can use a face frame to give almost any project a timeless look. The face frame pieces can be used to add details like beads, reeds, and flutes. Finally, it often provides a mounting surface for doors and frames the openings for drawers and shelves.

How the pieces of a face frame are joined and attached to a case depends on the type of project you're building and which of the roles is most important.

Strength. For a large, free-standing project that needs to support a lot of weight, like a bookcase, a sturdy assembly is a primary goal. So it's a good idea to take advantage of the strength a joined face frame provides.

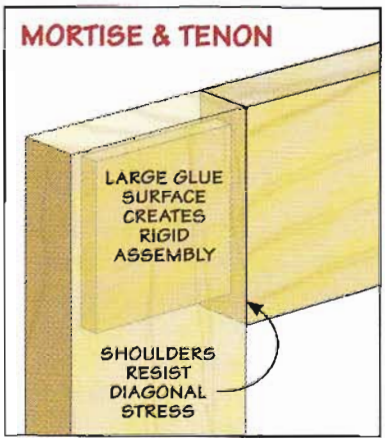
While mortise and tenon joints are the traditional choice, you could use half laps or even pocket screws to assemble the parts, as illustrated in the lower left drawing. To maximize the strength, you'll want to attach the face frame to the case with splines, biscuits, or pocket screws.

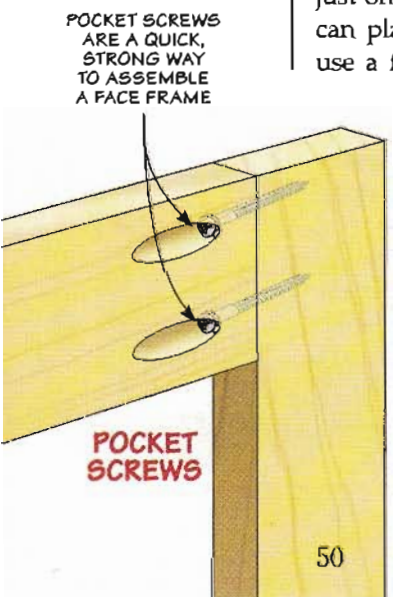
It isn't always necessary to go this far. For instance, a small wall cabinet doesn't face much racking stress. So a fully assembled face frame isn't really necessary.

Finding a Balance. In solid cabinet construction, the strength of the whole is more than the sum of its parts. Well-fitting fixed dividers, shelves, and even a thin, plywood back contribute a good amount of strength and stiffness.

In these situations, simply cutting the face frame pieces and gluing them in place works well. And a glued on face frame with no joinery does have some structural benefits. The wide pieces add stiffness to the case parts they are glued to. It's the reason wide edging is added to a plywood shelf to strengthen it.

Ease of construction also plays a role, too. Cutting each face frame piece to fit lets you aim for tight-fitting joints that add strength and account for inconsistencies in case construction.





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 listed here. You'll find each part number listed by the company name. Check out 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.

ROUTER BITS *(p.8)*

- **Amana Tool**
  E-Z Change Bits . . . . . Varies
- **Razor Tools**
  Slot Cutter Set 600-506

CORDLESS SAWS *(p.10)*

There are more than 20 models of cordless circular saws. So you're sure to find one that suits the type of work you do. You can find many of the saws at home centers, hardware stores, and online retailers, see the right margin.

EXPANDABLE TABLE *(p.16)*

- **Rockler**
  48" T-Track 20054
  5/16"-18 Flange Bolts 33939
  5/16"-18 Knobs 23812
  Hold-Down Clamps 35283

ROUTER MILLING JIG *(p.24)*

- **McMaster-Carr**
  1"-5 ACME Rod 98935A110
  1"-5 ACME Nut 94815A110
  1" Sleeve Bearings 2938T25
  1/2" Sleeve Bearings 6338K418
  1" Flat Washers 97416A146
- **Reid Supply**
  Crank Handle JCL-1150
  Revolving Handles JCL-835
  5/16"-18 Knobs DK-138
  1/4"-20 Studded Knob . . . RST-101
- **Rockler**
  48" T-Track 20054
  6' Self-Adhesive Tape 69116

PULL SAW MITER JIG *(p.36)*

- **Reid Supply**
  3/4"-dia. Ball Knob R-22
- **Lee Valley**
  Low-Friction Tape 25U04.01

LUMBER RACKS *(p.44)*

- **Lee Valley**
  Heavy-Duty System . . . . . Varies
- **Rockler**
  Portamate Wood Rack 41961
  Lumber Storage Rack 39227
- **HTC Products**
  Portamate Wood Rack . . . PBR001

TABLE SAW CLEANUP *(p.46)*

- **Rockler**
  TopCote 97594
- **McFeely's**
  Sandflex Blocks KSA-9999

APRON TOOLS *(p.48)*

- **Lee Valley**
  4" Double Square 24N08.01
  Pocket Mkg. Gauge 15N02.01
  Adjustable Hook Rule . . 24N08.10
- **Rockler**
  4" Precision Square 37480
- **PockeTweez.com**
  Tweezers . . . . . PockeTweez

MAIL ORDER SOURCES

Woodsmith Store
800-444-7527

Rockler
800-279-4441
rockler.com

Amana Tool
800-445-0077
amanatool.com

Amazon.com

HTC Products
800-624-2027
htcproductsinc.com

Lee Valley
800-871-8158
leevalley.com

Lowe's
800-445-6937
lowes.com

McFeely's
800-443-7937
mcfeelys.com

McMaster-Carr
630-600-3600
mcmaster.com

PockeTweez.com
541-480-2320

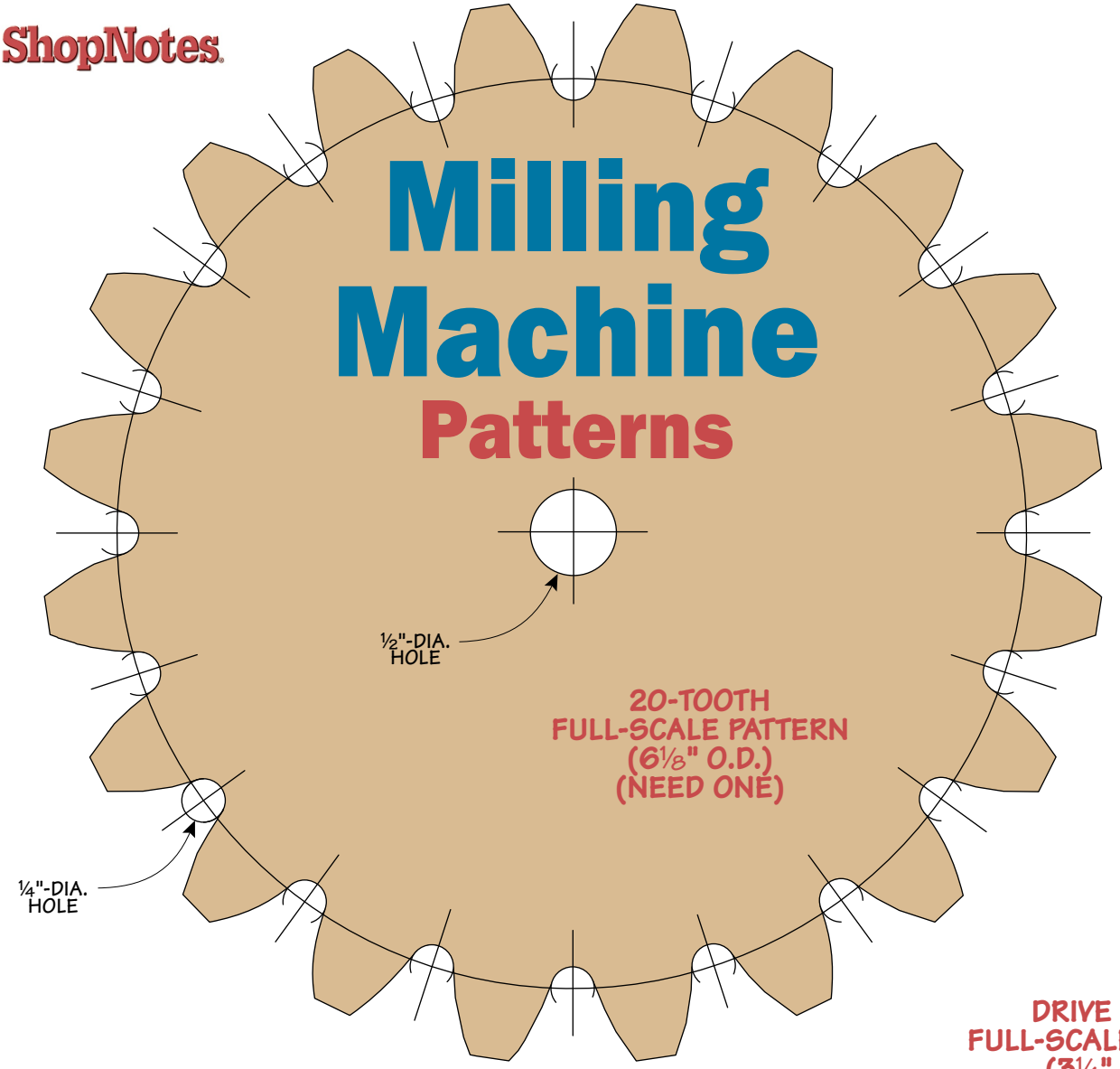
Razor Tools
877-898-6657
razorwoodworks.com

Reid Supply
800-253-0421
reidsupply.com

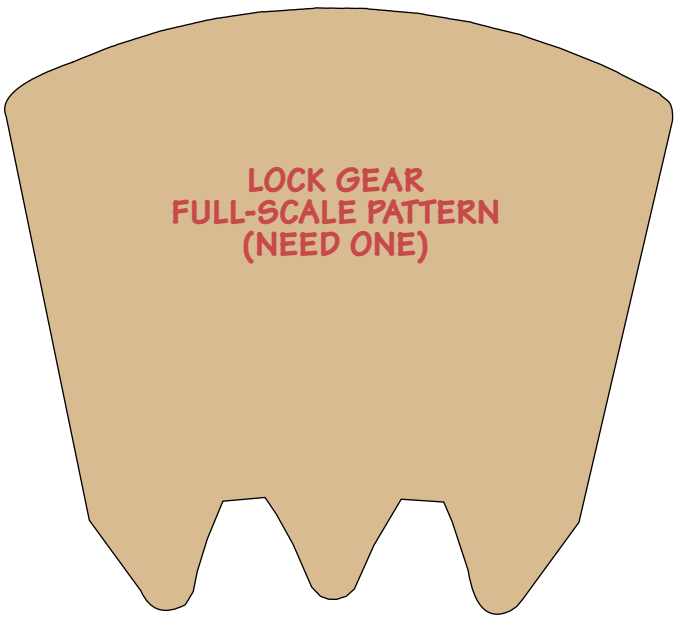
The Home Depot
800-466-3337
homedepot.com

ShopNotes

Milling Machine Patterns

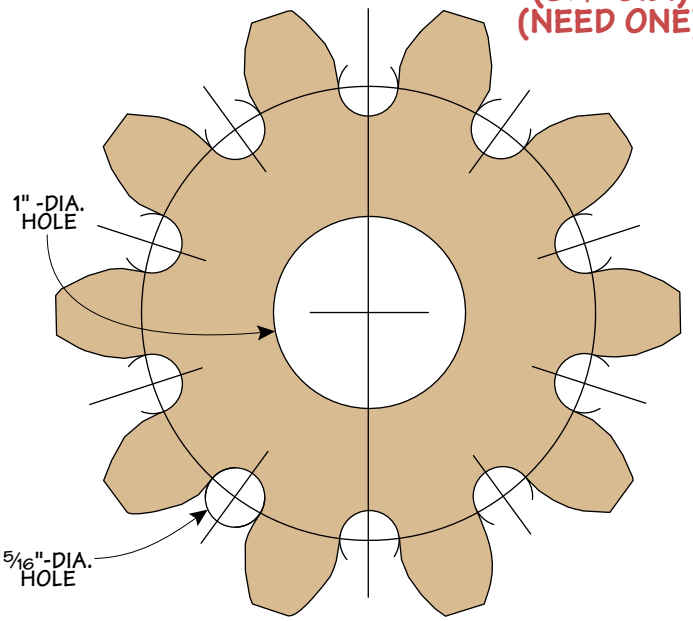


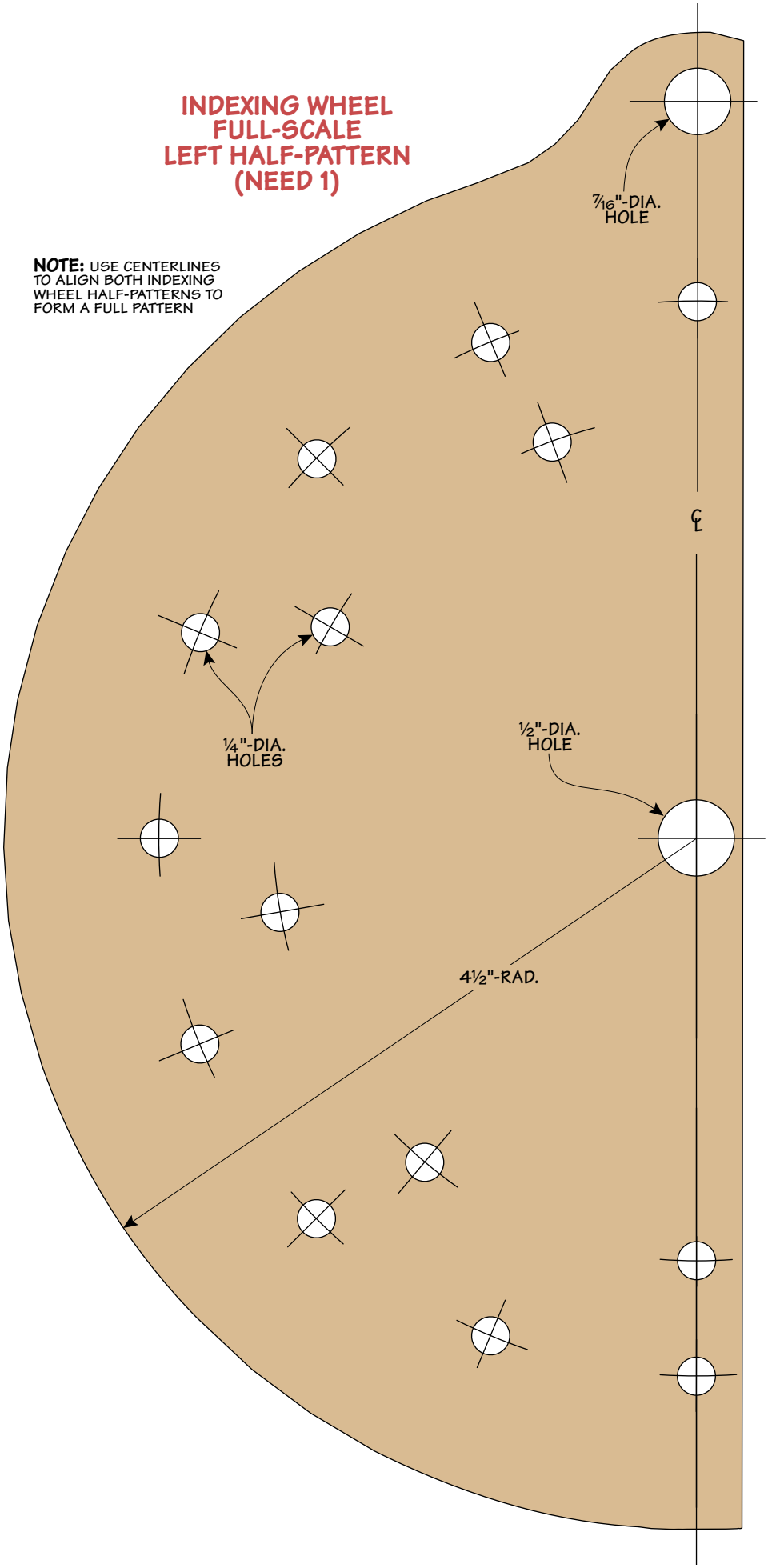
20-TOOTH
FULL-SCALE PATTERN
(6⅛" O.D.)
(NEED ONE)



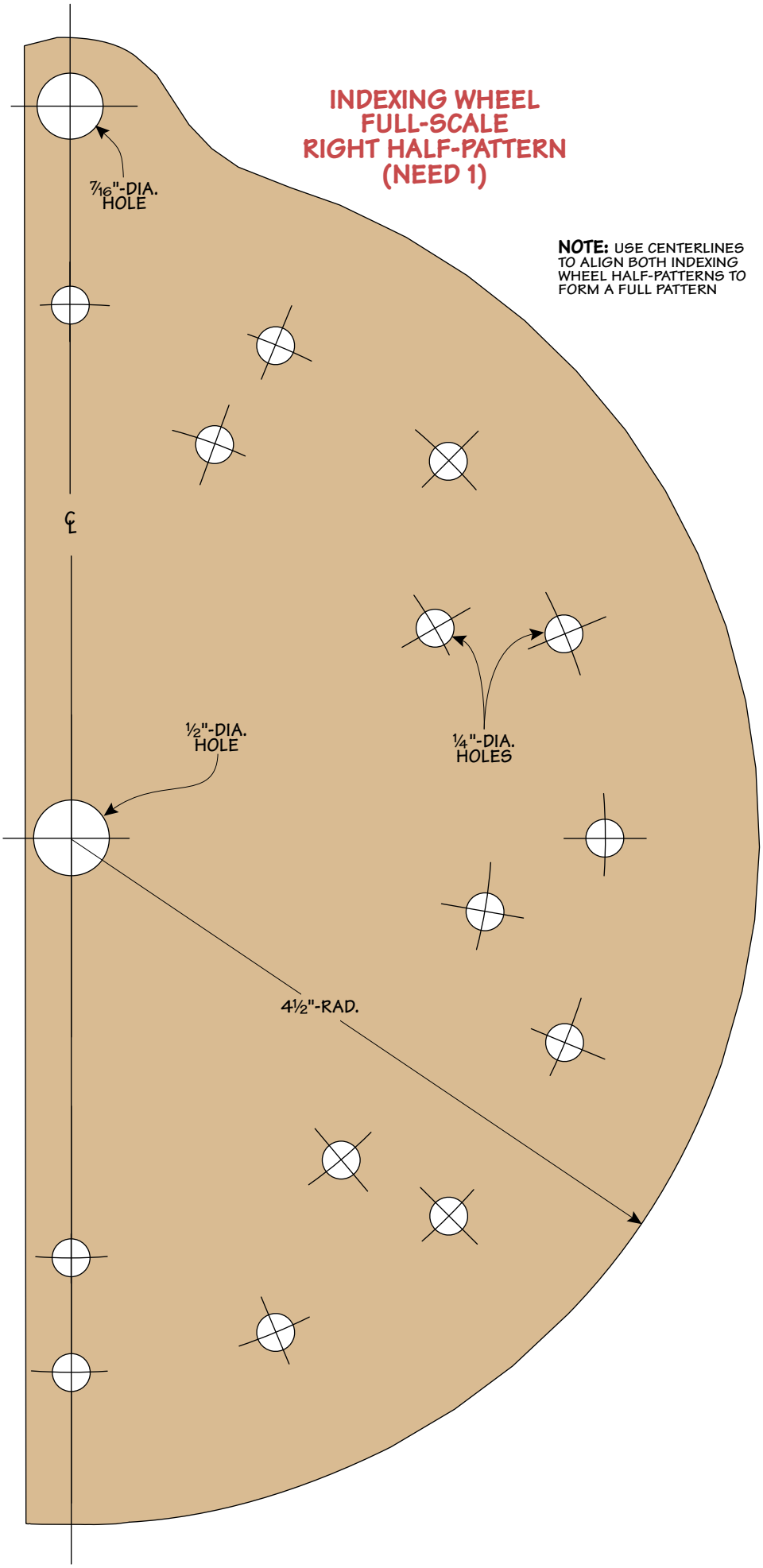
LOCK GEAR
FULL-SCALE PATTERN
(NEED ONE)

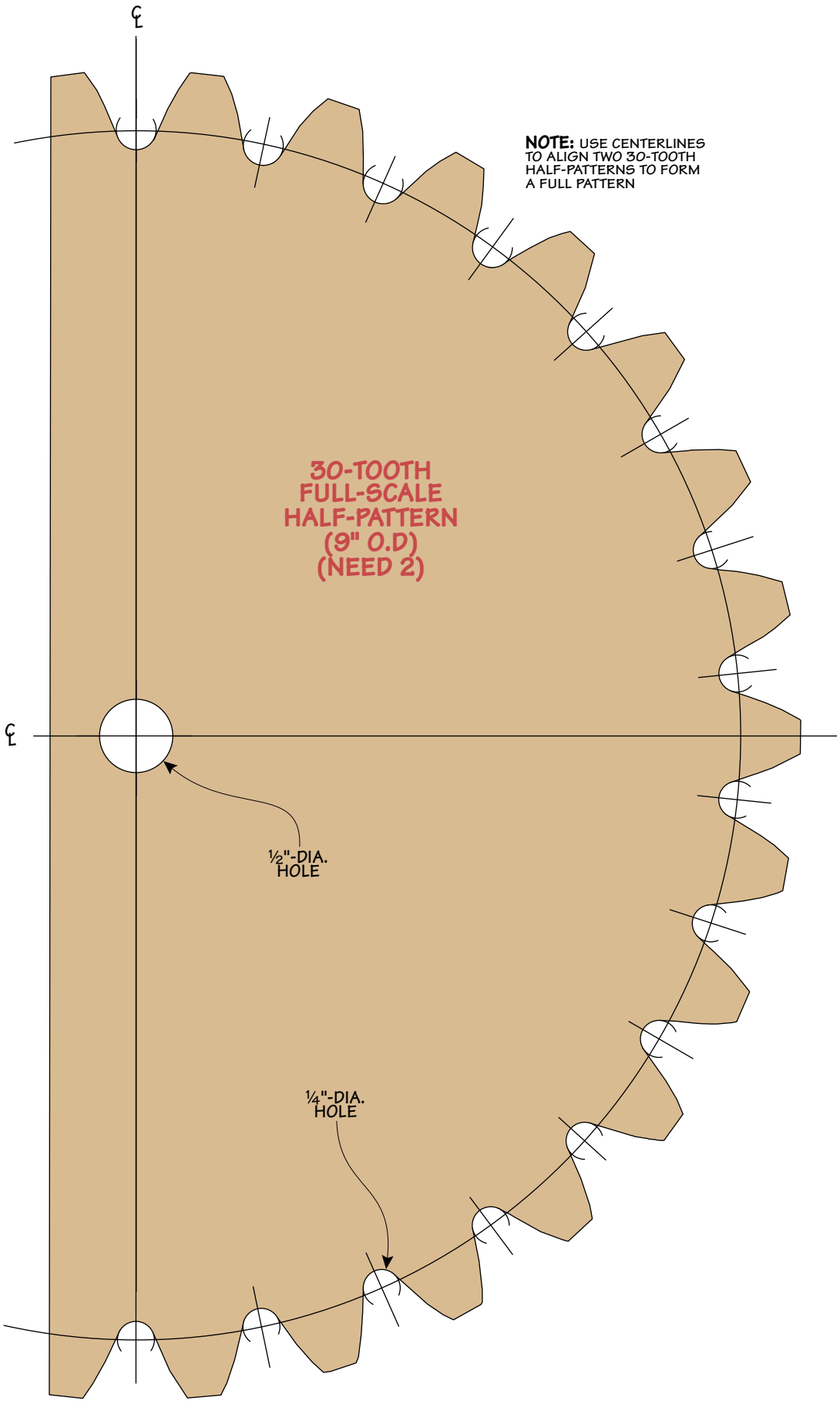
DRIVE GEAR
FULL-SCALE PATTERN
(3¼" O.D.)
(NEED ONE)

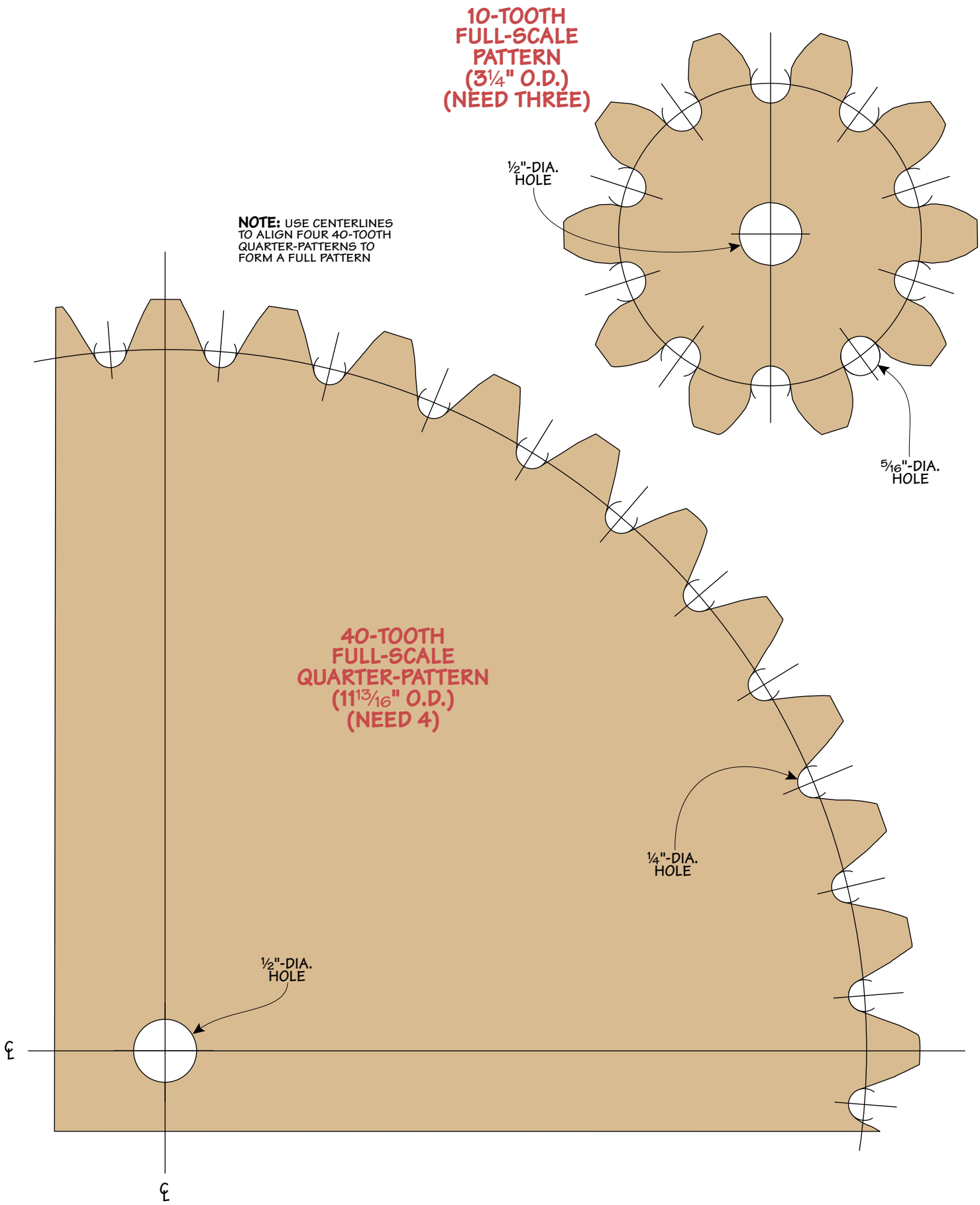




INDEXING WHEEL
FULL-SCALE
RIGHT HALF-PATTERN
(NEED 1)





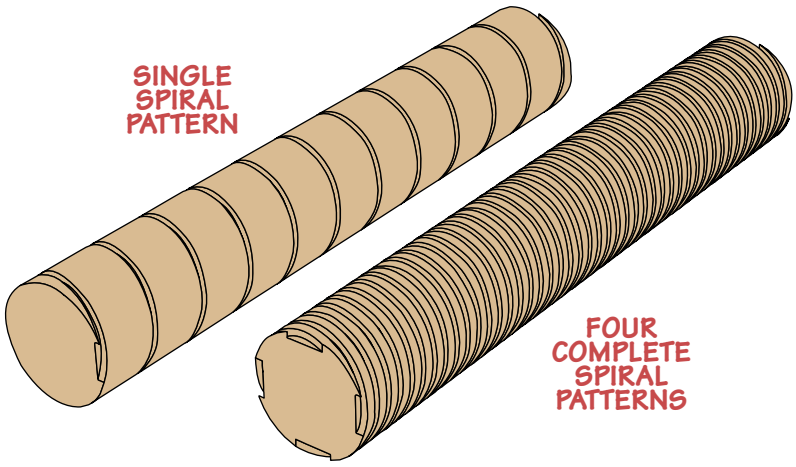


Milling Machine
Gear Setups

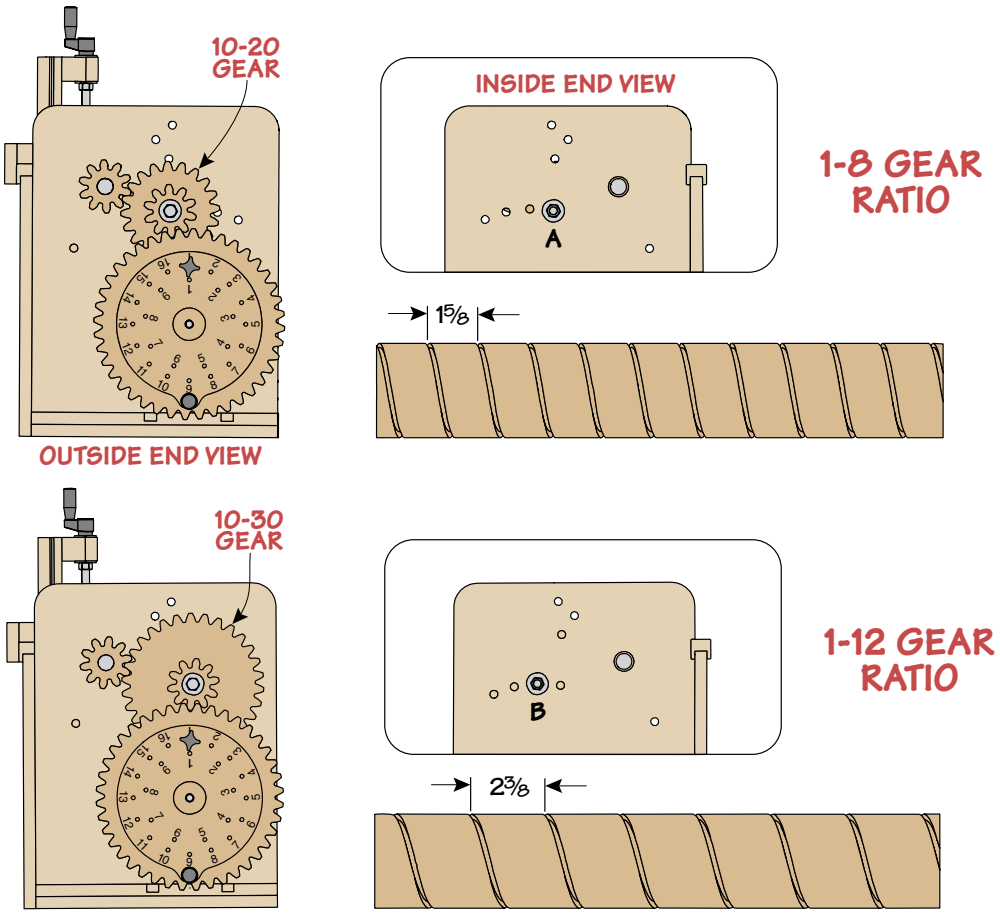
The router milling machine allows for six different gear setups to create spiral patterns (like flutes and reeds). Depending on the setup, the gear ratio, and therefore the spacing of the spirals changes. The direction of the spiral depends on whether one or two gears are used to connect the drive gear and main gears, as you can see in the drawings below and on the following page.

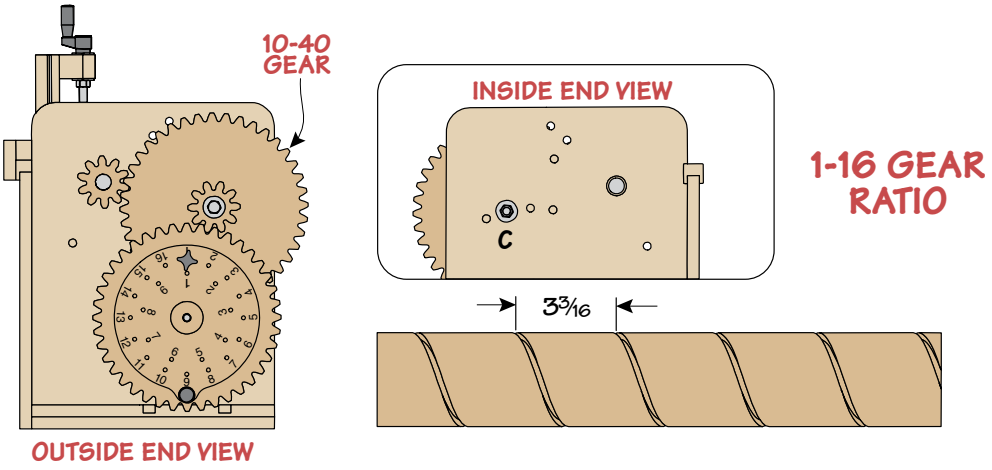
Each set of drawings below shows the gear setup and resulting spiral pattern. You can use the information to determine what will work best for the type of bit you're using. It's always good idea to try out different gear setups and bit combinations on a practice blank to determine the best spacing and number of spirals.

Over time, you'll develop a sense for the number of spirals you can use in a design depending on the gear ratio and the size of the bit (or a portion of a bit) you use.

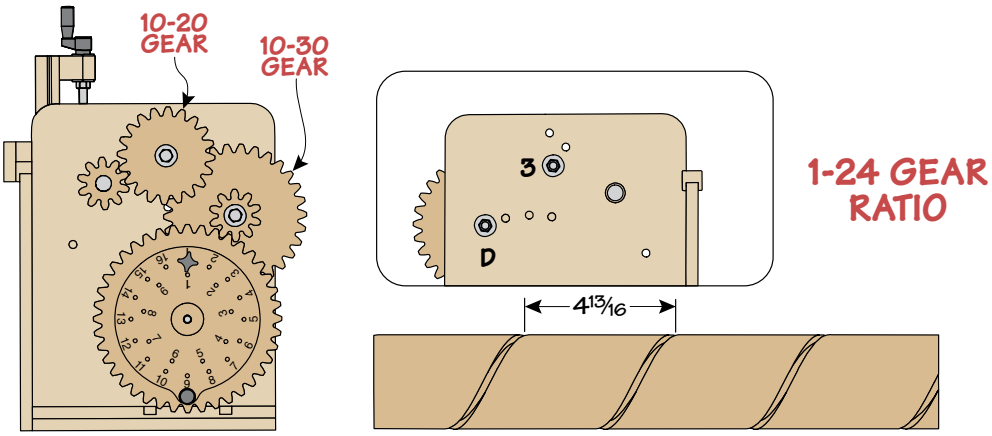


▲ ***Spiral Pattern.*** *Each specific gear setup results in a particular spiral spacing (left example). The indexing wheel ensures that spirals are evenly spaced for a consistent look once they're complete (right example).*

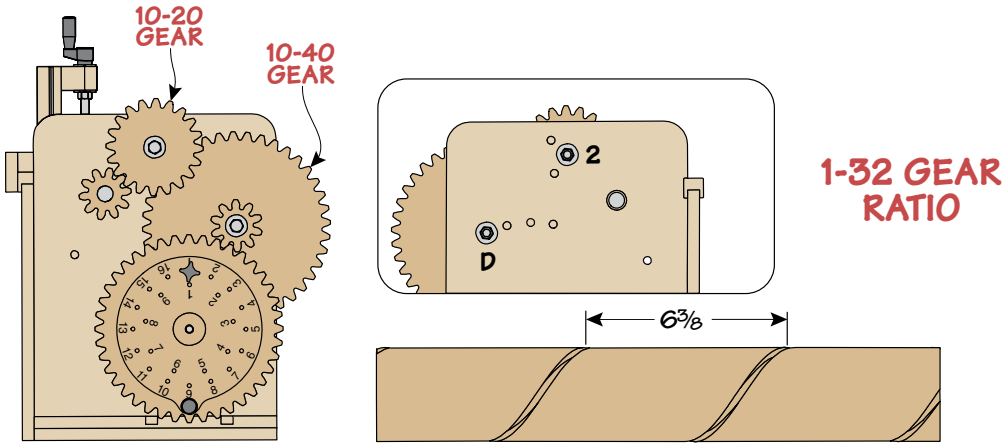




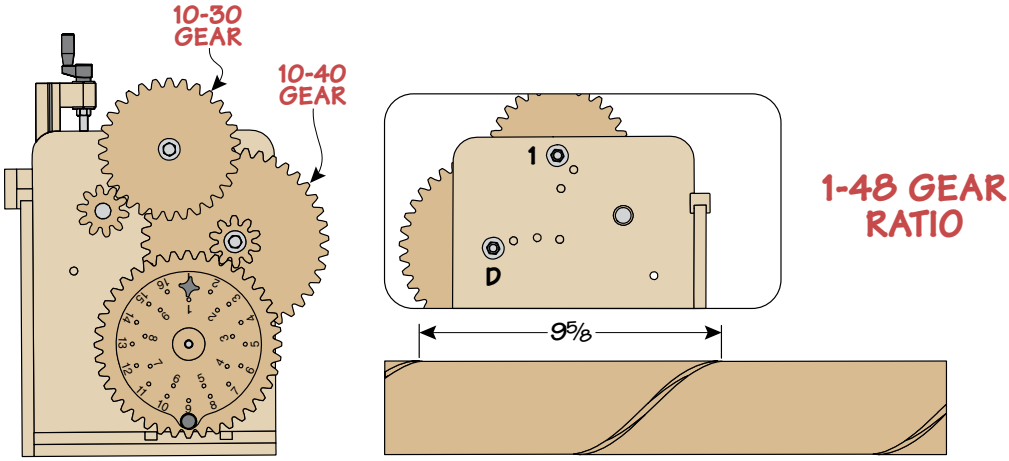
1-16 GEAR RATIO



1-24 GEAR RATIO



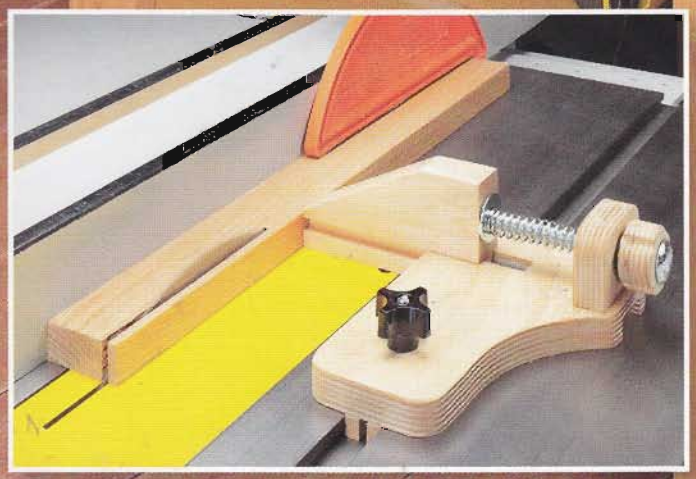
1-32 GEAR RATIO



1-48 GEAR RATIO

Scenes from the Shop

This all-purpose, expandable worktable is a great project for any size shop. With the extensions pulled out, it'll handle a full-sheet of plywood with ease. You'll find complete plans starting on page 16.



This thin-strip ripping jig is just one of the great reader's tips you'll find starting on page 4. With just a handful of hardware and some scrap stock, you'll be cutting dead-on thin strips easily and safely.

Getting your saw table in tiptop shape is the key to better cuts. Turn to page 46 to learn the tips and techniques for doing it right.