NO. 45 NOTES FROM THE SHOP

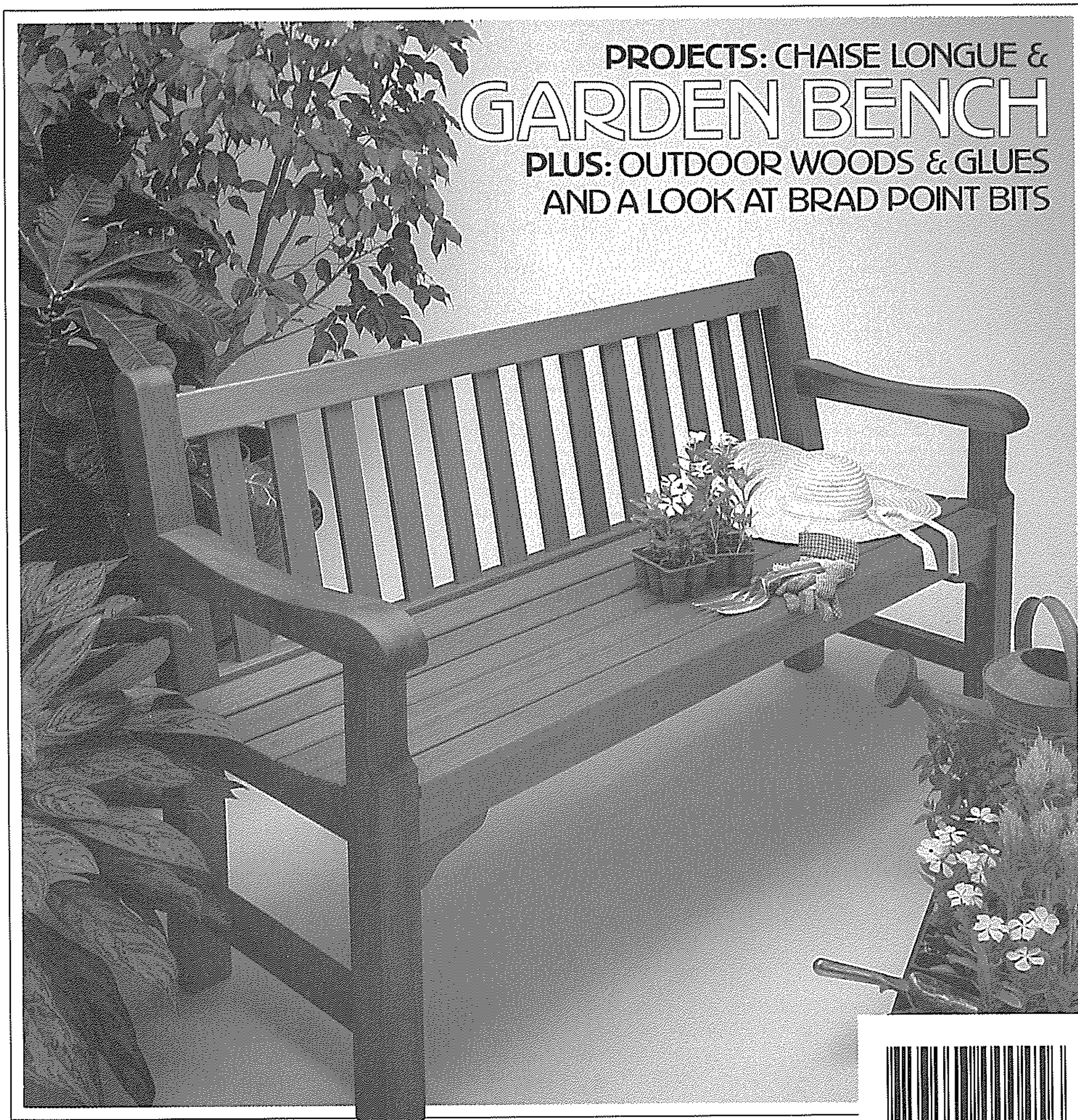
Woodsmith®

PROJECTS: CHAISE LONGUE &

GARDEN BENCH

PLUS: OUTDOOR WOODS & GLUES

AND A LOOK AT BRAD POINT BITS



Woodsmith®

Number 45 June, 1986

WOODSMITH® (ISSN 0164-4114) is published bimonthly (February, April, June, August, October, December) by Woodsmith Publishing Co., 2200 Grand Ave., Des Moines, Iowa 50312.

Printed in U.S.A., 1995

Sawdust

ABOUT THIS ISSUE. When I was growing up in St. Louis, I used to visit Shaw's Garden which was right across the street from where I was born. (Now it's called the Missouri Botanical Center. But it was originally the country estate of Henry Shaw, a nineteenth century botanist who collected all types of trees and plants from around the world.)

This huge garden estate has always been open to the public but I always considered it my playground — with special "climbing trees" here and there.

In the past ten years or so, the gardens have been upgraded and new areas added. My favorite areas are the Japanese garden and the English walking garden.

The walking garden is not a formal garden. It's more of a rustic tree-shaded path surrounded by hostas and other plants that thrive in the shade.

Well, it was in this garden that I first encountered an English garden bench like the one shown in this issue. They are quite handsome and seem sturdy enough to be right at home in a wooded setting. They're also quite comfortable — with a contoured seat and angled back.

As we started work on this bench, there was a temptation to simplify the construction. It would have been easier to use half-laps or maybe dowel joints to build it.

But the mortise and tenon joinery we used seems much more appropriate. More work, granted, but much more in keeping with this project. When it's built, and you stand back to look at the final product, it has the look of a bench that will last many, many years.

CHAISE LONGUE. Spelling has never been one of my strong points. In fact, I think it's a lack of imagination to assume that there's only one way to spell a word.

So as I was looking in the dictionary to verify the spelling of "chase lounge," I had some difficulty finding it. When I finally did find "chaise longue," imagine my surprise to find that I had also been mispronouncing it all these years. It's pronounced "shaze long" (with a little pucker to the lips), and means "long chair," literally.

Beyond spelling and pronunciation, this long chair was a challenge to build. Whenever you try to make straight pieces of wood conform to an adjustable and bendable human body, you've got some design problems to work out.

I've always admired the ingenuity of the folding aluminum chairs — they certainly contort all the ways you expect them to. But all that aluminum tubing and plastic webbing seems out of place in the great outdoors.

The chaise we're showing in this issue is made of redwood and seems right at home out in the sun. It also has all the adjustable features to make you comfortable.

NEW FACES. In the two months since the last issue came out, we've added three new faces to our group.

Jim Prill has signed on as a technical illustrator. Jim (along with about 40 others) answered the help-wanted "ad" in this column last winter. At that time, Jim was a designer/craftsman for Kodak in Rochester and was attending the Rochester Institute of Technology.

Jim is now learning the process we use to produce all the artwork in each issue. It's more involved than you might think — each drawing requires about 8 hours to complete — through a series of stages that includes planning, sketching, "tight" pencil drawings, redrawing, the final inking, and adding the "keyline" (the typeset words and dimensions).

Since each issue has about 100 drawings, it adds up to a lot of time — so we're fortunate to have Jim helping out.

Kate Bauma has also joined our staff to help me with the circulation work and some of the business end of putting out a magazine. She has also "volunteered" to do this year's *Sourcebook* (which will be out in late September).

While I'm on the subject of the *Sourcebook*, I'd like to mention that last year's edition was very successful. Over 240,000 catalogs and product information kits were ordered by *Woodsmith* readers. We're very happy to provide this service to our subscribers and hope you feel it's helpful.

(For new subscribers, the *Sourcebook* is a "catalog of catalogs." Since we don't carry advertising in *Woodsmith*, we decided to put out the *Sourcebook* to provide an easy way to order woodworking catalogs and product information. The *Sourcebook* comes out in the fall and is mailed to all of our subscribers free of charge.)

And there's one more addition to the *Woodsmith* group. Pat Koob's voice will probably be the first one you hear if you have a reason to call us. Pat is in charge of customer service and is anxious to help you if there's a problem with your subscription, a damaged or missing issue, or a question about a renewal or back issue order.

Most of her time is spent responding to the service form attached to the envelope in each issue. So if you have a problem with your subscription, please feel free to use that form. Pat will be glad to help.

NEXT MAILING. The August issue of *Woodsmith* (No. 46) will be mailed during the week of August 31, 1986.

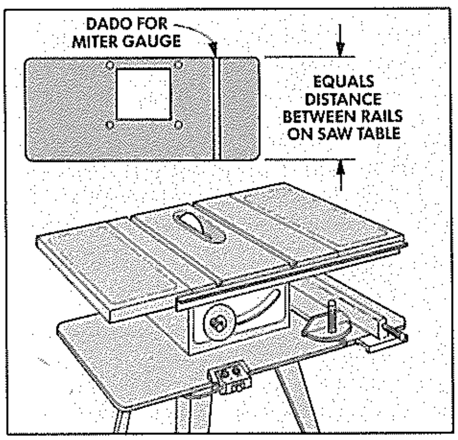
Tips & Techniques

TABLE SAW SHELF

When working on the table saw it seems like there's never enough space to set things down (the miter gauge, rip fence, jigs, or workpieces). I used to always end up cluttering up a corner of the saw's tabletop. Then I wondered where all my work surface had gone.

To solve the problem I added a piece of 3/4" plywood *between* the saw cabinet and the legs. (Note: To do this on some table saws you may have to buy longer bolts.) The plywood is about the size of the saw table with the extensions so it creates a shelf under both of the extensions.

By making the width of the shelf equal the distance between the rails on the saw, the rip fence can be clamped to the shelf when it's not in use. I also routed a shallow dado across the shelf for the miter gauge.



To keep sawdust from building up in the cabinet, I cut a square hole in the center. A dust collection drawer or bag could also be added under the hole.

Finally, my Sears table saw has a push on-off switch that I mounted to the front of the shelf. It's easy to push it off with my knee if both hands are on a workpiece.

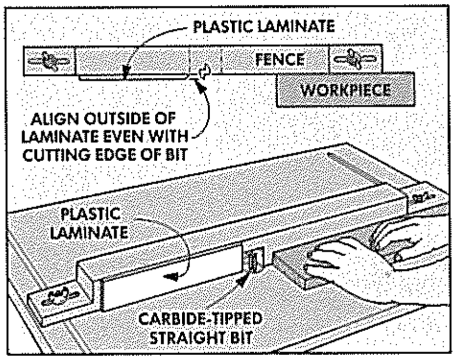
David Stewart
Bellevue, Washington

ROUTER TABLE JOINTER

I don't have a jointer in my shop, but I found an easy way to make my router table smooth and straighten the edge of a piece of wood like it had been passed over a jointer.

To make the "jointer," glue a piece of 1/16"-thick plastic laminate (Formica) to the left (outfeed) side of the fence so that one end lines up with the bit opening in the fence. Then slightly bevel the edge of the laminate near the opening so that it won't "catch" the leading corner of the workpiece.

Next mount a carbide-tipped straight bit in the router and align the fence so the outside of the plastic laminate is even with the outermost cutting edge of the bit. This will take a 1/16" cut out of the workpiece. The



only limitation is that the thickness of the workpiece can't exceed the length of the bit's cutting edge.

Since the fence on the *Woodsmith* router table is reversible, I decided to add my jointer attachment to the *back* of the fence and then just turn the fence around when I wanted to use the router table as a jointer.

David E. Logan
Springfield, Missouri

Editor's Note: We added David's simple attachment to the router table in our shop and were surprised how smooth and straight a cut we were able to get. If your router will accept it, a 1/2" shank router bit works better than a 1/4" shank bit since the thicker shank helps cut down vibration.

COPYING PATTERNS

It always seems like a lot of trouble to copy an intricate pattern from a book, magazine, or plan onto a wooden workpiece. It's a matter of connecting grid points, using carbon paper, or cutting out the pattern and then tracing around it.

As a Xerox service representative it occurred to me that the process used to transfer ink to paper in photocopy machines could be used to transfer patterns to wood. Most major brand photocopiers use a heat-sensitive ink (toner). By reapplying heat to the ink, some of it will leave the photocopy and transfer to the wood.

To begin, I make a standard photocopy of the pattern. Some of the more sophisticated machines at retail copy services even have variable enlargement and reduction capabilities. This means you can enlarge a scaled grid drawing up to full size.

Then turn the photocopy over (ink side down) and tape it to the workpiece. Next, heat up a clothes iron to its highest setting and "iron" right over the pattern. It may take a little practice to determine the right amount of heat and time to get the ink to transfer. (Taping the pattern just at the top allows you to lift up the bottom and see where more heat might be needed.)

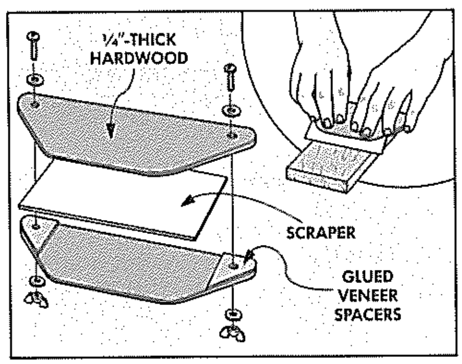
The only drawbacks to this method are that the pattern size is limited to the size of the photocopy paper (though they could be pieced together), and it makes a mirror-image of the actual pattern (which isn't a problem on most work).

Keith Anderson
DeKalb, Illinois

SCRAPER HANDLE

It seems like every time I use a scraper for a period of time my fingers start to ache and then get hot (from the friction of scraping). And if that doesn't happen, I get a scratch or nick on a finger from a sharp corner or edge of the scraper.

To solve the problem, I made a handle for my scraper by resawing a piece of hardwood to create two 1/4"-thick pieces that sandwich the scraper. Each of the pieces has a slight taper on it to follow the natural angle of my hand down to the blade.



To make a channel for the scraper and protect the burr on the back edge (so the scraper can be sharpened on both edges), I glued a couple of small scraps of veneer to the outside corners on one of the boards. Then the whole assembly is held together with a couple of bolts and wing nuts.

Dean Feight
Altoona, Iowa

SEND IN YOUR IDEAS

If you'd like to share a woodworking tip with other readers of *Woodsmith*, send your idea to: *Woodsmith*, Tips & Techniques, 2200 Grand Ave., Des Moines, Iowa 50312.

We pay a minimum of $10 for tips, and $15 or more for special techniques (that are accepted for publication). Please give a complete explanation of your idea. If a sketch is needed, send it along; we'll draw a new one.

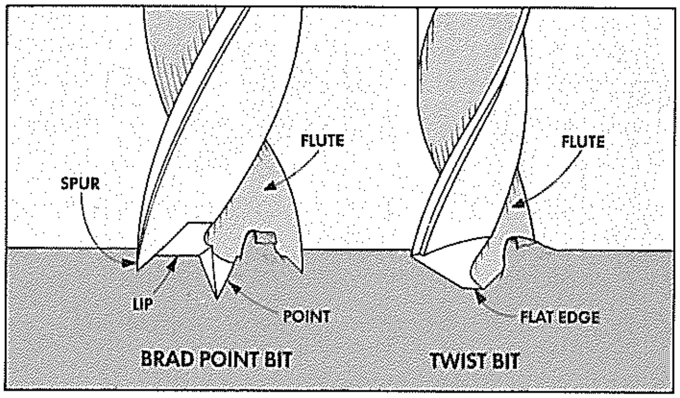
Brad Point Bits

GETTING RIGHT TO THE POINT

What could be more basic than boring wood? Just grab the right size bit, chuck it in the drill, and bore the hole. Unfortunately, I've found the more basic the procedure the more likely Murphy's Law will apply.

Sometimes the tip of the bit spins off the mark and wanders just enough so the hole starts in the wrong place. Or the tip follows the path of least resistance through irregular grain and causes the bit to actually bend as the hole is being bored. Or, the flutes clog with sawdust, and the bit starts to squeal and smoke and turns blue.

These problems are usually the result of using the wrong *type* of bit — twist bits — to bore holes in wood. Twist bits are relatively inexpensive and available everywhere, but they're not very good woodworking tools. They're designed for drilling holes in metal. When a hole has to be bored in wood (that is, boring an accurately located hole with clean edges), you need a bit with a center point — a brad point bit.



THE WOOD BORING BIT

Brad point bits are direct descendants of hand-driven auger bits. Since auger bits have been in use for centuries, they've had time to evolve to do their job well. That job is *cutting* round holes in wood.

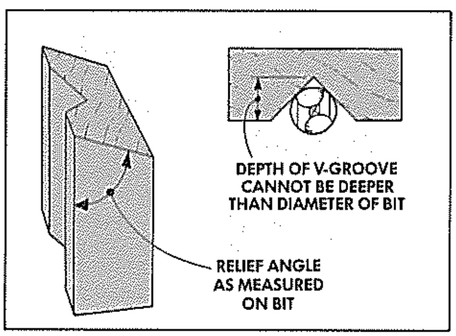
Brad point bits are designed as a machine-driven version of auger bits — and differ significantly from twist bits. There are four basic design features that make the working end of brad point bits work well in wood (while twist bits don't), refer to the illustration at the left.

THE POINT. First, the *point* on a brad point bit is sharp and tapered. This point positions the bit at the exact center of the hole location and guides the bit as the hole is bored. A twist bit, on the other hand, doesn't have a point. In fact, there's a flat edge between the two cutting surfaces, so the twist bit tends to drift away from the center as soon as it starts rotating.

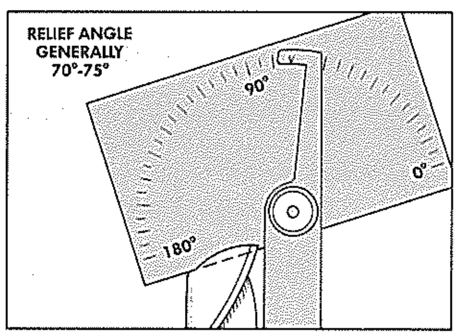
THE SPURS. In addition to the point, most better-quality brad point bits have two sharp *spurs* that shear the wood fibers at the perimeter of the hole, making clean, smooth sides. (Brad point bits with spurs are sometimes called spur bits.)

THE LIPS. As the point enters the wood and the spurs cut and define the perimeter of the hole, the *cutting lips* on the brad point bit act like revolving chisels. They pare away wood shavings within the perimeter scored by the spurs.

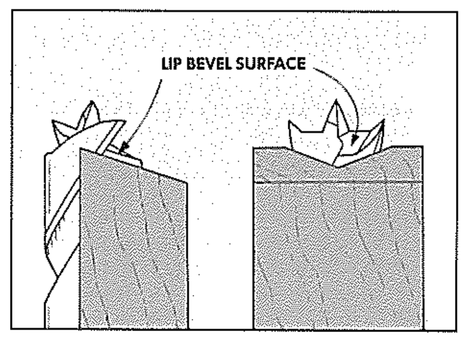
THE FLUTES. Finally, the *flutes* on a brad point bit are steeper and deeper than the



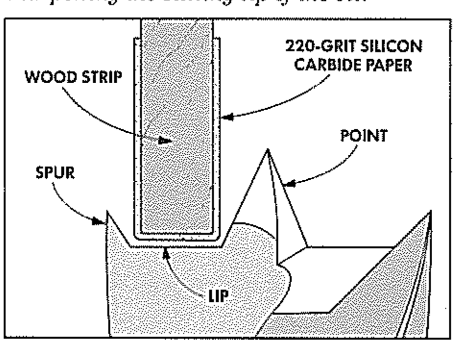
1 *The V-groove cut into the face of the support block grips the bit. The beveled end of the support block provides a guide for sharpening the cutting lip of the bit.*



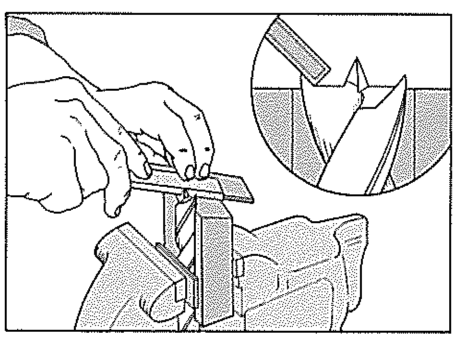
2 *Use a shop protractor to measure the relief angle. This angle is the slope from the edge of the lip to the back of the bevel and is generally between 70° and 75°.*



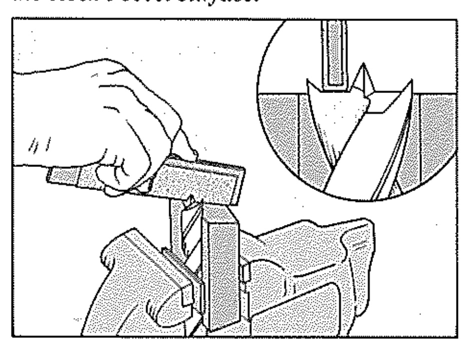
3 *The relief angle should be lined up with the bevel of the support block. The bit's bevel surface should be slightly higher than the block's bevel surface.*



4 *The distance between the base of the spur and the base of the brad point determines the thickness of the sandpaper-wrapped "file" strip used to sharpen the lip.*



5 *To sharpen the spurs, tilt the "file" strip flat against the inside surface of the spur. Use the bevel of the block to maintain correct stroking angle.*



6 *To sharpen the lips, stroke the edge of the "file" strip over the cutting bevel face and follow the bevel on the block. Be careful not to "rock" the file.*

flutes on a twist bit. They're designed to eject wood shavings quickly.

SELECTING A BRAD POINT BIT

Okay, so brad point bits are better than twist bits for boring clean holes in wood. But there are a lot of brad point bits on the market — ranging in price from less than $10 for a set of seven to almost $50 for a set of five. What causes such a dramatic difference in price?

"There are two basic differences between cheap and expensive brad point bits," according to David Draves of Woodcraft Supply. "First is the quality of steel used to make the bit. Second, the higher quality brad point bits have two cutting spurs, while the cheaper ones lack the spurs and rely on a different grinding method to perform a similar (but not quite as good) function.

"While these bargain bits don't cut as cleanly as brad point spur bits, they're still far superior to twist bits for boring holes in wood. I still recommend buying two high-quality spur bits (1/4" and 3/8" diameter) for boring holes for dowels."

OPERATING SPEED

One other question pops up frequently when using almost any kind of bit. How fast should it spin? There's no question that heat build-up is the enemy of all power cutting tools, so the speed of operation is a critical factor. But the speeds recommended in most tables seem excessive.

For example, the recommended speed for a 1/4" bit in wood is 6400 rpm according to the chart on the side of our Sears drill press. Well, that's ridiculously high.

"The speeds we usually recommend are for use in power boring machines," according to Al Brown, Sales Director for Forest City Tool Company. (Forest City Tool manufactures high-quality brad point spur bits for the furniture industry.)

"Boring machines control the feed rate precisely, so the bit is always in *new wood* and doesn't overheat. But the feed rate in a drill press or portable drill is hard to control. So, the correct speed in the home shop is the *slowest* possible. Otherwise the bits will burn."

The best policy is to ignore the charts of recommended speeds shown in most books or on the side of the drill press. They were developed for power-fed boring machines, not "arm-operated" drill presses. Go with the slowest speed on your drill press for the best results.

SHARPENING

Selecting and using brad point bits is only one side of the coin. The next problem is how to sharpen them.

I'll admit the business end of a brad point bit looks complex. But, it turns out to be one of the easiest of all drill bits to sharpen. No special tools are required. I just use 220-grit silicon carbide abrasive paper. And, to secure the bit, I make a simple support block from a scrap of wood.

SUPPORT BLOCK. To make the support block, cut a V-groove down the length of a scrap of wood, see Fig. 1. The depth of the groove isn't critical — it should be deep enough to hold the bit securely when the block and the bit are clamped in a vise.

After the V-groove is cut, bevel the end of the support block to match the relief angle (the angle of the cutting lip on the bit). I measure this angle with a shop protractor, see Fig. 2. Then set the saw to match the relief angle, and cut the end of the block at this angle, see Fig. 1.

MOUNT BIT IN BLOCK. After the block is cut, position the bit in the V-groove so the angle of the cutting lip (the relief angle) lines up with the beveled end of the block, see Fig. 3. I position the bit so the surface of the bevel is just a hair higher than the block (so the abrasive is cutting the bit, not sanding the top of the block).

ABRASIVE FILE. Now to do the sharpening, I make a "file" by wrapping 220-grit silicon carbide abrasive paper around a thin strip of wood. This strip is ripped from a piece of scrap so it's about as thick as the distance between the base of the brad point and the base of the spur, less two thicknesses of the sandpaper, see Fig. 4.

SHARPEN THE SPUR. To begin the sharpening process, I work on the spurs. (For bits without spurs, see box below.)

Align the "file" on the surface of the beveled end of the block. Then tilt the "file" so the side is against the inside face of the spur, see Detail in Fig. 5. Now stroke the inner surface of the spur until it's shiny and flat to produce a sharp cutting edge.

Note: Don't be tempted to sand the outside of the spur. This will change the profile and make the spurs cut a circle smaller than the drill diameter.

SHARPEN THE LIP. After the spur is sharp, the cutting lip can be sharpened. Begin by holding the sanding "file" so its edge is flat on the beveled surface of the cutting lip, see Fig. 6. Then stroke the "file" back and forth, being very careful to avoid rocking. When the entire surface of the bevel is shiny and flat to the edge, the cutting lip should be sharp enough to produce clean shavings.

BARGAIN BRAD POINT BITS

Until recently, the only source for brad point bits has been woodworking stores and mail order catalogs. Now brad point bits are popping up in chain hardware stores and home centers. Many of these bits are downright cheap.

DIFFERENT DESIGN. The basic design difference between bargain bits and the higher quality spur bits is that the bargain bits lack the spurs that score the perimeter of the hole. Instead, the lip on the bit is ground with a compound bevel.

Spur bits are ground so the cutting lip is perpendicular to the axis of the bit, see Fig. A. But on the bargain bits, the cutting lip is ground so it slopes up from the base of the brad point to form a point that takes the place of a spur.

As the bit spins, these points enter the wood to define the perimeter. But the points dull very quickly and cause a torn edge and somewhat rough hole walls.

Fortunately, a bargain bit is even easier to sharpen than a brad point spur bit. The difference is preparing the support block.

SUPPORT BLOCK. As before, begin by cutting a V-groove on one face of the support block. Next, use a protractor to measure the relief angle of the cutting lip (as shown in Fig. 2 on previous page). Then measure the secondary angle — the one from the base of the brad point to the tip of the cutting lip, see Fig. B, below.

Now to cut the support block, tilt the table saw blade angle to match the relief angle, and set the miter gauge to match the secondary angle of the cutting lip. Then, make a compound bevel cut on the end of the support block.

After cutting the compound bevel, place the bit in the support block so the two angles on the bit align with the two angles on the block. Then clamp the bit and block in the vise. Now wrap 220-grit silicon carbide abrasive paper around a strip of wood to make a "file" and stroke the flat side of the "file" back and forth until the surface of the compound angle is flat.

FIGURE A

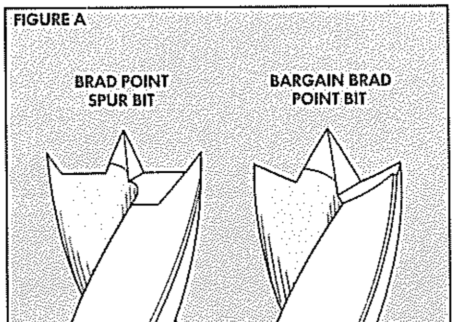
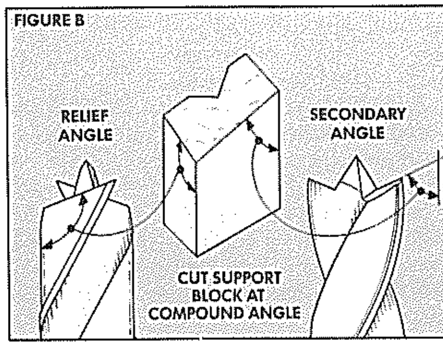


FIGURE B



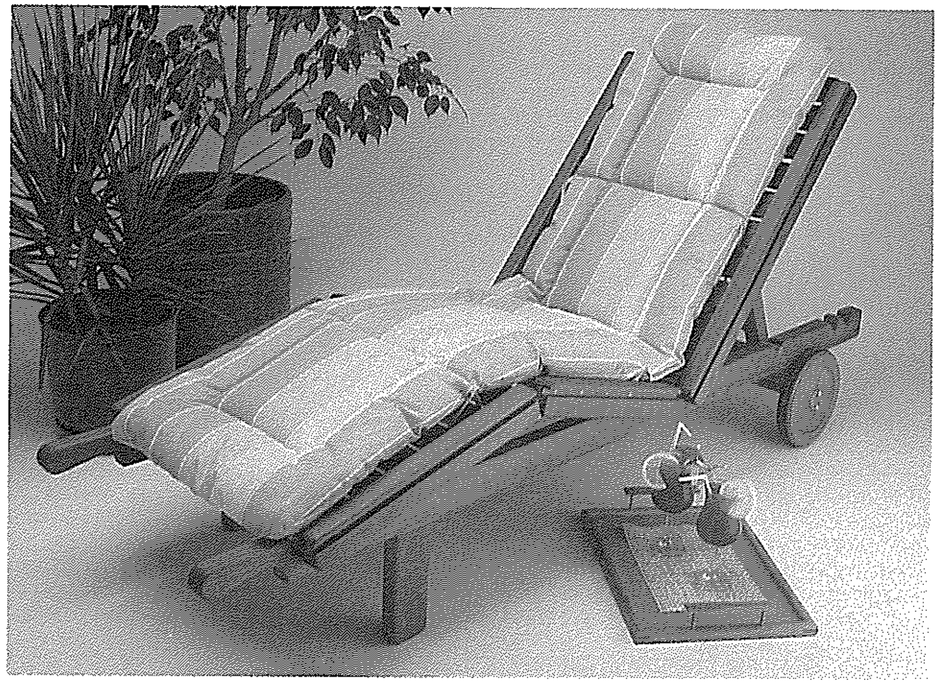
Chaise Longue

CHAISE THOSE DOG DAYS AWAY

There are two challenges in building this chaise longue. First is pronouncing the name. I discovered that I've been mispronouncing it for years. It's actually pronounced "shaze long" — literally, a long chair.

After mastering French, the second challenge was to design the chaise to accommodate the human body — to provide some comfort. That meant having a platform that could be adjusted from a flat position to raising the back rest a little for sunning, or a lot for reading, and raising the leg rest to a comfortable angle.

To get all this to work, this chaise consists of two assemblies — a lounging platform (with a back rest, seat, and leg rest), and a support frame, see Fig. 1. I started by building the support frame.



SUPPORT FRAME

The support frame consists of two side rails (A) connected by two stretchers (B), refer to Fig. 8. This frame rests on four legs that are half-lapped into the side rails and joined with a third stretcher. All frame parts are made from "2 by" redwood lumber (see page 23 for the dimension standards of redwood).

SIDE RAILS. To start construction, I laid out the dadoes for the stretchers and legs. Since the two rails are mirror images of each other, I found it easier to cut all the dadoes on a single 2x8 78" long. (Before starting, I ripped just a hair off each edge to make sure it would be straight and square. Then later I ripped this 2x8 piece to form the two side rails.)

CUT DADOES. To minimize the chance of making mistakes, I measured from the "head" end of the 2x8, see Fig. 2.

When marking the width of the dadoes, the two for the legs are 3" wide, but the two for the stretchers are cut to equal the actual thickness of the stock for the stretchers. After marking their positions, cut all four dadoes ¾" deep.

LOCATE HOLES. Next, a series of ¾"-dia. holes is drilled for the pivot dowels and support notches. (Holes "d" and "e" shown in Fig. 3 are for pivot dowels for the back rest and seat, refer to Fig. 1. Holes "a, b, c" and "f, g" are formed into notches to support the back and leg rests.)

Again, work from the "head" end of the board to locate the position of these holes along the board according to the measurements given in Fig. 3.

Next, mark the center of the holes ¾" from each edge — except hole "f" which is located 1⅛" from the edge, see Fig 5. When all the holes are located, bore them with a ¾" bit.

CUT NOTCHES. Now the notches can be formed. I used a sabre saw to cut out V-shaped notches at holes "a, b, and c", see Fig. 4. I also cut the double notch at holes "f and g" as shown in Fig. 5.

RIP RAILS. After the notches are cut, the rails can be ripped to their final width of 3" as shown in Fig. 3.

CUT OUT HANDLES. To complete the rails, mark the shape of the handles by drawing two circles as shown in Fig. 6. Then cut off the waste with a sabre saw.

MAKE LEGS

When the frame rails are complete, the legs can be made. I ripped four legs to a width of 3" from 2x4 stock. (Since the 2x4s have rounded edges, rip a little from each side so both edges are nice and square.)

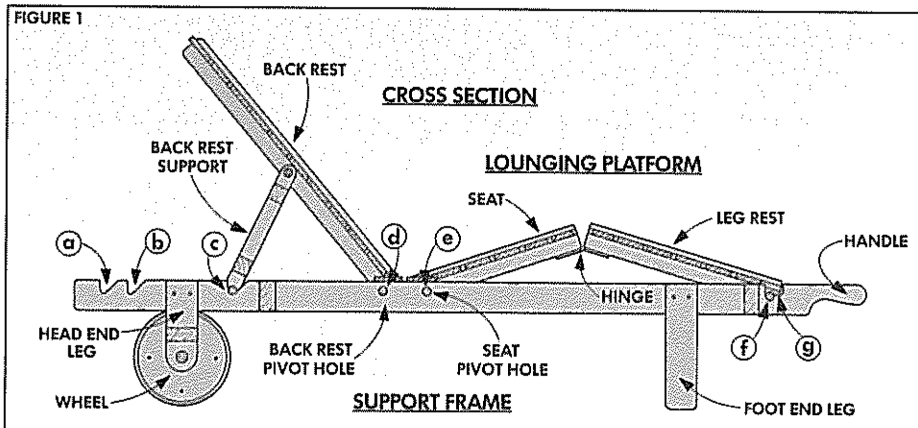
Now cut the legs (C) that go at the "foot" end 11" long, and the legs (D) at the "head" end 8¼" long, see Fig. 7. (These legs are shorter to accommodate the wheels.)

MAKE HALF-LAPS. The legs are joined to the rails with half-laps. To make sure the surface of the joints is flush, cut the half-laps on the legs so the thickness matches the depth of the dadoes already cut in the rails, see Detail B in Fig. 8.

After the half-laps are cut on all four legs, a ¼"-deep dado is cut in the "head end" legs (D) for a cross stretcher (E).

To complete the "head end" legs (D), mark the location of the axle hole 1½" up from the bottom of the leg, see Fig. 7. Before drilling the hole, draw a semi-circle

FIGURE 1



with a 1½" radius on the bottom of these legs. Then bore the axle hole, and round the ends of the legs. Also, round the bottom corners of the "foot end" legs (C) to a ½" radius, see Fig. 7.

MAKE THE STRETCHERS. The only thing left to do on the support frame is to make the stretchers that hold the frame together. Rip 2x4 stock 3" wide. Then cut the two frame stretchers (B) 18⅞" long, and cut the leg stretcher (E) 17⅞" long.

FINAL ASSEMBLY

After all the parts are cut to size, the frame can be assembled. I used epoxy and brass screws to assemble it.

ATTACH LEGS. Start by attaching the legs to the rails with glue and No. 8 x 1¼" Fh screws, countersinking the heads, see Detail B in Fig. 8.

ATTACH STRETCHERS. Before attaching the three stretchers, round over all edges of the rails and legs with a ¼" round-over bit. Then drill counterbore holes for the stretchers, glue and screw them in place, and plug the holes, see Detail A in Fig. 8.

FIGURE 2

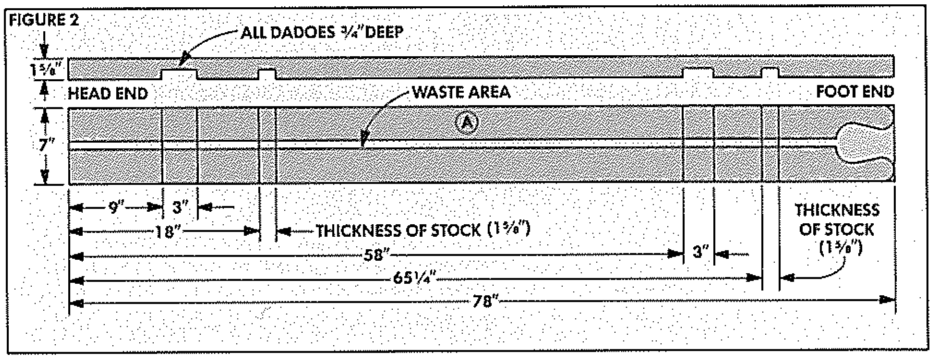


FIGURE 3

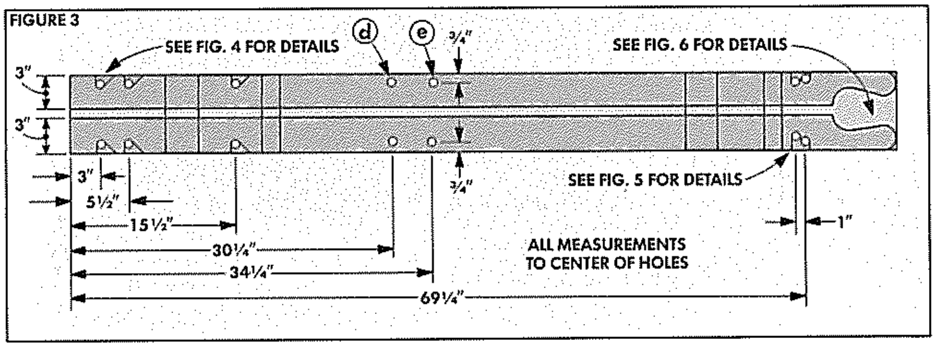


FIGURE 4

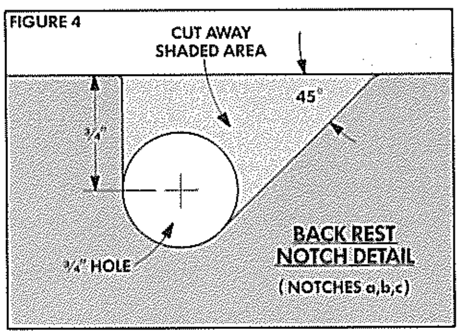


FIGURE 5

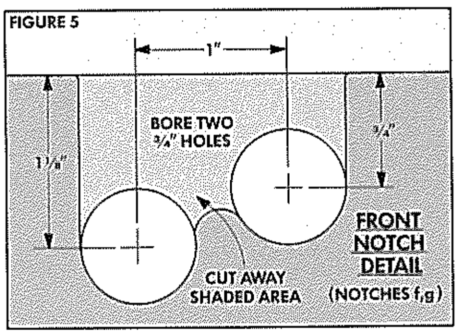


FIGURE 6

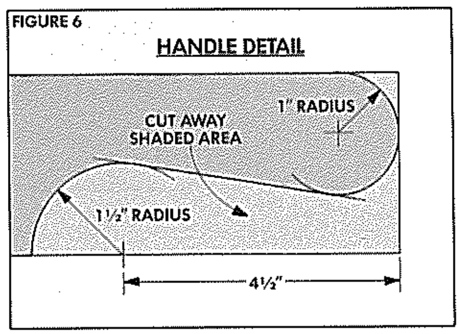


FIGURE 7

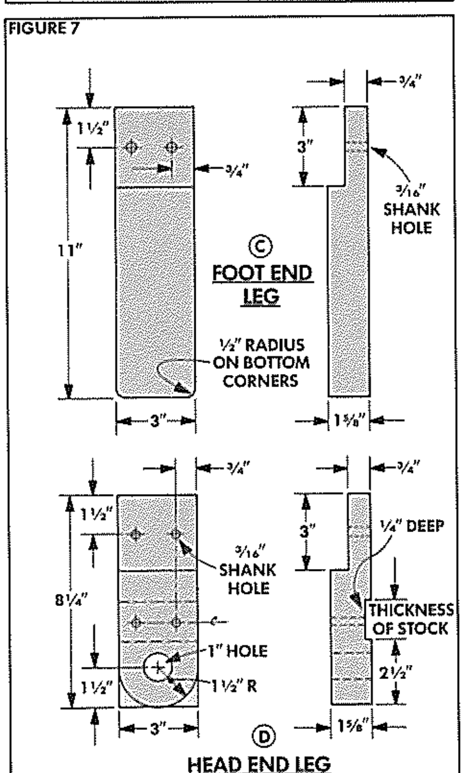


FIGURE 8

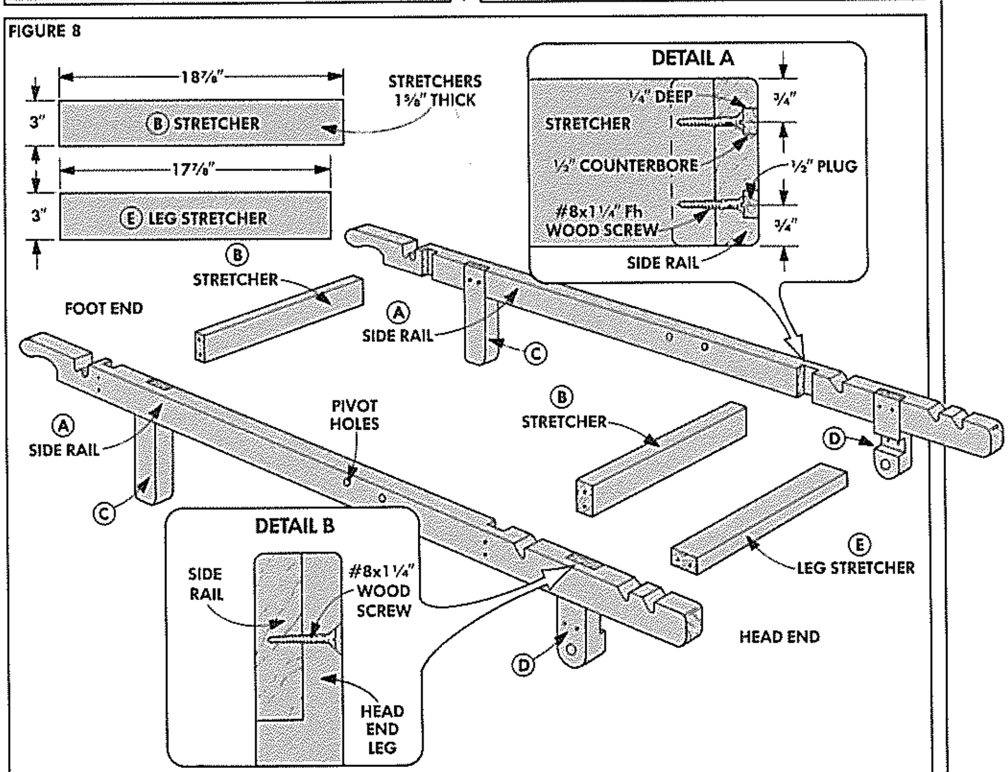


FIGURE 9

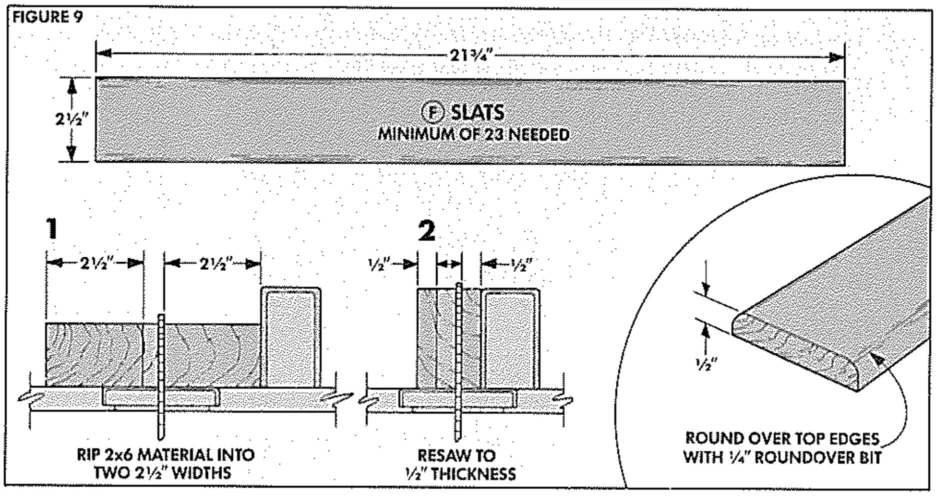


FIGURE 10

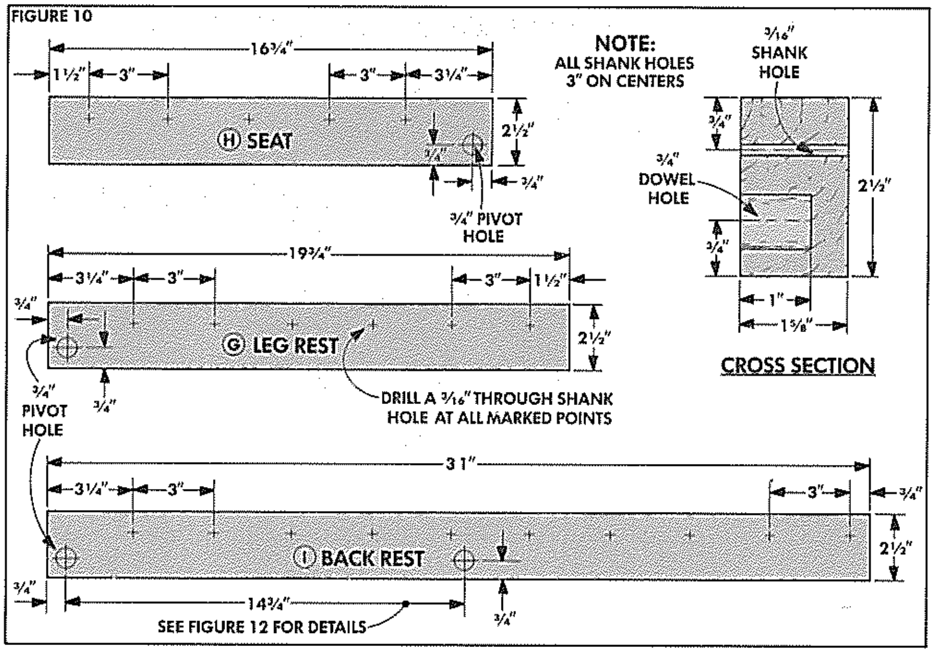


FIGURE 11

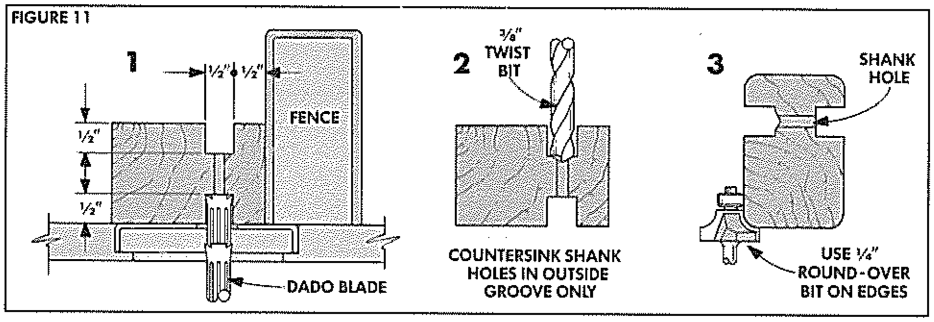
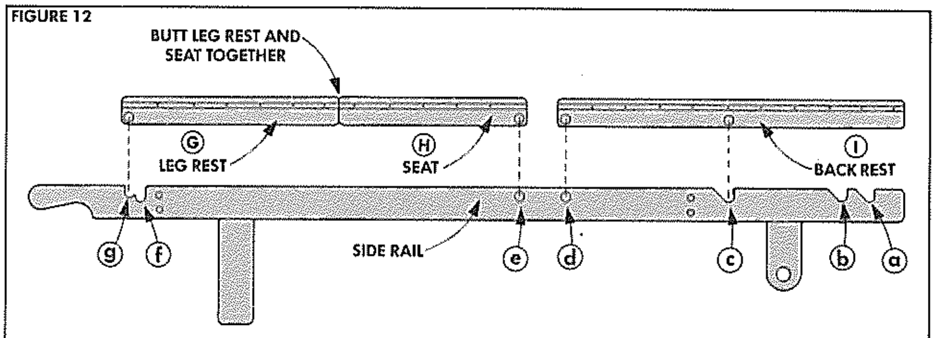


FIGURE 12



THE LOUNGING PLATFORM

After the support frame is complete, the three-part lounging platform can be assembled. There are actually three frames — the back rest, the seat, and the leg rest.

There's not much to these frames — each is just a series of ½"-thick slats held together with two outside rails, refer to Fig. 14.

SLATS. To make the ½"-thick slats, I resawed 2x6 material down to size. First, rip the 2x6 into two pieces 2½" wide, see Step 1 in Fig. 9. Then turn these pieces on edge to resaw them to a thickness of ½", see Step 2. (You need 23 slats in all, but I made a few extra just in case.)

Now cut the slats to a length of 21¾". (This should equal the outside width of the assembled support frame, plus 1⅛" for the ½" grooves in the frame rails and ⅛" clearance.) And finally, round over the top edges on all slats with a ¼" round-over bit.

THE RAILS

The slats are joined to three sets of rails (G,H,I) to form the leg rest, seat, and back rest. To make these rails, begin by ripping 2x6 stock to a width of 2½", see Cross Section in Fig. 10. Then cut the six rails to final length as shown in Fig. 10.

PRE-DRILL HOLES. Next, I pre-drilled the shank holes for the screws used to mount the slats to the rails. On each rail, start by marking the first hole 3¼" from one end of the rail and centered ¾" down from the top edge.

Then mark off holes every 3" along the rail, see Fig. 10. After the positions of the holes are marked, drill ³⁄₁₆" shank holes all the way through at each point.

GROOVES. Next, I cut ½"-wide grooves on both sides of the rails. (The inside groove is used to hold the slats in place, and the outside groove is a way to recess all the screw heads.)

Cut these ½"-wide grooves ½" deep on both sides of the rails so they're centered over the shank holes, see Step 1 in Fig. 11. Then use a ⅜" twist bit to countersink the holes in the outside groove, see Step 2.

PIVOT HOLES. These rails also have ¾"-dia. holes for the dowels that fit in the pivot holes and notches in the support frame, refer to Fig. 12. The trick to getting the precise location of these holes is to partially assemble the platforms and use the holes in the side rails as a guide.

Begin by drilling a ¾"-dia. hole 1" deep on the inside face at the end of the rails of the seat (H) and the back rest (I), see Fig. 10. (These holes are the ones that correspond with pivot holes "d" and "e" on the support rails, refer to Fig. 12.)

Then in order to locate the other two holes (that correspond with holes "c" and "g"), you have to partially assemble the platforms. Insert two slats between the ends of each pair of rails and put ¾" dowels in the two holes already drilled.

Now place the platforms over the side rails with the dowels in holes "d" and "e". Butt the ends of the leg rest and seat together and mark the location of the hole that corresponds with notch "g". Then mark the hole in the back rest that corresponds with notch "c".

When these holes are marked, drill ¾"-dia. holes 1" deep at each location.

ROUND EDGES. Then round the ends at a ½" radius, see Step 2 in Fig. 13. And round all the edges with a ¼" round-over bit, see Step 3 in Fig. 11 and Fig. 13.

ASSEMBLY

Assembly is a little tricky because you want to get the spacing of the slats even, and there are also some special spacing requirements for the outside slats at both ends of all three platforms, see Fig. 14.

LEG REST. I started assembly with the leg rest. Place six slats between the rails and loosely clamp the rails against the ends of the slats. Now tap the two outside slats into final position.

At the end with the dowel hole (which is the "foot" end of the leg rest), space the slat 2" from the end. Then at the other end space the slat ¼" from the end. Now it's just a matter of jogging the four interior slats to get them evenly spaced — about ½" apart.

SEAT. The same basic procedure is followed on the seat. Loosely clamp five slats between the rails. Then adjust the one at the "foot" end (the end that butts up against the leg rest) so it's ¼" from the end of the rails. And adjust the slat at the other end (the end with the dowel hole) so it's 2" from the end.

BACK REST. The back rest uses 10 slats. The slat at the end of the rail with the pivot dowel hole (the end that goes against the seat) is spaced 2" from the end.

At the other end (the "head" end of the chaise), the slat is not inset as on all the others. Instead, I positioned it so it projects ½" from the ends of the rails and rounded the exposed corners, see Fig. 14.

PILOT HOLES. When the slats in each assembly are clamped to final position, use a ⁵⁄₃₂" bit to drill pilot holes for the screws. Try to center the bits in the shank holes and drill ⅞"-deep pilot holes, see Step 2 in Fig. 15. Then screw No. 8 x 1½" Fh brass screws in each hole.

JOIN REST AND SEAT. When the leg rest and seat are assembled, they are hinged together with a 3" strap hinge, see Fig. 16. (On a 3" strap hinge each leaf is 3" long — for a total of 6" when open.)

I mounted this hinge "upside down" on the bottom edges of the rails — so the knuckle is set into the crack, see Cross Section in Fig. 16. This puts the countersinks on the wrong side, so I used panhead screws to mount the hinges.

FIGURE 13

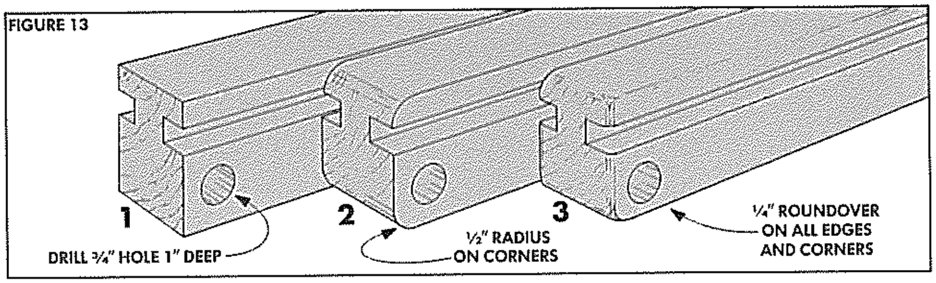


FIGURE 14

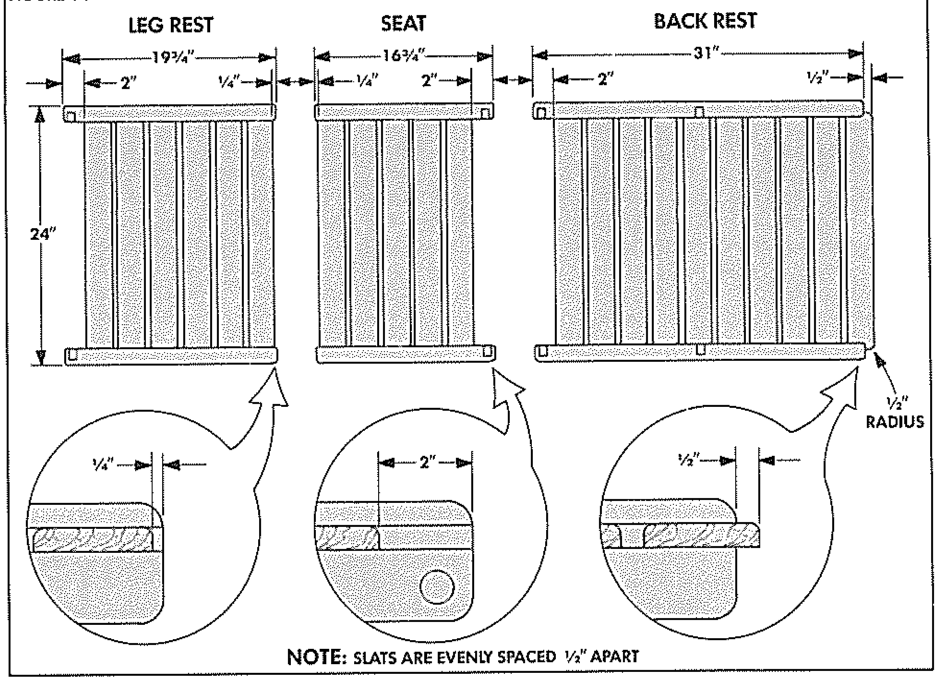


FIGURE 15

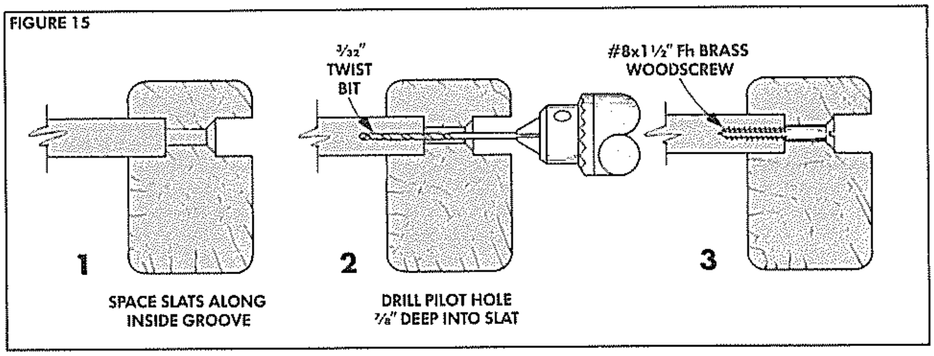


FIGURE 16

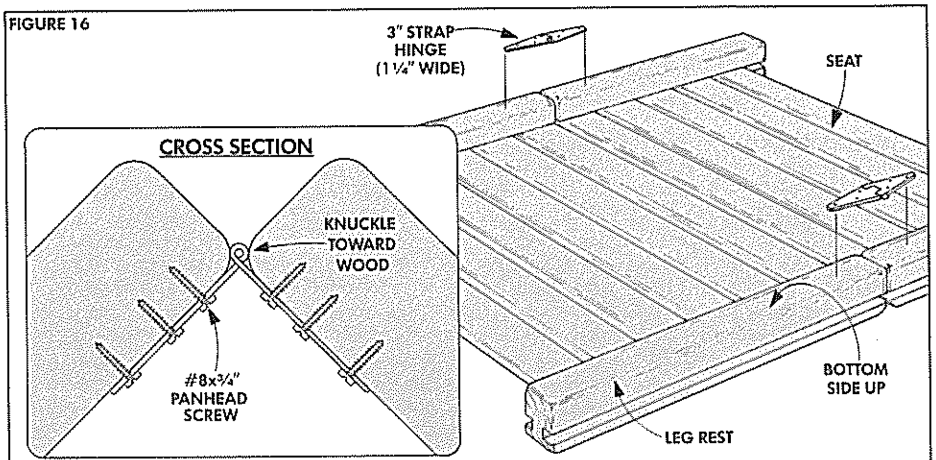


FIGURE 17

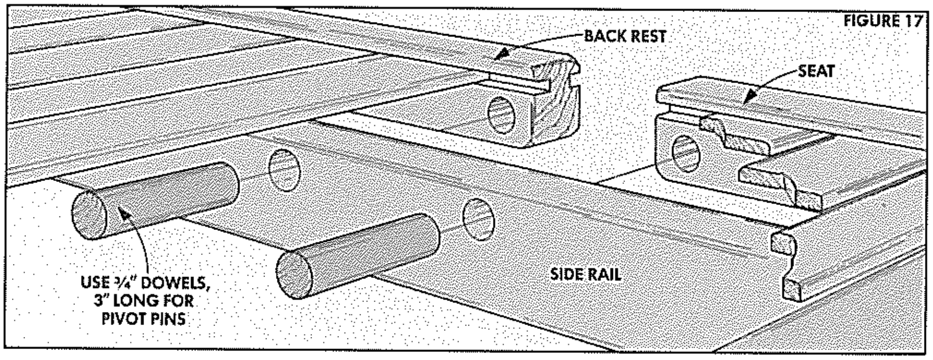


FIGURE 18

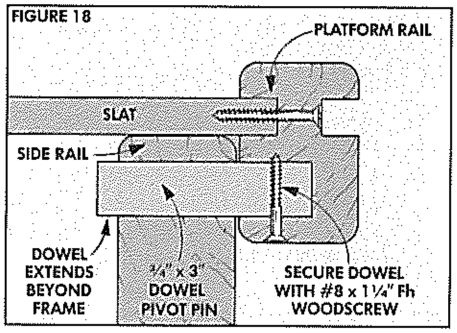


FIGURE 19

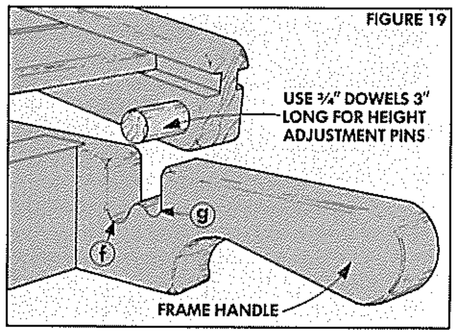


FIGURE 20

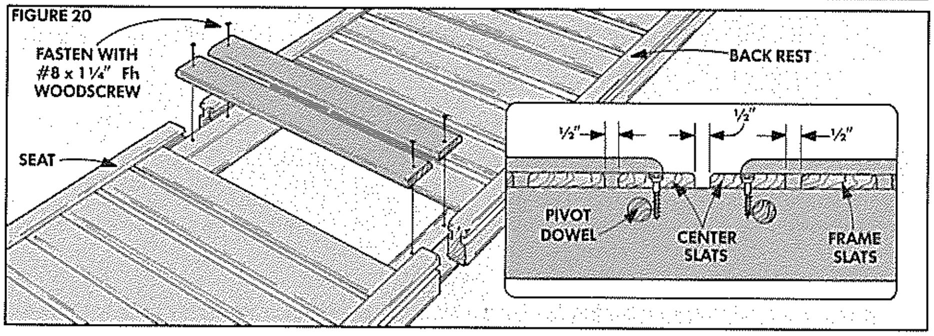


FIGURE 21

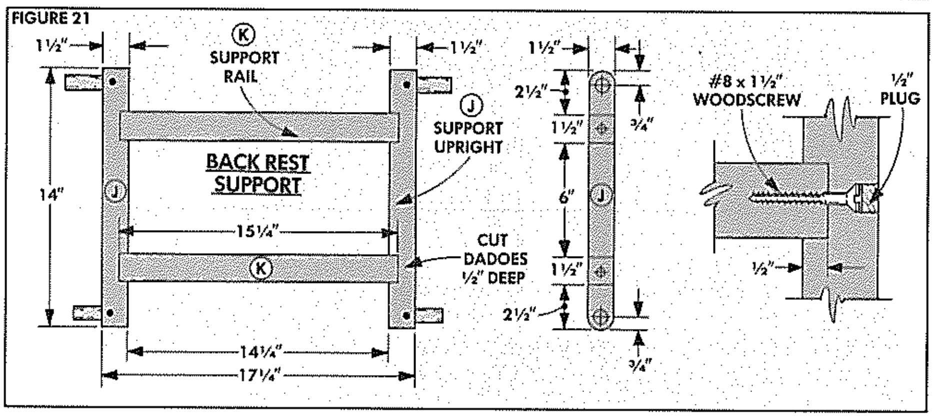


FIGURE 22

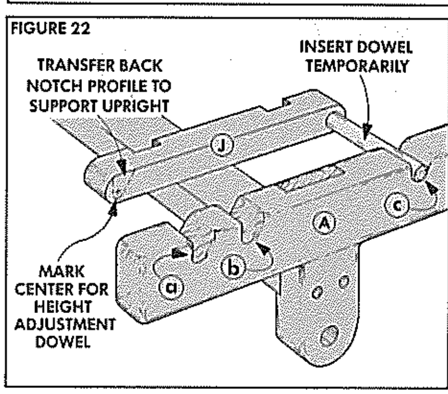
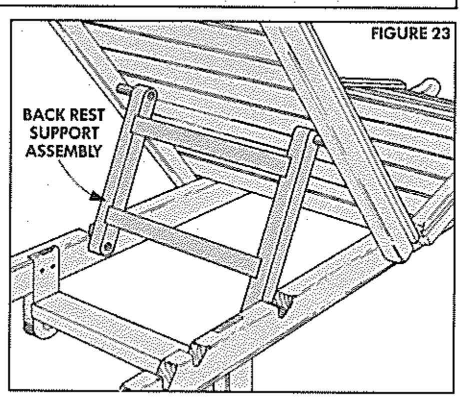


FIGURE 23



ASSEMBLE THE CHAISE

After the platforms were assembled, I mounted them to the frame. The first step here is installing the pivot pins for the back rest and seat.

PIVOT PINS. The pivot pins are ¾"-dia. dowels, 3" long that pass through the side rails and into the stopped holes in the platform rails, see Fig. 17.

After inserting these pins, I secured them (to prevent them from twisting out) with No. 8 x 1¼" screws, see Fig. 18.

ADJUSTMENT PINS. Next, I installed the adjustment pins that fit into the two-position notches (f, g) to control the angle of the leg rest, see Fig. 19.

FRAME SLATS. When these pins were in place, I installed the two remaining slats. These two slats are fastened directly to the side rails between the seat rest and back rest, see Fig. 20.

Begin by trimming the slats to length to equal the distance between the outside edges of the side rails. Next, drill and countersink $\frac{3}{16}$" shank holes centered ¾" from the ends of the slats.

Shop Note: When mounting these slats, there should be ½" space between them and the slats in the seat and leg rest, see Detail in Fig. 20. Just "eyeball" the spaces to make sure they're approximately equal. Then screw the slats in place.

BACK REST SUPPORT

After the seat and leg platforms were mounted, I made the assembly that supports the back rest. This assembly is a simple frame that also pivots on ¾"-dia. dowels.

CUT STOCK TO SIZE. Begin by ripping "2 by" stock to 1½" square. Then, cut the two support uprights (J) to a length of 14", see Fig. 21.

CUT DADOES. These two uprights are joined with two rails (K) that fit into ½"-deep dadoes cut on the insides of the uprights. Locate these dadoes 2½" from both ends of the uprights, see Fig. 21.

DOWEL HOLES. To complete the uprights, drill ¾"-dia. holes at both ends. To locate these holes, first drill holes ¾" from the top ends, see Fig. 21.

Then to get the location of the bottom holes, insert a dowel in the top hole and place the upright alongside the side rails (A), see Fig. 22. With the dowel in notch "c", mark the position of the other hole in line with notch "a".

RAILS. When the uprights are complete, cut the rails (K) to final length so the support frame fits between the main side rails (A) of the chaise, see Fig. 23. Then glue and screw the frame together.

INSTALL DOWELS. The support frame is mounted to the chaise with two pairs of pivot dowels. The upper pair of dowels lets the assembly pivot on the back rest rails, see Fig. 23. The lower pair of dowels fits into the height adjustment notches. I installed the dowels in the lower holes first.

Press the ¾"-dia. by 3"-long dowels into the holes in the support frame until the ends are flush with the inside of the frame. Then secure them with No. 8 x 1¼" screws. Next, insert the 4½"-long top pivot dowels through the holes in the upper part of the support assembly and into the holes in the back rest rails. Also, secure these dowels with screws from the bottom.

INSTALL THE WHEELS

At this point the chaise is virtually complete. All that's left is installing the wheels. Wheels can be purchased to fit this chaise at most hardware stores, but I decided to make my own, see page 12.

Once the wheels were made, they're mounted to the chaise with an axle assembly. This assembly consists of a 1" dowel for an axle and a tapered pin to hold the wheel in place. But, to keep the wheel from rubbing on the rear legs, I made spacer washers from ⅛" tempered Masonite.

SPACER WASHERS. To make the washers, first tack the Masonite to a plywood scrap. Then drill the axle holes with a 1" Forstner bit, see Fig. 25.

Note: To make finding the center of the hole easier in the next step, bore into the plywood just enough so the center point of the Forstner bit leaves an impression.

Now, to cut the washers to size, I used a 2" hole saw, see Fig. 26. (The mark left by the center point helped me center the bit of the hole saw.)

AXLE PINS. Mount the washers and wheels to the axle and hold them on with axle pins made out of ¼" dowels, see Fig. 27. (Taper the axle pins so they can be tapped securely into place.)

FINISH. Finally, to get a smooth, satin finish that adds protection for outdoor use, I applied my own mixture of tung oil and spar varnish (described on page 15.)

FIGURE 24

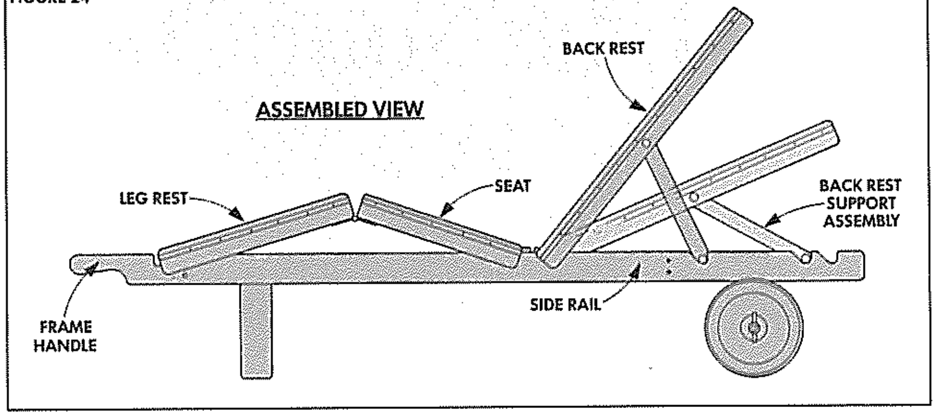


FIGURE 25

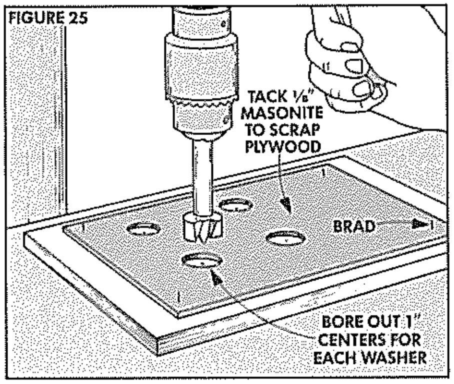


FIGURE 26

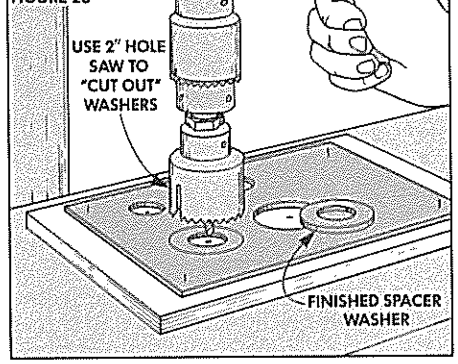


FIGURE 27

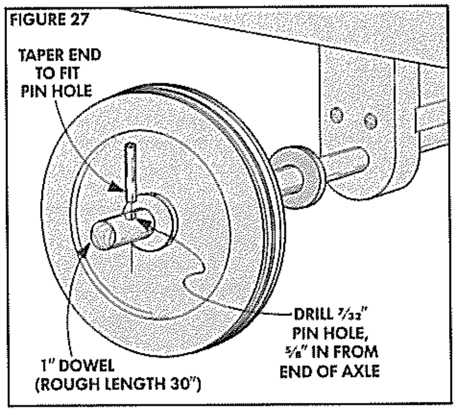
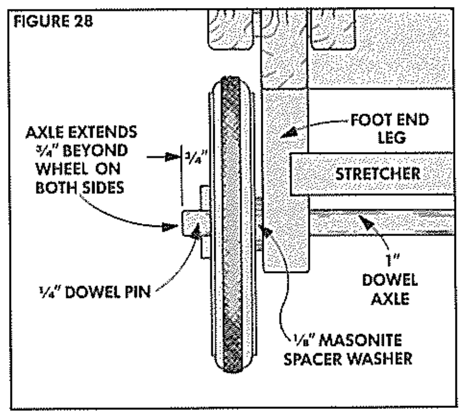


FIGURE 28

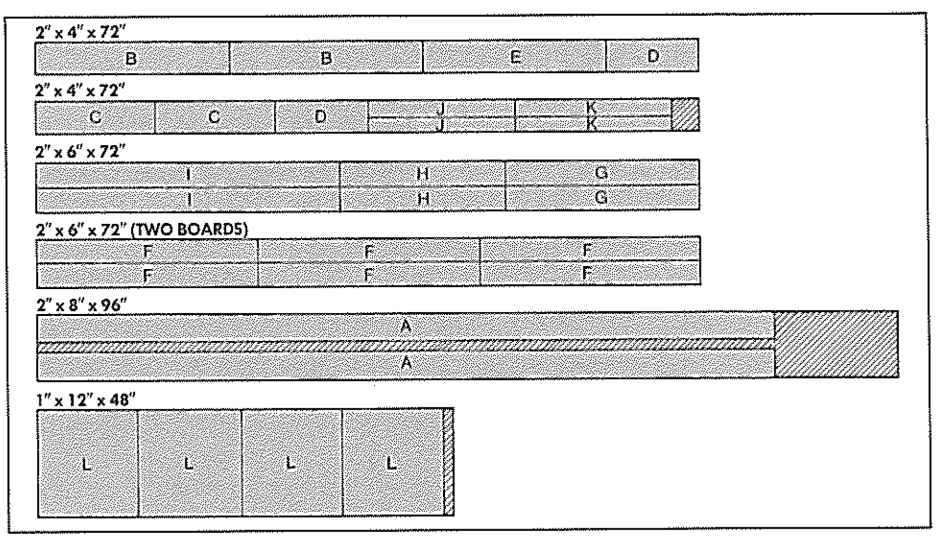


MATERIALS LIST

Overall Dimensions: 12" h x 24" w x 78" l

A Side Rails (2)	1⅝ x 3 - 78
B Stretchers (2)	1⅝ x 3 - 18⅞
C Foot End Legs (2)	1⅝ x 3 - 11
D Head End Legs (2)	1⅝ x 3 - 8¼
E Leg Stretcher (1)	1⅝ x 3 - 17⅞
F Slats (23)	½ x 2½ - 21¾
G Leg Rest Rails (2)	1⅝ x 2½ - 19¾
H Seat Rails (2)	1⅝ x 2½ - 16¾
I Back Rest Rails (2)	1⅝ x 2½ - 31
J Back Support Upright	1½ x 1½ - 14
K Back Support Rail	1½ x 1½ - 15¼
L Wheel Sides	¾ x 11 - 11
ALSO REQUIRED:	
V-BELTS (2)	30" x ⅝"
¾" DOWEL	48" NEEDED
1" DOWEL	30"
¼" DOWEL	6"

CUTTING DIAGRAM

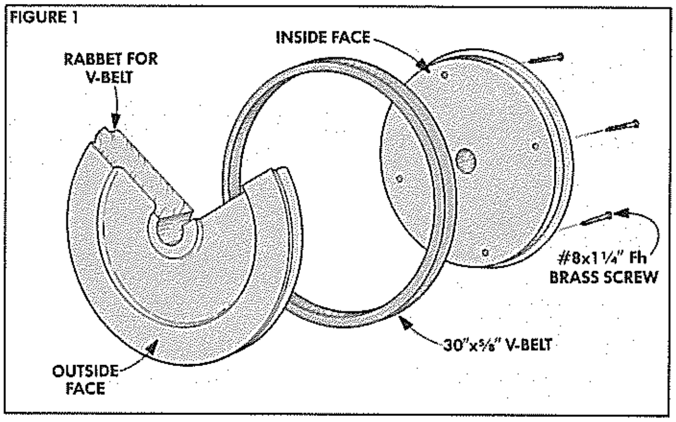


Make Your Own Wheel

Although you can buy metal or plastic (lawnmower) wheels at most hardware stores that will work on the chaise, they're usually pretty small. Besides, I wanted to make mine out of redwood.

The wheel itself consists of two disks with rabbets on the inner perimeters, see Fig. 1. When the two disks are screwed together, the facing rabbets form a groove to hold a V-belt "tire."

I used a Sears router with a trammel point attachment (9 HT 25179 — called a "multi-purpose router guide" in the 1985/86 Power and Hand Tools Specialog) to rout the rabbet for the tire and the decorative profiles on the outside face of the wheel.



MAKE JIGS

To hold the square workpieces securely while routing the rabbets and profiles, make four holding jigs — one for each of the four disks. (Four jigs are needed so duplicate cuts can be made without changing the router setting.) Each holding jig is a scrap of 3/4" plywood fastened to a 2x4 so it can be held in a vise, see Fig. 2.

PREPARE WORKPIECES. The workpieces start out as 11" squares of "1 by" redwood. Each square has a 9/64" hole through the center for the trammel point.

CENTER PIN. To position the square on the jig, drive a 6d finish nail into the center of the jig, and cut it off 1/8" high. Now place the trammel point hole (in the square workpiece) over this pin, see Fig. 5.

HOLDING BRADS. To keep the square from moving, I drove four 1" brads through the bottom of the jig so they projected about 1/4" into the workpiece.

ROUTING

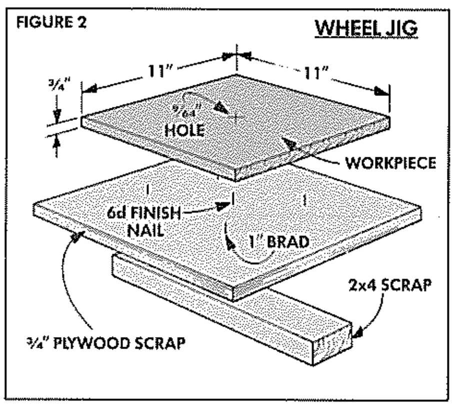
Now the squares can be routed into disks. I used the trammel attachment and a 1/4" straight bit to rout these circles, see Fig. 3. Set the trammel attachment to rout a 9½" circle (4¾" radius) on each disk and rout successively deeper grooves in a counterclockwise direction until the circle (wheel) is complete.

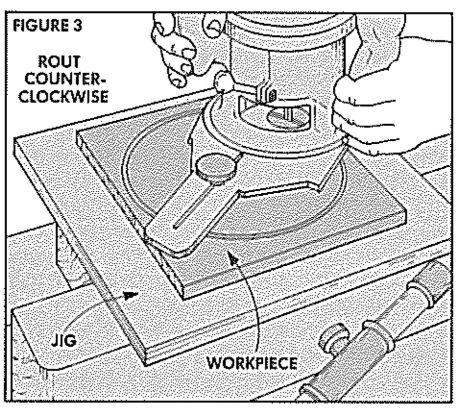
WHEEL RABBET. Next, switch to a ½" straight bit to cut a 5/16"-deep rabbet around the perimeter of each disk, see Fig. 4. Begin by cutting this rabbet to width so it's a little larger than the inner diameter of the V-belt "tire." Then decrease the diameter until the V-belt fits tightly around the disk in the rabbet.

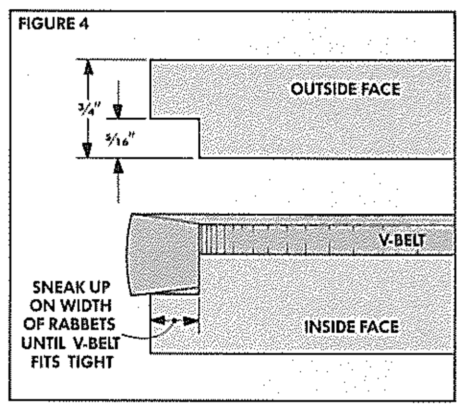
EDGE PROFILE. After the rabbet is cut on all four disks, pry them up, flip them over, and press them back on the brads. Then cut the perimeter contour on all four disks with a 1/4" round-over bit, see Fig. 5.

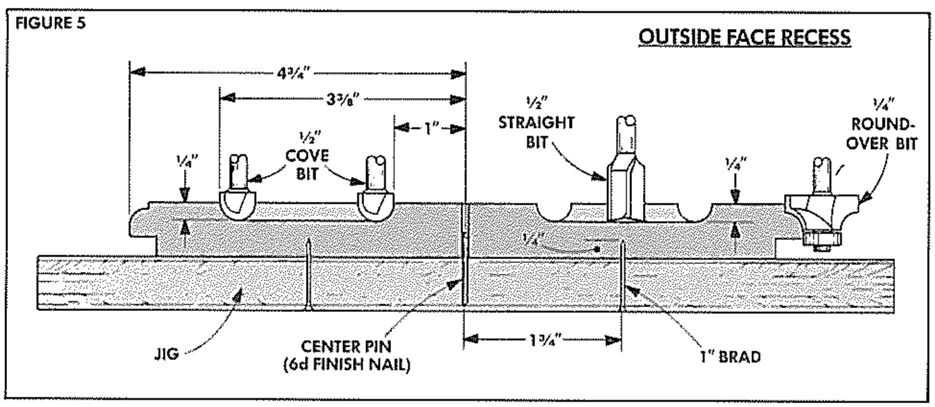
ROUT RECESS. Finally, a recess is routed just a little deeper than 1/4" on only two disks to make the outside face of the wheels. This requires using two bits: a ½" cove bit and a ½" straight bit, see Fig. 5. (Shop Note: When this recess is routed the first holes left by the brad points that held the workpiece are removed.)

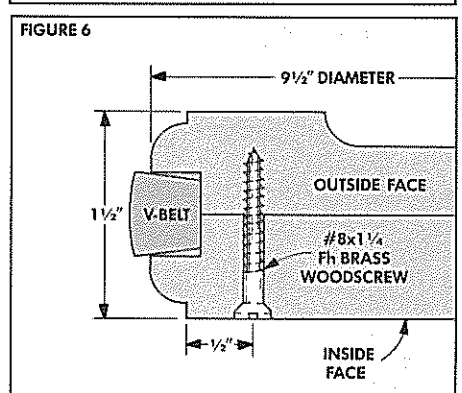
ASSEMBLY. To assemble the wheels, put the V-belt over the rabbet on an inside disk, see Fig. 6. Then, make sure the grain in the facing disks is at right angles and fasten the disks together with glue and No. 8 x 1¼" screws. Finally, drill a 1"-dia. hole for the axle.











Outdoor Woods

THE BEST WOODS FOR OUTDOOR PROJECTS

Redwood is usually the first choice for outdoor furniture since it's got everything going for it: natural resistance to decay, dimensional stability, and beauty. But it's not alone in these characteristics.

DECAY RESISTANCE

The U.S. Forest Product Laboratory's "Wood Handbook" lists twenty-one domestic woods and twenty-three imported woods as "resistant or very resistant to heartwood decay." The list includes cedar, black cherry, black locust, white oak, redwood, black walnut, genuine mahogany, and teak.

What's important here is that the woods on the list are resistant to *heartwood* decay. Heartwood is the central core of a tree — the part that doesn't contain living cells. And the heartwood is the most decay resistant since it's the only part that contains extractives.

EXTRACTIVES. So what's an extractive? They're substances that make up 5 to 30% of the wood, but are not a part of the wood's cellular structure. They might include tannic acids, oils, fats, gums, starches, and phenolics. Extractives add to the strength, odor, color, and insect and decay resistance of wood. Some woods contain high amounts of more toxic extractives in their heartwood and are naturally resistant to decay. The toxic extractives block the cell cavities and slow down the passage of air and water needed for fungi to grow. They also kill off wood-deteriorating organisms. And without the fungi or these organisms, there's no decay.

COLOR AND OIL. Extractives usually, though not always, make the heartwood darker in color than the sapwood (the outer part of the tree) and give the distinct, desirable color to walnut, cherry, redwood, and mahogany.

Some of the extractives — such as the oils in cedar, teak, and rosewood — don't add any color, but serve to repel water. Yet at the same time these oily extractives can lead to gluing problems, see page 14.

REDWOOD

Probably the most common wood associated with outdoor furniture is redwood. Twenty-five years ago redwood was readily available and inexpensive. But since it grows only on the coast of California and large forests have been recently protected by the government, the amount available for cutting has been severely limited. This has made the price increase, especially when you add transportation costs to other parts of the country.

Redwood is soft and easy to work although it tends to splinter. The heartwood is a beautiful red-brown color and the sapwood is a creamy white. But most important, the heartwood is decay resistant and more dimensionally stable than most woods. (Note: See information on redwood standards and grading on page 23.)

CEDAR

Another wood used for outdoor projects is cedar. There are a number of different cedar species. The heartwood of all of them is decay resistant and fairly dimensionally stable. Eastern red cedar is the most aromatic and usually used for cedar chests, closets and posts. Its numerous knots make it difficult to work and undesirable for most furniture (except lining chests).

Incense-cedar and Western red cedar are both often confused with redwood since their heartwood is reddish-brown. But the color of these cedars is a little lighter and they have a distinctive odor.

Both of these cedars are soft and easy to work but fairly weak in strength and shock resistance. Incense-cedar is commonly used for pencils and western red cedar is seen most often as shingles and exterior siding. They're both used for fence posts and poles, more for their decay resistance than their strength.

TEAK

The garden bench in this issue is similar to those made in England of solid teak. Teak is a decay resistant, stable wood that feels a little waxy to the touch and seems to repel moisture.

It's an expensive, straight-grained wood that's generally easy to work. But it contains a high content of silica, a fine sand, that dulls cutting tools. Boatbuilders use it not only for its decay resistance and beautiful yellow-brown color but also because it doesn't rust or corrode metal hardware.

MAHOGANY

Boatbuilders also use the three main groups of mahogany: African mahogany (technically khaya), Philippine mahogany (lauan), and genuine or Central American (Honduran) mahogany. The most decay resistant and the strongest is the genuine mahogany but all three could be used for outdoor furniture.

African and genuine mahogany are close in appearance. Both vary from a pale to a dark reddish-brown and have similar textures. Philippine mahogany (lauan) has a coarser texture and is used for inexpensive doors and interior trim. It's not as dimensionally stable as the other two (but shrinks and swells about like oak).

OAK

What about oak? It was originally used by coopers to make casks, barrels, and tubs. How does it work for outdoor furniture?

That depends on which oak you're using. The large pores of red oak are open (you can even blow through the end grain of a thin sample) so it will soak up preservatives, but it's not naturally very water resistant. The coopers used white oak.

White oak's pores (and to a lesser extent ash, hickory, and black locust) are plugged with ingrowths called tyloses. Under a hand lens or microscope it looks a little like the frothy head on a beer. (Note: One way to tell the difference between white oak and red oak is to look for the plugged cells on the end grain.) It's the tyloses that make white oak more water resistant than red oak.

Then there's the question of shrinking and swelling. The cooper wanted his barrels to swell shut when filled with liquid, and white oak really expands when wet. But swelling and shrinking of outdoor furniture can lead to warping and checking.

PRESSURE-TREATED WOOD

There's one other kind of wood to consider: pressure-treated wood (sometimes called Outdoor Wood or CCA). Pressure treatment involves saturating wood (of a variety of species) with water-borne copper salts under extremely high pressure. Pressure-treated wood is readily available since it's used for construction work.

The main drawback to using pressure-treated wood for outdoor furniture is its color — usually light green. But it can be painted or stained (see article on stains and preservatives in *Woodsmith* No. 27).

CONCLUSION

When it gets right down to it, the final decision of what wood to use for outdoor projects might depend on availability and price. Redwood is probably the best overall choice for the money. But it can be expensive, especially on the east coast. Teak and genuine mahogany make beautiful furniture, but they can be even more expensive and difficult to find, except in boatbuilding areas on the coasts. (See source for these woods listed on page 24.)

One final note: All these woods will eventually turn gray when left outside. I apply a spar varnish finish for protection and to slow down this process, see page 15. But the light gray, silvery sheen that these woods eventually take on is a beautiful addition to an outdoor setting.

Outdoor Glues

STICKING TOGETHER IN THE WORST WEATHER

When it came time to glue up the garden bench and chaise for this issue, I did a little research to try to determine what kind of glue would be best for outdoor conditions. Both of these projects will probably sit out in the rain and sun, but they won't be completely submerged for long periods of time (like a boat). I also wanted to find a glue that could be used with oily woods, such as teak, or a porous wood, such as oak.

POLYVINYL ACETATES

The glues most commonly found in wood shops are water soluble and known chemically as polyvinyl acetates, or PVAs for short. But most of us call them simply white glue and yellow glue.

WHITE GLUE. The first PVA, white glue, was developed in the 1940s as an improved alternative to traditional hide glue. White glue (such as Elmer's) dries quicker than hide glue, but it's still a water-soluble adhesive that has very poor water resistance and creeps under a load. So it's not a good choice for outdoor projects.

YELLOW ALIPHATIC GLUE. In recent years yellow glue (such as Elmer's Carpenter's Wood Glue and Franklin Titebond) has been developed as a modified polyvinyl acetate or aliphatic resin glue. It dries quicker than white glue and manufacturers claim it to be water resistant. (But if you have ever left a dried-up glue brush in a can of water for a couple hours, you know it loosens right up)

Yellow aliphatic glue would be okay if I planned to have the garden bench and chaise indoors or on a covered porch. But I know they will eventually end up on the patio, so I had to consider other glues.

PLASTIC RESIN

Considerably more moisture resistant are plastic resin glues. Technically, these glues are urea-formaldehyde mixtures but they usually go simply by the name plastic resins (such as Weldwood Plastic Resin and Wilhold Plastic Resin). Plastic resin glue is a tan powder that is mixed with water to form a creamy paste.

Glue manufacturers claim joints put together with plastic resin glue will stand up to moisture, but probably not long submersions in cold water or shorter dips in boiling water. (These are the tests to determine if a glue is waterproof.) Hardwood plywood and particle board are often glued together with urea-formaldehydes.

But there are some drawbacks to plastic resins. Since they need room temperature (70°) or higher to cure, they won't bond well in a cold garage in winter. And they give off toxic formaldehyde gas while curing.

Since plastic resin glues are poor gap fillers, they need tight-fitting joints and good clamping. And finally, they don't bond to oily woods very well.

But even with these problems, plastic resin glue might be a good, inexpensive choice for most protected (non-submerged) outdoor applications.

RESORCINOL

When I made the initial prototype back leg for the garden bench, I decided to use a "waterproof" resorcinol glue (such as Weldwood Waterproof Glue, Elmer's Waterproof Glue, or Wilhold Waterproof Glue). It's a two part system — a liquid resin and a powdered hardener.

Since resorcinol is also based on formaldehyde, it releases toxic formaldehyde gas during curing. But that wasn't my first objection to it.

The problem was the color. It's a dark red wine color that brings out every glue line (such as the one in the back leg of the garden bench). I also had a little trouble mixing it. It was very grainy and when it was stirred for 5-10 minutes as recommended on the label, some of the lumps disappeared, but it started to set up. And a final problem with resorcinol is the price. I paid $6.69 for a (4 oz.) can at a local hardware store.

Resorcinol will stand up to most solvents, chemicals, and being submerged in boiling water, but I really don't plan on boiling the bench in the near future. And that dark glue line still bothered me.

EPOXY

That's when I decided to use epoxy. Epoxy is a two-part (resin and hardener) liquid system. It's an incredibly strong, gap-filling glue that's supposed to hold wood (and dissimilar materials such as metal and wood) together under just about any situation (chemicals, submersion in hot water). I thought it would be the perfect solution, and so I used it to glue the garden bench and chaise together.

But one of the problems I had with it was its strength. Cured epoxy won't come off anything very easily after it has completely dried. It sticks to the clamps and any glue squeeze-out is almost impossible to scrape off the wood. The soft redwood I used splintered and stuck to the glue causing large chips in the wood.

Another problem was the price — the smallest quantity that would do the job cost about $9 mail order. (The small tubes of epoxy in the hardware store aren't enough.) Finally, the smell of epoxy isn't pleasant and rubber gloves should be worn for protection. The first time I used it without gloves, and the smell stayed on my hands all day.

SOME OUTSIDE OPINIONS

So, did I make the right decision to use epoxy?

"Epoxy will surely hold but is probably extreme overkill for your bench or chaise," explained D. Homer of Jamestown Distributors. "I think a plastic resin glue would probably be durable enough." Jamestown Distributors is a Rhode Island retail and mail order firm that sells mostly to boatbuilders.

"It's kind of like the difference between a Timex water-resistant watch and a diver's watch," she explained. "You can wear a water-resistant watch while you do the dishes, take a shower, and maybe even for swimming. But if you want to go down 100 feet below the surface you need a diver's watch to resist the pressures.

"Your bench and chaise won't be constantly submerged over a long period of time like a boat. They might get wet and then dry out repeatedly. I think plastic resin is all you need for them."

A caution: Homer also warned that the chemicals in good quality epoxies can be dangerous if not disposed of properly. And the acetone needed to clean it up is even more dangerous.

A SECOND OPINION. "I agree that epoxy probably isn't necessary for your projects as long as you're going to apply a finish and *maintain the finish every year*," said Land Washburn, President of Headland International. Headland is the American importer and distributor for the Canadian-made epoxy (known as G2) that I used on the bench and chaise.

"But there are a couple advantages to epoxy in some situations," Land continued. "In situations where repeated stress will be put on a joint, epoxy will hold from 6000-8000 p.s.i. while aliphatic glue will only hold about 3000 p.s.i. And epoxy can be colored with powdered alcohol-soluble aniline dyes or even small amounts of sanding dust to make a great filler." (See *Woodsmith* No. 40 for information on powdered aniline dyes.)

SQUEEZE OUT. I asked Land about my problem getting off hardened epoxy squeeze-out. He suggested that it should be scraped off while it's slightly soft. (I also found out it cleans up well with lacquer thinner, if you can get it while it's still wet.)

Finally, Land recommended epoxy as the solution for problem woods and special situations. "It's great for oily and porous woods as well as projects that flex such as bows and fishing rods," he said.

OILY WOODS

Some epoxies (such as G2) do the best job of joining oily woods such as teak. I'd always heard that it was a good idea to wipe the surface of any joint made with oily woods with lacquer thinner or rubbing alcohol first to remove any surface oil. Then dry it thoroughly with a dry rag. Once it's completely dry, epoxy can be used to glue up the joint within a couple hours before the oil seeps back to the surface.

Land disagreed. He recommended a different process when using G-2 epoxy. "It's better to work with a freshly cut surface," he explained. "Sometimes you can aggravate the situation with a petroleum product. Gluing *shortly* after planing or sawing is the best method. It doesn't allow the oxidation process to completely take place or airborne contaminants to build up on the surface."

POROUS WOODS

Another use of epoxy is on porous woods such as oak. Oak's open pores tend to absorb glue and create a starved joint. To solve the problem, one epoxy manufacturer (Chem Tech) recommends pre-sealing oak with a thin coat of epoxy and then letting the joint dry open. After it's dry, lightly scuff the mating surfaces and apply another thin even coat of epoxy and clamp it closed.

TESTING

After talking to Land about epoxy, I decided to do some testing of my own. I glued up five sample boards of redwood with Elmer's white glue, Franklin's Titebond (yellow glue), Weldwood Plastic Resin, Weldwood Resorcinol, and G2 Epoxy. (See page 24 for mail order sources for these and other glues.)

Next I cut the samples in half and submerged one half in boiling water for three hours and the other half in cold water overnight. I figured these would be tougher conditions than the garden bench or chaise would ever have to go through.

BOILING WATER TESTS. After about one hour in boiling water I wasn't surprised to see the white and yellow glues give way. But to my surprise the epoxy gave way from the heat in about three hours, while the plastic resin and the resorcinol both held tight. (Later I learned that some epoxies start to soften at 140° F. And they can even start to shrink and break down below -4° F.)

COLD WATER TESTS. After overnight in cold water, the white and yellow glue both gave way under slight pressure, but the plastic resin, resorcinol, and epoxy all held tight.

CONCLUSION

So what would I use if I built another garden bench or chaise? If they were to be built in redwood and the joints were good and tight (so there wouldn't be a need for a gap-filling glue), I'd probably use plastic resin glue (as long as I was working in a warm, well-ventilated area). If I were using oak or teak, I'd use epoxy. And if I planned to use the project only indoors or on a completely covered porch, I'd stick with yellow glue (pun intended).

OUTDOOR FINISH . . . *a recipe from our shop*

How do you finish outdoor furniture to make it durable but still beautiful? It seems like we've been around and around this topic (see *Woodsmith* Nos. 27 and 39), and I'm not sure there's one solution for every situation.

SPAR VARNISH. For the oak swing/glider featured in *Woodsmith* (No. 39) last summer, we recommended spar varnish. It's waterproof, tough, and elastic — just what we wanted for that project. But I didn't think it was quite right for the redwood furniture featured in this issue.

Spar varnish is a fairly high-gloss, built-up finish. That's fine for oak, but for the redwood furniture in this issue I was looking for something more satin and natural. A finish that would soak into the wood like an oil but still offer some protection.

Another problem with a surface finish like spar varnish is brushing it on evenly — without runs or drips. That's especially difficult when finishing a project that has slats with small spaces between them.

A COMBINATION. So on the garden bench and the chaise I mixed my own combination of spar varnish and tung oil to get a finish that is durable but still offers a smooth, satin, penetrating finish. It's a finish that soaks *into* the wood.

To make the finish, I mixed 50% Behlen's Water White Restoration (spar) Varnish and 50% Sutherland Welles Tung Oil Sealer in a mayonnaise jar, see Sources, page 24. (Note: Sutherland Welles Tung Oil Sealer is only about 20% tung oil. The remainder is thinner and driers. If you're using 100% pure tung oil, such as Hopes' Tung Oil, you should probably start by thinning the tung oil about 50% with mineral spirits.)

APPLICATION. Once the spar varnish and tung oil are mixed, liberally brush the mixture on one section of the project and let it soak into the wood. After about ten minutes, sand the wet surface with 320-grit silicon carbide sandpaper to smooth the surface and produce a sawdust slurry that fills the minute pores in the wood. (I wrap the sandpaper around a felt block, and if it starts to dry out dip it into the varnish/tung oil mixture.)

Finally, wipe away any of the excess finish with a clean cloth and then work on another section of the project. After it's allowed to dry overnight, repeat the process again. On the third day, repeat the process, but this time work with a finer (400 or 600-grit) sandpaper.

A SLIGHT SHEEN. After the third coat, a very slight sheen starts to build up. That's just what I'm looking for — it's a sign that there's some surface protection, but not a high gloss. If the surface is still a little rough or the sheen too high, lightly smooth it with 0000 steel wool.

MAINTAINING THE APPEARANCE. One of the advantages of this "slight sheen" finish is that you can tell when it needs renewing, and it's easy to do. If next year the finish is dead flat, it's a sign that the piece could use another coat. Just wipe on the same mixture and sand it as before.

If you want a little more *surface* protection, increase the spar varnish. If it won't soak into the wood, increase the tung oil or add some mineral spirits. The color of the wood may change through the years as it sits out in the weather, but the satin smooth finish will be maintained.

Garden Bench

FOR QUIET THOUGHTS IN A SHADY SPOT

The first time I saw a bench like this was in an English Walking Garden I visited in St. Louis. The bench was nestled under a large shade tree and offered a welcome relief for my weary legs. It also proved to be much more comfortable than I thought it would be at first sight.

It's been a few years since I sat on that bench, but I'm finally getting around to building my version. Although the original I sat on was made of teak, I built the bench shown here out of redwood. (For more on redwood standards, see page 23).

BACK LEGS

I started building the bench by working on the trickiest part — the angled back legs. To cut angled legs like this, it meant finding some extra-wide lumber *or* gluing up a step-shaped blank. To save on lumber, I decided to glue up a blank from a couple pieces of 4x4 redwood posts (3½" x 3½" actual dimensions), see Fig. 1.

CUT LEGS. Start by cutting two long back leg pieces (A) to a length of 35" and two short back leg pieces (B) to a length of 18". Then these pieces are trimmed down before they're glued together.

TRIM TO THICKNESS. Since the 4x4 posts come with factory-rounded edges, trim off one side of all the pieces to get a flat side with square edges, see Step 1 in Fig. 1. Then with the flat side against the fence, resaw the posts to 2½" thick, see Step 2.

CLEAN UP THE EDGES. Once the leg pieces are cut to thickness, turn the workpiece 90° and trim about ⅛" off one edge of each piece to get a flat working surface, see Step 3. Then flip the piece around so the flat surface is against the fence and trim ⅛" off the other edge to get a clean gluing surface, see Step 4.

GLUING UP THE LEGS. Once the back leg pieces are cut to size, glue a long piece (A) and a short piece (B) to form a blank for each leg, see Fig. 1. (Note: See article on outdoor glues on page 14.)

LAYOUT. When the blanks are dry, lay out the legs with a 12° angle for the back rest. To get this angle, start by measuring from the bottom front corner over 3½" to mark Point A, see Fig. 2.

Then from Point A measure 17" to the front edge of the leg and mark Point B. Connect these two points to establish the 12° angle.

To mark the overall length of the leg, start at Point B and measure 17" along the front edge of the leg to the top front corner and mark Point C.

Finish the leg layout by marking the back edges of the leg parallel to and 2½" from the front edges. (Note: Label the point where these two lines intersect — the back of the knee — as Point D.)

CUTTING THE ANGLE. At first, I considered cutting out the legs on a bandsaw. But I was concerned about getting a straight cut and how to clean up the rough saw marks. So I switched to a table saw, which presented a problem with cutting the "inside bend" at Point D.

To cut the legs on a table saw, tack a ¼"-thick plywood carrier piece (about 10" x

FIGURE 1

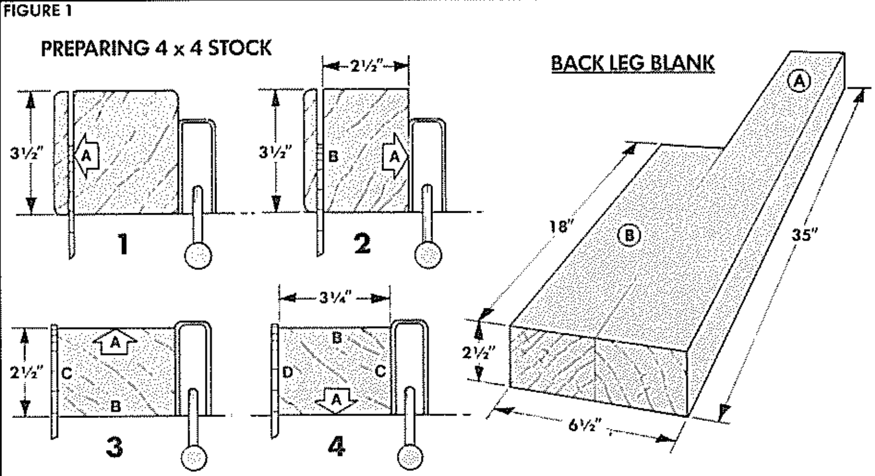
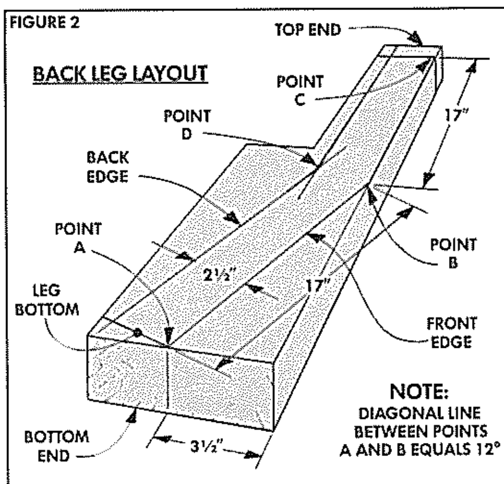


FIGURE 2



36") to the leg blank so one edge lines up on the angled pencil line connecting Points A and B, see Fig. 3. Then make a cut right on the edge of the plywood to trim off the angled part of the leg, see Fig. 4.

CUT THE BACK EDGE. Next, I cut the "inside bend" in two passes. The first pass goes almost to the back of the knee. The second pass also goes almost to the back of the knee, but from the *other* end. The problem is determining where to stop.

To determine the stop point, lay out a reference line from Point D (on the back of the knee), across the short board, and down the side, see Fig. 5.

Next raise the blade 2¾" high and place a pencil mark on the saw table right at the point where the front of the blade enters the opening in the table, see Fig. 6. Extend a reference line from this mark about 5" out from the blade.

Now set the rip fence to make a 2½"-wide cut and cut the *top* of the leg to width, stopping a little short of the point where the reference line on the workpiece lines up with the line on the saw table, see Step 1, Fig. 7. Turn off the saw and remove the leg.

To cut the *bottom* of the leg, flip the leg over and turn it end for end. Once again stop short of where the two reference lines line up, see Step 2, Fig. 7.

FINISH THE CUT. To finish the cut use a hand saw or bandsaw. Then use a sharp chisel to clean up the back of the knee, see Detail in Fig. 7.

CUTTING TO LENGTH. After the back of the legs are cleaned up, cut both ends to final length (17" from Point B, see Fig. 2).

FRONT LEGS

Next cut two front legs (C) from a 4x4 post to a rough length of 25", see Fig. 9. Follow the same procedure as on the back legs (Steps 1 and 2 in Fig. 1) to resaw the front legs to 2½" thick and then rip them 2½" wide.

MORTISE LAYOUT

Once all four legs are cut to size, I laid out the positions of the mortises for the mortise and tenon joints that hold the whole bench together.

Shop Note: To keep everything straight and get mirrored sets, I found it was easiest to stand up all four legs into position (see Fig. 8) and pencil in rough reference marks where the mortises are located.

All the mortises are centered on the thickness of the stock and ½" in width. It's the length and location of the mortises that varies.

MORTISES. I started at the top of the back legs laying out the 1½"-long mortises for the upper back rail on the *inside* faces of each back leg, see Fig. 9.

Then I worked my way down the legs, laying out the mortises for the arms, the front and back rails, the seat supports, and the stretchers as shown in Figs. 8 and 9.

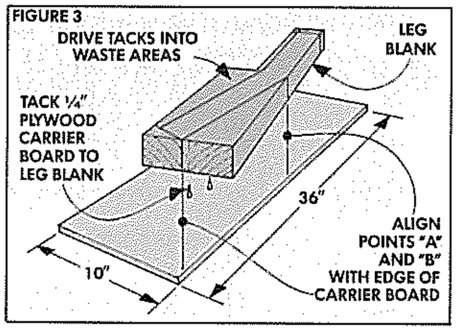
FIGURE 3


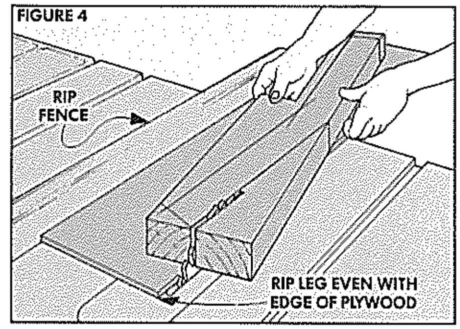
FIGURE 4


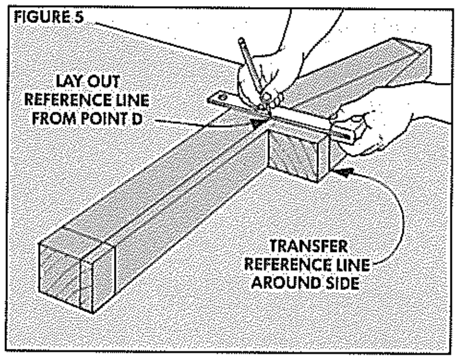
FIGURE 5


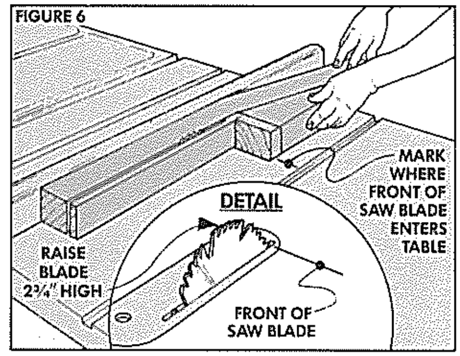
FIGURE 6


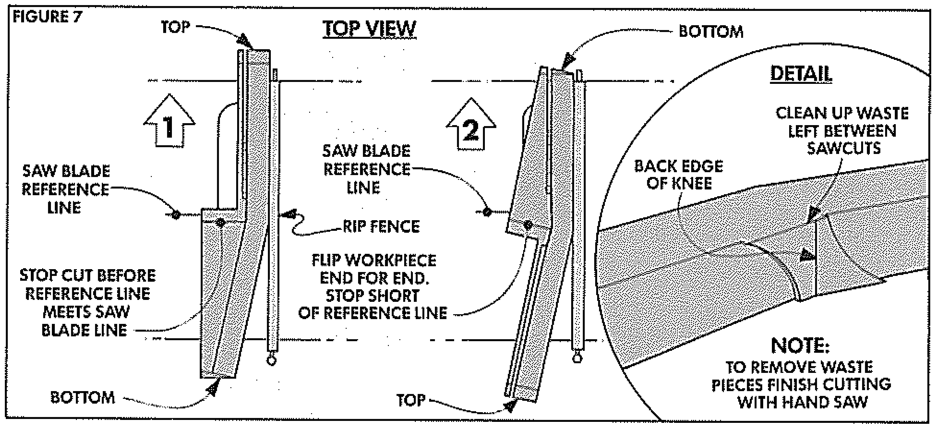
FIGURE 7


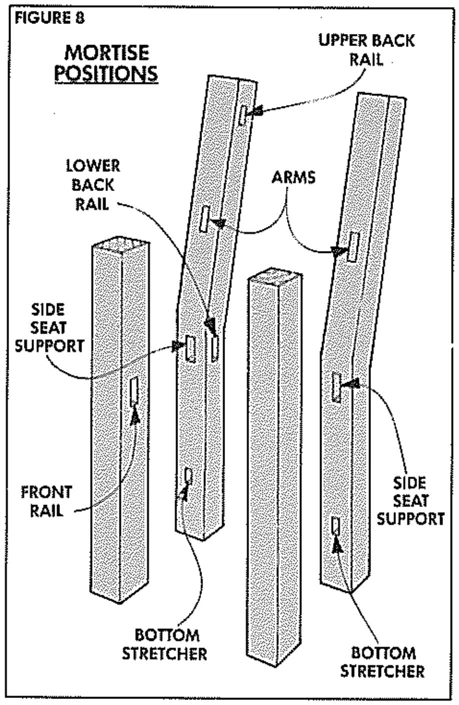
FIGURE 8


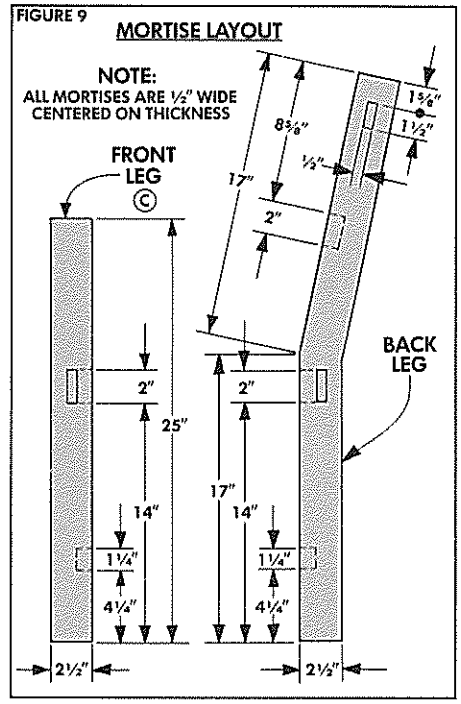
FIGURE 9


FIGURE 10

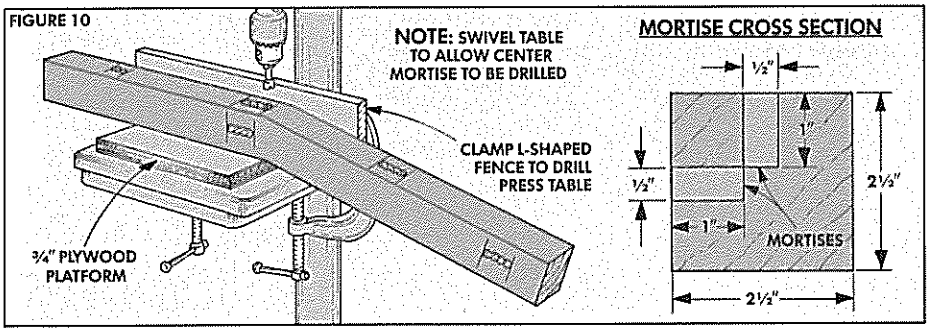


FIGURE 11

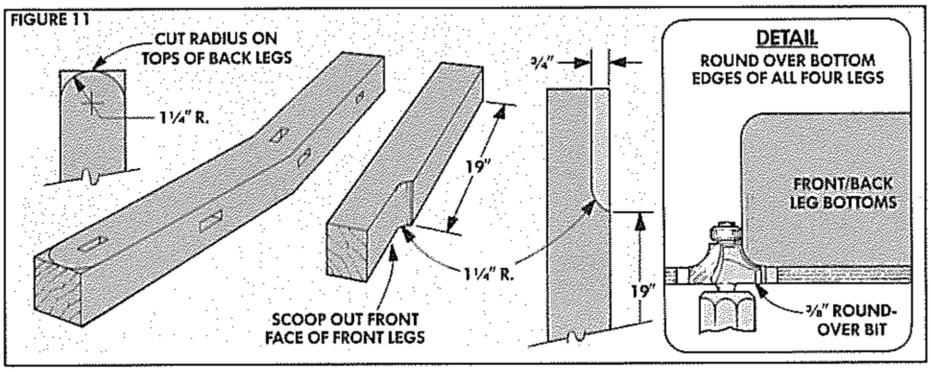


FIGURE 12

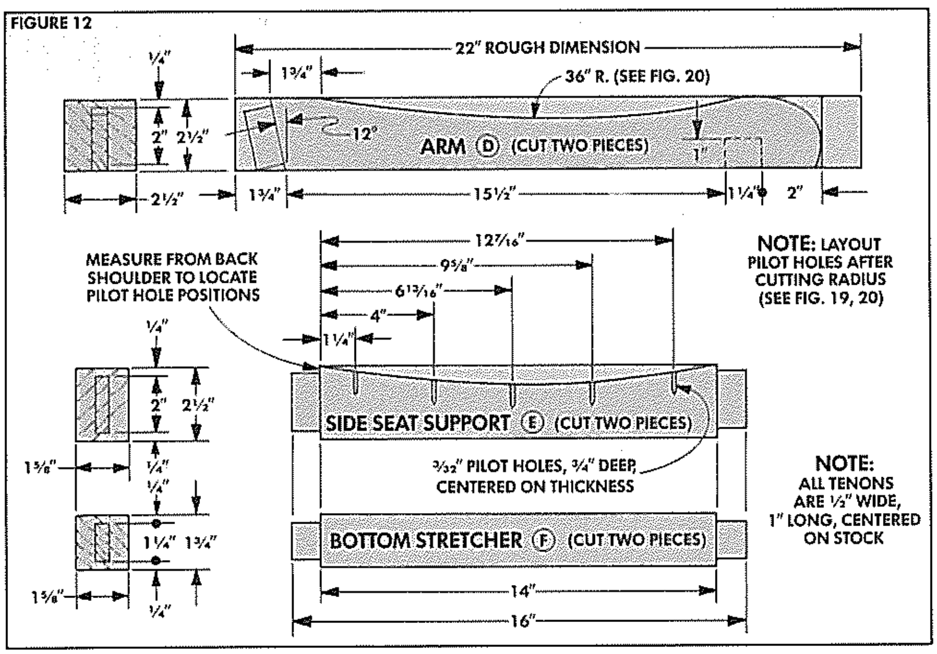
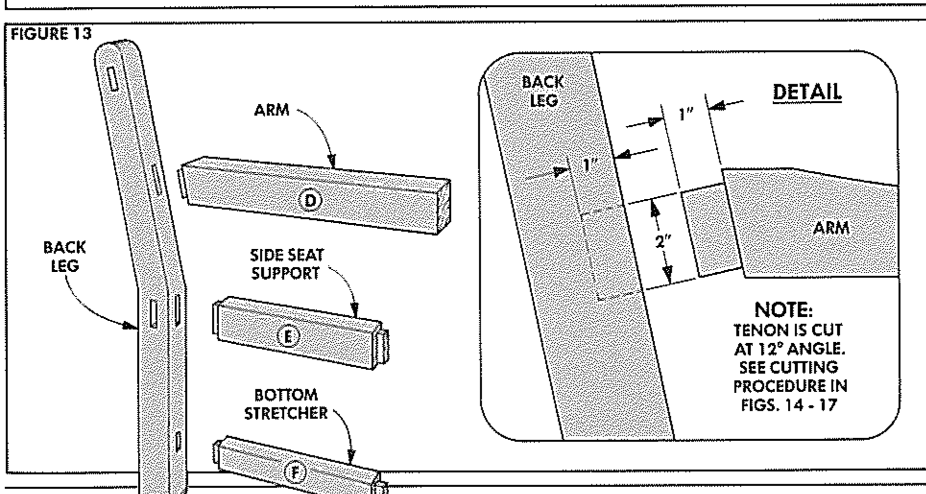


FIGURE 13



CUTTING THE MORTISES

Once the mortises were laid out on the legs, I roughed them out on a drill press with a ½" mortising bit by drilling overlapping holes. (Shop Note: Since the back leg won't sit flat on the drill press table, I built a temporary platform to support it, see Fig. 10.) After roughing out the mortises, I cleaned up the cheeks with a chisel.

FINISHING THE LEGS

There are still a couple of finishing steps on the legs. First, the *top* end of each back leg is rounded to a 1¼" radius, see Fig. 11. Then on the front legs, use a band saw to cut a ¾"-deep decorative scoop on the front face.

To keep the bottom of the legs from chipping, round over all four legs with a ⅜" round-over bit on the router table, see Detail in Fig. 11.

ARMS, SUPPORTS, STRETCHERS

Next work can begin on the arms, seat supports, and stretchers that fit between the front and back legs.

ARMS. Start by cutting two arm blanks (D) from a 4x4 post to 2½" square (follow the same procedure as the front legs) and to a rough length of 22", see Fig. 12.

SUPPORTS AND STRETCHERS. Next cut two seat support blanks (E) from "2 by" lumber to a width of 2½", and the two bottom stretcher blanks (F) to a width of 1¾". Trim the supports and stretchers to a finished length of 16", see Fig. 12.

THE TENONS

After these six pieces were cut to size, I began work on the tenons. The tenons on the back of the arms are angled, but the tenons on the seat supports and bottom stretchers are straight. I like to do the easy ones first, so I started on the straight tenons.

SEAT SUPPORTS. The tenons on both ends of the seat supports are ½" thick, 1" long, and cut to width (height) to fit the mortises (2"), see Fig. 12.

BOTTOM STRETCHERS. The tenons on the bottom stretchers are the same, except they're only 1¼" wide, see Fig. 12.

ARMS. Now for the fun part. To make the angled tenon on the arm so it matches the 12° bend in the leg, you have to cut a tenon with angled shoulders, see Detail in Fig. 13. To do this, angle the miter gauge at 78° (which is 12° on some miter gauges), see Fig. 14. Then raise the blade to a height of 1" and set the rip fence 1¾" away from the *outside* edge of the blade to act as a stop.

Shop Note: Before actually cutting the tenon on the arm, I worked through the entire process with a piece of scrap the same thickness as the arm blank.

Once all the settings are accurate, make the angled shoulder cut on the arm. Then make repeated passes over the blade until one side of the tenon is cut.

Now flip the workpiece over and switch the miter gauge so it's set at the opposite 78° (12°) setting, see Fig. 15. Leave the rip fence at the same setting and cut the other side to form the tenon.

To cut the tenon to length, move the rip fence out of the way and raise the blade. Use the same miter gauge setting and trim the tenon to 1" long, see Fig. 16.

Finally, I laid out the width of the tenon using the end of a ruler as a square, see Fig. 17. After it was laid out, I trimmed the shoulders down with a hand saw and smoothed them up with a chisel.

DRY ASSEMBLE. There's one more mortise and tenon joint to cut — the one needed to attach the arm to the front leg. To determine the location of this joint, dry assemble the back leg, arm, seat support, and stretcher, see Fig. 18.

Then to locate the position of the mortise on the bottom of the arm, put a straight edge on the shoulders of the tenons of the seat support and stretcher. Run the straight edge up to the bottom of the arm and mark a line at this position, see Fig. 18. Then mark out a 1¼"-long mortise ¼" in front of this line and bore it out.

TENON. The last step is to cut the mating tenon on the top of the front leg. To determine the location of the tenon's shoulder, measure from the bottom of the *back* leg to the bottom of the arm, see Fig. 18. Now make the shoulder cuts and then cut the tenon to fit the mortise, see Detail in Fig. 18.

SHAPING ARMS AND SEAT SUPPORTS

Before final assembly of the leg units, there are just a couple more steps.

RADIUS. The top of the seat supports are curved to make a comfortable seat. To make this curve, I made a template from a piece of poster board. Attach the poster board to the edge of a table and strike a 36" radius using a strip of wood as a beam compass, see Fig. 19. Then locate and mark the centerline at the low point of the arc and cut the template 2½" wide.

Now align the centerline of the pattern with the centerline of the seat support and mark the curve, see Fig. 20. While I was at it, I used the same curved template to mark the curve on the top edge of the arm, except this time the template is placed 1¾" from the top shoulder of the tenon to start the radius, see Fig. 20.

Finally, cut the arm to finished length and gently round over the front end of the arm as shown in Fig. 12.

SEAT SLAT HOLES. Before assembling the leg units, I drilled ³⁄₃₂" pilot holes on the seat support so the seat slats could be attached later. Center the holes on the thickness of the seat supports and at the locations marked in Fig. 12.

ASSEMBLY. After the pilot holes are drilled, the leg units can be glued and clamped together.

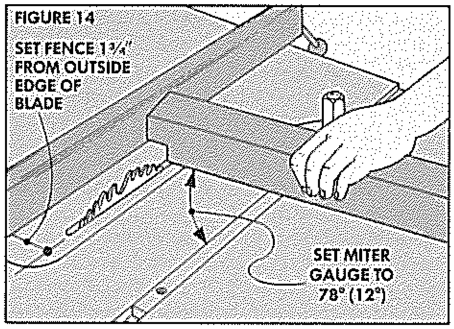


FIGURE 14

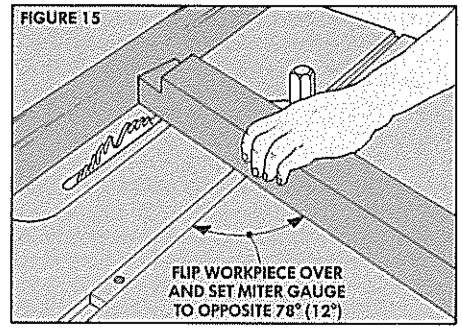


FIGURE 15

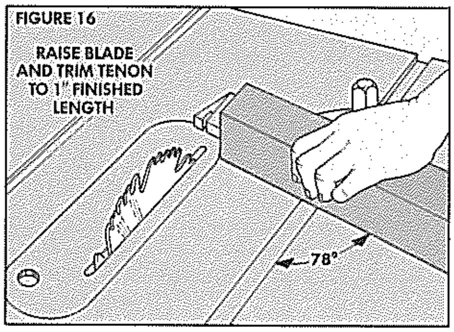


FIGURE 16

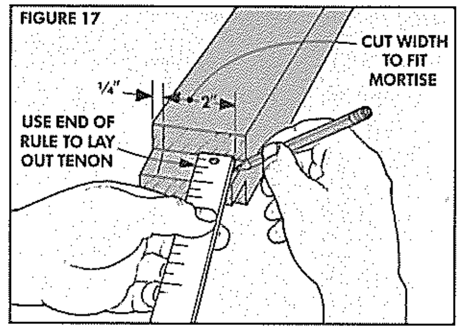


FIGURE 17

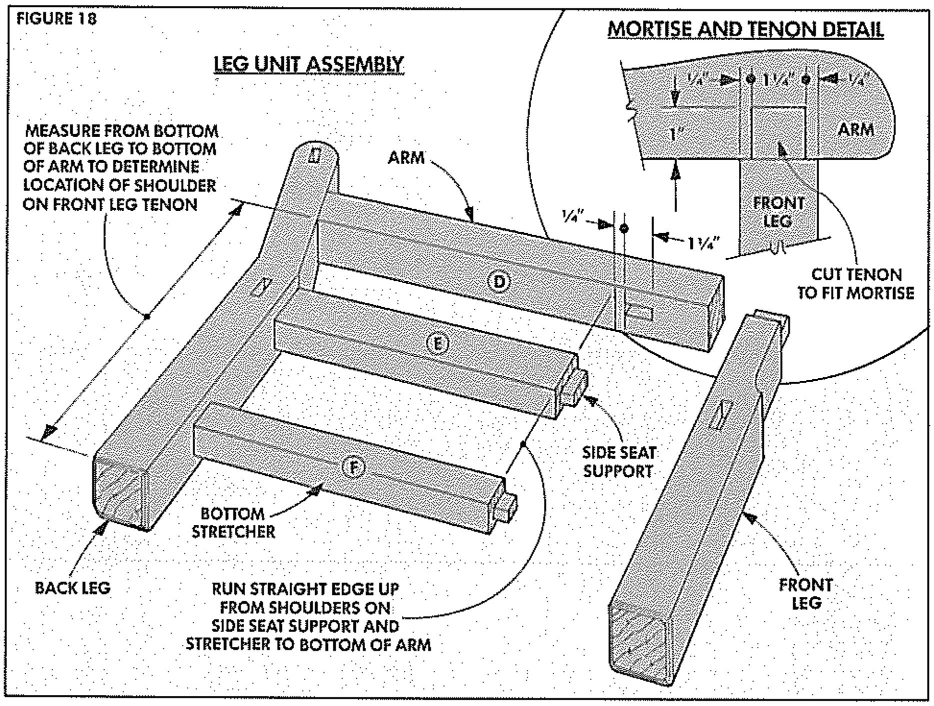


FIGURE 18

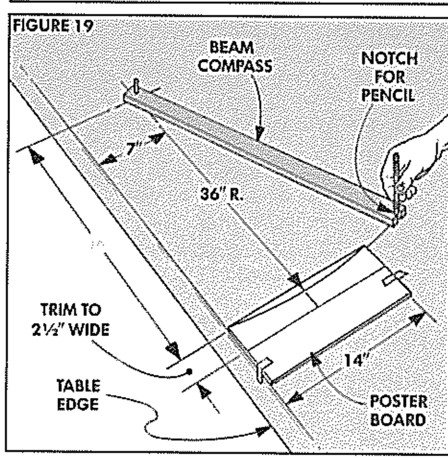


FIGURE 19

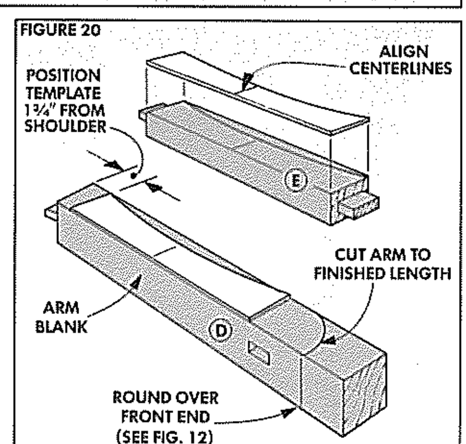


FIGURE 20

FIGURE 21

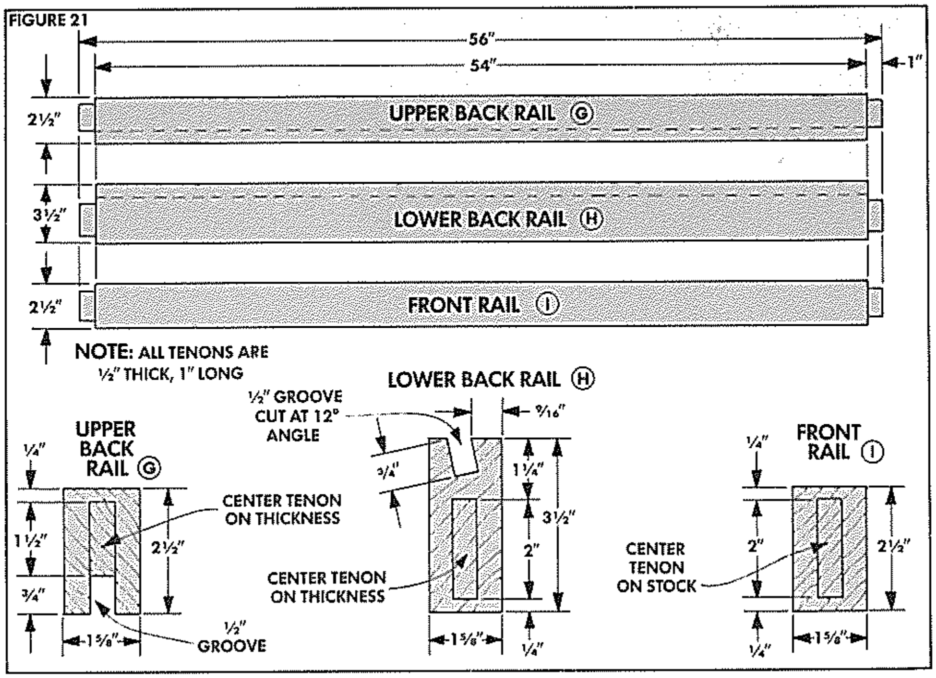


FIGURE 22

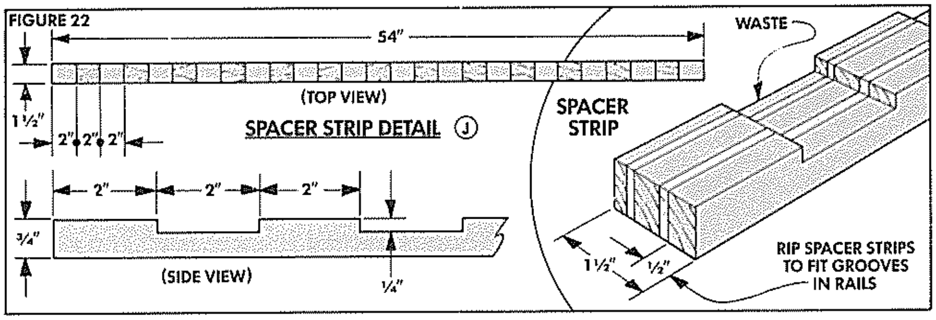


FIGURE 23

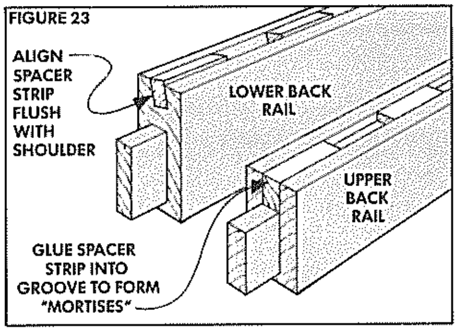


FIGURE 24

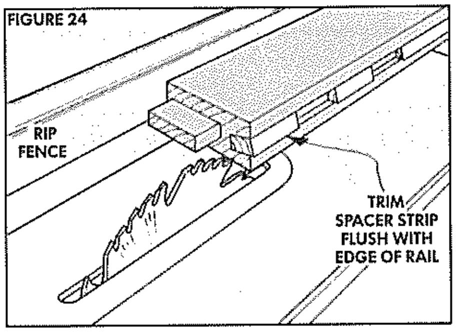
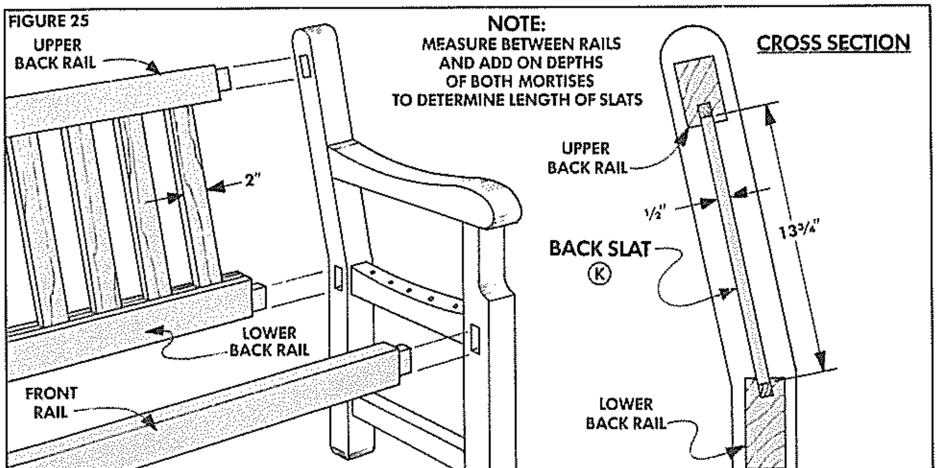


FIGURE 25



THE RAILS

Now work can begin on the three rails that connect the two assembled leg units in order to form the seat and back rest.

CUT TO SIZE. Start by ripping the upper back rail (G) and the front rail (I) from "2 by" stock to a width of 2½", see Fig. 21. Also rip the lower back rail (H) to a width of 3½". Then cut all three rails to a final length of 56".

TENONS. After the rails are cut to size, cut 1"-long tenons on the ends of each rail. To allow space for the grooves for the back slats, offset the tenons on the width of the upper and lower back rails (G and H), see End Views in Fig. 21.

GROOVES. The back slats would normally be mounted to the rails by cutting a whole series of individual mortises. But there's an easier way. I used a notched spacer strip that's set into a groove on the edge of the rails, refer to Fig. 23.

The ½"-wide groove in the upper back rail is ¾" deep and centered on the thickness of the rail, see End View in Fig. 21. But to match the angle of the back rest on the back leg, the groove in the lower back rail is cut at a 12° angle, see End View in Fig. 21.

SPACER STRIPS. Once the grooves are cut in the rails, I cut notched spacer strips (J) to hold the slats. Start with a piece of "1 by" stock 1½" wide and trimmed to length to match the shoulder-to-shoulder length of the rails, see Fig. 22.

Now lay out the 2"-wide notches (dadoes) for the back slats along the spacer strip. Then cut the ¼"-deep dadoes across the strip. (Note: The strip starts and stops with a space, not a dado, see Fig. 22.)

When all the dadoes are cut, rip this piece to form the two spacer strips, see Fig. 22. Rip each strip to width (½") so it fits snugly in the grooves in the rails.

Once the strips fit the grooves, glue them in place making sure that the ends of the strips are flush with the shoulders of the tenons, see Fig. 23. When the glue is dry, trim the spacers flush with the edge of the rails, see Fig. 24.

BACK SLATS

Before joining the rails to the leg units, the thirteen back slats (K) have to be cut.

CUT SLATS TO SIZE. To make the back slats, start with seven pieces of "2 by" stock cut 2" wide and to a rough length of 15" long. Now resaw these pieces in half and then reset the fence to resaw the halved pieces to a final thickness to match the "mortises" (½"). (This basic procedure is shown in Fig. 9 on page 8.)

To determine the final length of the back slats, dry-assemble the leg units and the rails and measure the distance between the grooves in the upper and lower rails, see Fig. 25. (In my case this was 13¾".)

ASSEMBLY. After the slats are cut to length, mount them between the "mortises" on the edges of the rails. (Don't use any glue here, just let the slats "float" in the mortises.) Then glue and clamp the leg units and three rails together.

SEAT SLATS

Next, work can begin on the seat slats. There are five long seat slats (L) and one shorter slat (M) that fits on the front between the legs, refer to Fig. 27.

CUT TO SIZE. To make the slats, cut six pieces of "1 by" stock to a common width of 2½" and a rough length of 60", see Fig. 26. Then to determine the finished length of the seat slats (L), measure the distance from the outside of one front leg to the outside of the other front leg. (In my case this was 59".) The finished length of the front slat (M) is the distance *between* the front legs. (In my case this was 54".)

CENTER SEAT SUPPORTS

Before attaching the seat slats, I added two center seat supports (N) cut from "2 by" stock to a width of 2½", see Fig. 27.

To determine the length of these supports, measure the distance between the front rail (I) and the lower back rail (H). (In my case this was 15".) Then cut the pieces to length and cut the same curve on the top edge that is cut on the side seat supports (E), refer to Fig. 20.

MOUNT SUPPORTS. Position the center seat supports between the rails so they're centered 17" from the legs, see Fig. 27. Then to mount them, drill counterbored screw holes 1¼" from the bottom edge of the rails and centered on the thickness of the supports, see Figs. 28 and 29.

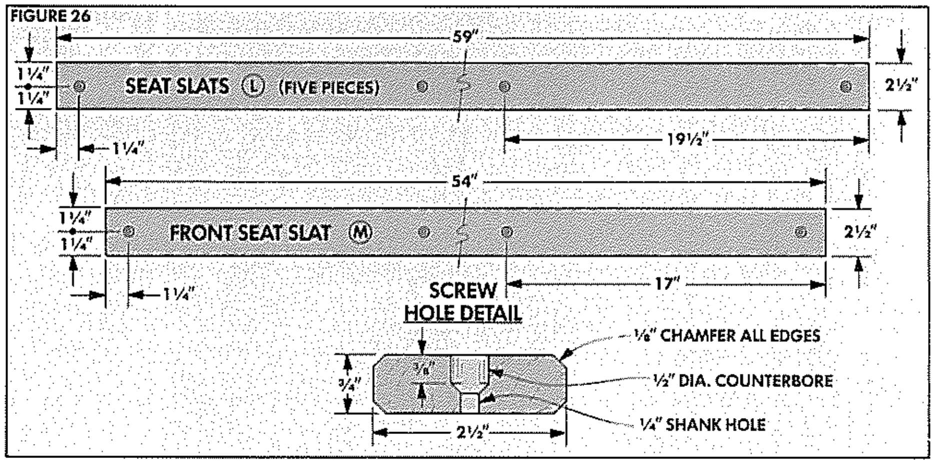
SCREW HOLES. After the center seat supports are attached, drill four counterbored holes on each slat, see Fig. 26. The holes at each end should be positioned so they line up with the pilot holes already drilled in the seat supports (E). The other two holes are centered over the two center seat supports (N).

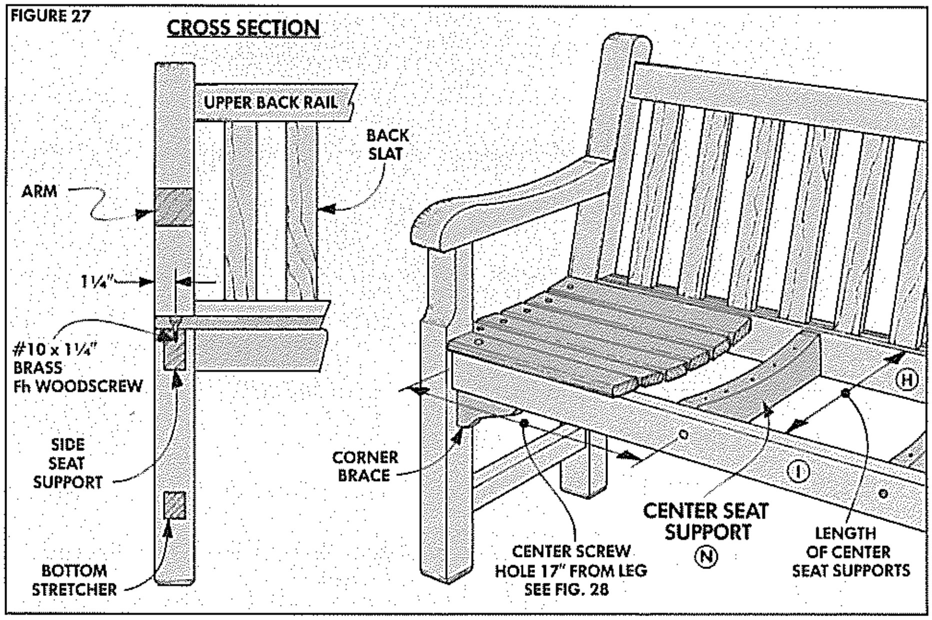
After the counterbores are drilled, chamfer all the edges and ends of each slat (except the ends of the front slat).

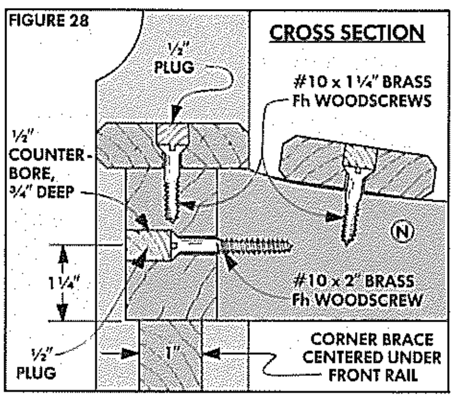
ASSEMBLY. Now screw down each seat slat (L) to the side seat supports (E) at each end, see Fig. 28 and 29. Then drill 3⁄32" pilot holes through the shank holes and into the center seat supports. And screw the slats down in the center. Finally plug all of the counterbored holes with ½" plugs.

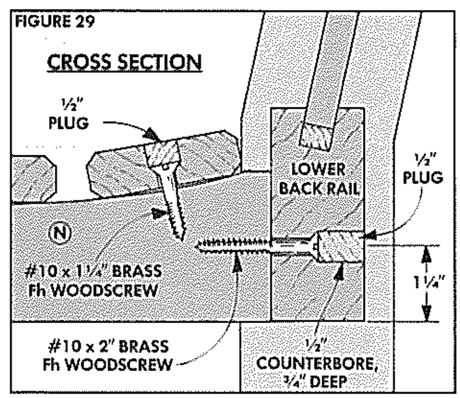
CORNER BRACES

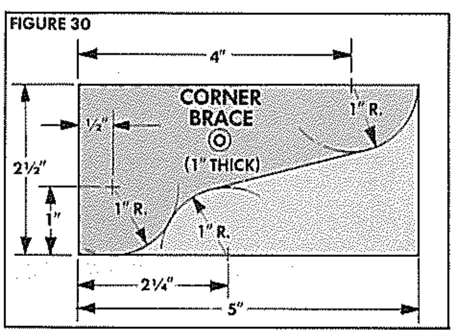
When all the plugs were cleaned off flush, I added corner braces (O) under the front rail where it meets the front legs, see Fig. 31. Cut these braces to shape from a piece of "2 by" stock resawn to 1" thick, see Fig. 30. Then screw the corner braces in place, see Fig. 31.











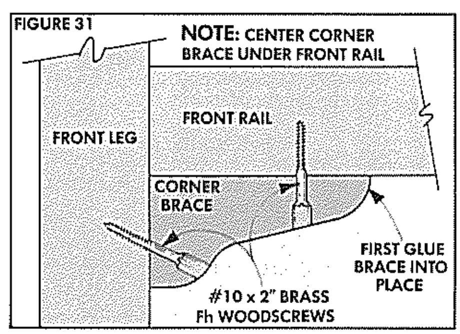


FIGURE A

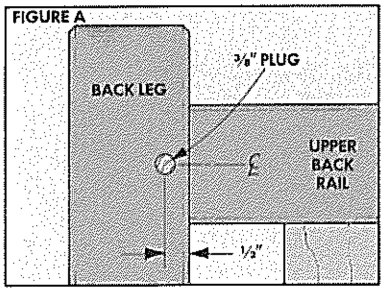


FIGURE B

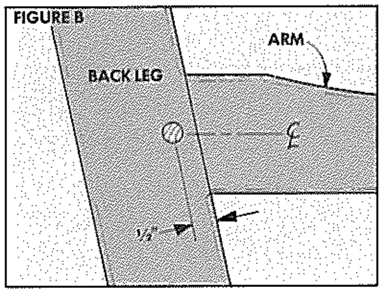


FIGURE 32

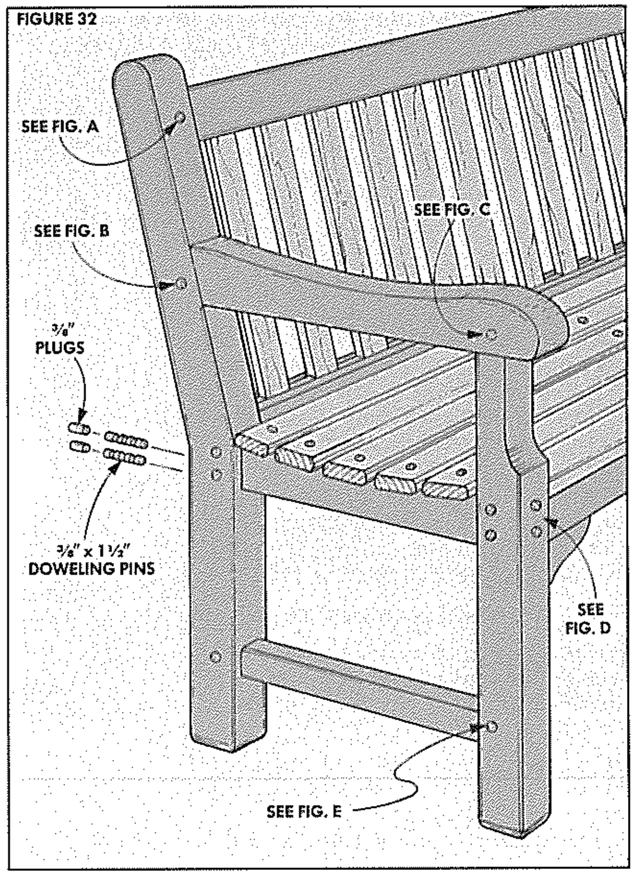


FIGURE C

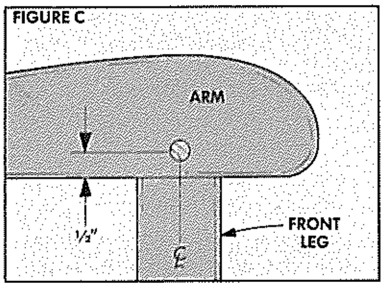


FIGURE D

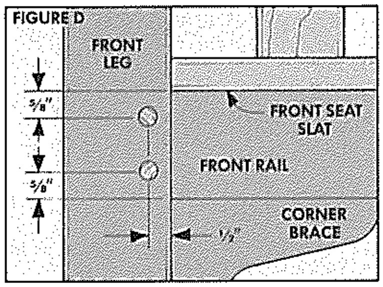
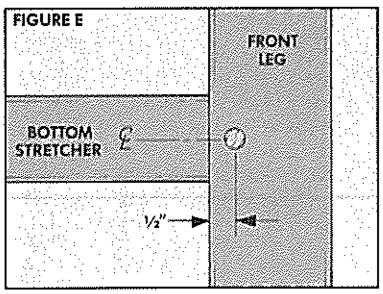
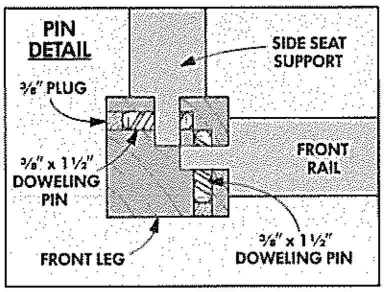


FIGURE E



PIN DETAIL



PINNING THE MORTISES

There's really only one more step in building the bench — pinning the mortise and tenon joints. Since the bench is going to sit outside, the wood will expand and contract, possibly weakening the joints. So I put dowel pins through each joint to hold it tight.

LOCATING THE HOLES. Center the holes for the pins over the upper back rail (see Fig. A), arms (Figs. B and C), and the bottom stretchers (Fig. E). There are two pins in each of the joints that attach the front rail and lower back rail (Fig. D) and side seat supports to the legs.

All the holes are centered 1/2" away from the shoulder line of the tenon. When all the holes are located, drill 3/8"-dia. holes, 1 7/8" deep at each location.

DOWELING PINS. For the pins, I used 3/8" x 1 1/2" doweling pins (sometimes called gluing dowels). These pins (with spiral or fluted grooves and tapered ends) slide into the holes a little easier. After applying glue and driving all the pins to the bottom of the holes, I plugged them with 3/8" plugs and cut the plugs off flush.

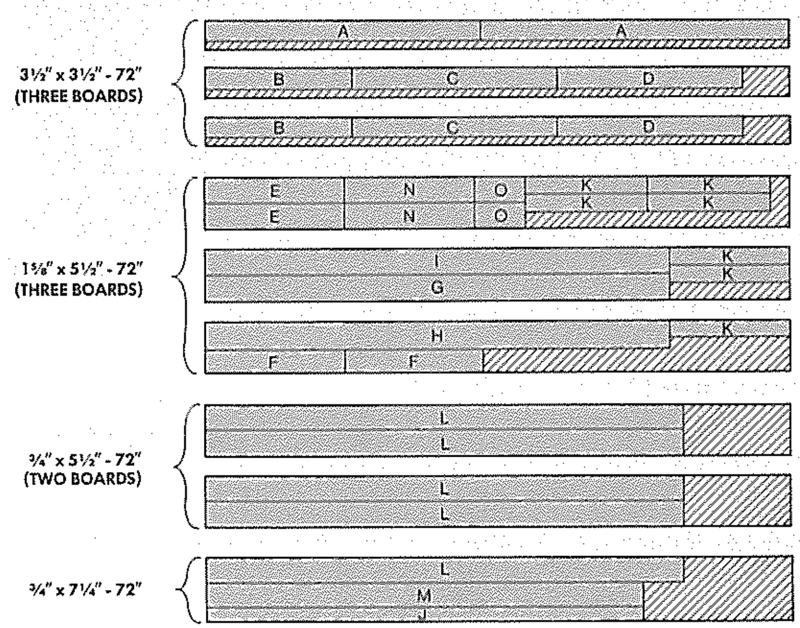
FINISHING

Before I finished the bench, I slightly rounded all the exposed edges with 150-grit sandpaper to prevent splinters. Then I applied three coats of a spar varnish/tung oil combination. (See article on page 15). And, finally, I had my own bench to rest my weary legs.

MATERIALS LIST AND CUTTING DIAGRAM

Overall Dimensions: 33 3/4" h x 23 1/2" d x 59" l

A Long Back Leg Pieces (2)	2 1/2 x 3 1/4 - 35	H Lower Back Rail	1 5/8 x 3 1/2 - 56
B Short Back Leg Pieces (2)	2 1/2 x 3 1/4 - 18	I Front Rail	1 5/8 x 2 1/2 - 56
C Front Legs (2)	2 1/2 x 2 1/2 - 25	J Slat Spacer Strip	3/4 x 1 1/2 - 54
D Arms (2)	2 1/2 x 2 1/2 - 22	K Back Slats (13)	1/2 x 2 - 13 3/4
E Side Seat Supports (2)	1 5/8 x 2 1/2 - 16	L Seat Slats (5)	3/4 x 2 1/2 - 59
F Bottom Stretchers (2)	1 5/8 x 1 3/4 - 16	M Front Seat Slat	3/4 x 2 1/2 - 54
G Upper Back Rail	1 5/8 x 2 1/2 - 56	N Center Seat Supports (2)	1 5/8 x 2 1/2 - 15
		O Corner Braces (2)	1 x 2 1/2 - 5



Talking Shop

AN OPEN FORUM FOR COMMENTS AND QUESTIONS

REDWOOD STANDARDS AND GRADES

When the projects for this issue were designed, we decided to use redwood. It would be natural to assume that since redwood is a softwood, the thicknesses would be the same as standard construction lumber. For example, "1 by" lumber (such as a 1x4) should be the standard ¾" finished thickness.

But this isn't necessarily true. The "1 by" redwood I bought at one lumberyard was ¾"-thick as expected, but ¹¹⁄₁₆"-thick at another yard. The "2 by" redwood ran anywhere from 1½" thick (as expected) up to 1⅝" thick. And I expected the 4 x 4 redwood posts for the legs and arms on the garden bench to be the standard construction 3½" x 3½". But when I measured them I found that some weren't even square. The measurements ran from 3⅜" to 3⁹⁄₁₆".

STANDARDS. So what are the standards for redwood lumber?

"We have developed standards for the industry to assure that redwood is properly graded and is in accordance with set specifications," explained Chris Grover, who works in Product Publicity for the California Redwood Association.

"The mills send it out pretty close to these specifications. If it's kiln dried by one of the major mills and then surfaced by that mill, there will be a 'Certified Kiln Dried' stamp of the Redwood Inspection Service on every board and it should meet the specifications.

"But a lot of the lumber is sold rough and then it's remanufactured to a variety of thicknesses by different plants or wholesalers. It can pass through a lot of hands before it gets to the consumer and the thicknesses may vary from one dealer to another. Or in some cases it can go straight from the mill to the market and measure right on the specifications."

Chris sent me a copy of the standard specifications grade book published by the Redwood Inspection Service. The standards are set and clear, but there is a footnote next to the 1½" dressed thickness of "2 by" (nominal 2") lumber. The footnote reads "1⅝" dressed green and dry is *also being manufactured.*"

I guess the way redwood thickness specifications are applied ends up being closer to hardwood than softwood construction materials. There are established hardwood thickness specifications, but the actual finish thicknesses can vary from dealer to dealer. Softwood construction materials follow specifications much closer since they're used nationally for building construction.

GRADES. The grade book also explains the grading system for redwood. There are ten grades, but the redwood I found locally was one of four grades: Clear All Heart, Select Heart, Construction Heart, and Construction Common.

The ¾"-thick redwood I used for the seat slats on the the garden bench and the wheels on the chaise is Clear All Heart. It's cut from the heart of the tree (no white sapwood) and doesn't contain any knots or major defects.

The "2-by" material for the chaise and the garden bench is Select Heart. It's also all heartwood but may contain some small tight knots and other defects.

The "4x4's" for the legs and arms of the garden bench are Construction Heart posts since Clear or Select are hard to find in lumber this thick. Construction Heart is all heartwood (Construction Common contains some sapwood), and I did have to cut around some sizeable knots and include some smaller knots in the project. (This is where knowing the rough length of all the pieces *before* going to the lumberyard helps answer the question "Can I work around all these big knots?")

Chris also mentioned that the California Redwood Association will send out a free, four-color flier describing where to use the different grades and what to expect of each. To obtain the flier titled "Redwood Grades and Uses," send a self-addressed, stamped envelope to the California Redwood Association, 591 Redwood Highway, Suite 3100, Mill Valley, California 94941.

OUTDOOR SCREWS

There's nothing worse than building an outdoor project and then watching the steel screws or nails slowly react with the wood and moisture to create dark stains and streaks. Probably the worst culprit is oak's reaction to steel screws. The tannic acid in the oak reacts with the ferrous metal. But it can happen in just about any wood. One solution to this problem is to choose a different kind of screw.

ZINC PLATED SCREWS. If you go into a local hardware store and ask for wood screws you're likely to get zinc plated screws. These steel screws have been run through an electrically-charged zinc bath and some of the shiny zinc sticks to the screw. But like cheap gold jewelry, the zinc plating quickly wears or chips off. And then they rust and corrode in humid or wet conditions.

BRASS SCREWS. The other wood screws usually found locally are made from brass. They won't rust, streak, or react with the tannic acid like steel screws, but they will eventually oxidize and turn green. Nevertheless, I use them for outdoor furniture, especially if I'm going to counterbore and plug the holes.

But there's one major problem with brass screws — they're so soft that they break easily. If you're putting brass screws into a very hard wood like oak or maple and you twist it just a smidgeon too much, the head snaps off.

To prevent this problem, carefully drill the correct size pilot and shank hole and then drive a *steel* screw all the way into the hole. Then back the steel screw out and screw the brass screw into the already threaded hole.

If you shop around, you may be able to find or order three other special screws for outdoor projects. Most are sold to boatbuilders who need hardware that won't rust or corrode in extremely wet and salty conditions.

SILICON BRONZE SCREWS. Silicon bronze screws are similar in color to brass screws but are a different alloy. Brass is a copper and zinc mixture and bronze is a copper and tin mixture. The bronze screws won't oxidize or corrode as easily as brass. And they're stronger. They won't strip out of a hole or snap off as easily as brass.

HOT DIPPED GALVANIZED SCREWS. Hot dipped galvanized screws are made by dipping hot steel screws in molten zinc. The properties are the same as zinc plated screws, but the bond is better so the zinc won't flake off. (If you're working with nails outdoors, hot dipped galvanized nails — the ones that feel and look rough — are much better than the smoother-feeling electro-plated version.)

STAINLESS STEEL SCREWS. Stainless steel screws have chrome and nickel added to the iron to make it shiny and rust resistant. These screws are the strongest and most durable of all. Eventually they turn a reddish color, but like brass and silicon bronze, they won't stain the wood since they don't react as much with the tannic acid.

COSTS. Stepping up from zinc plated steel and brass screws to these others does increase the cost. Jamestown Distributors, a mail order source for boatbuilders (see Sources, page 24), lists the following prices for one hundred No. 8 x 1¼" flathead wood screws: zinc plated steel — $1.65; hot dipped galvanized steel — $2.80; brass — $2.80; stainless steel — $4.00; silicon bronze — $4.85.

Sources

CHAISE LONGUE

Parts for the Chaise can be bought locally:

- (2) 30 x 5/8" V-Belts
- (2) 1¼" x 3" Strap Hinges (folded length)
- (12) No. 8x ¾" Panhead Screws
- (36) No. 8 x 1¼" Fh. Brass Screws
- (46) No. 8 x 1½" Fh. Brass Screws

Note: You can use another type of metal screw besides brass listed above.

PLUG CUTTERS. You will need to cut some ½" wooden plugs for the Chaise (and 3/8" plugs for the Garden Bench) to cover the screws. Woodsmith Project Supplies is featuring a set of three cutters including: ¼", 3/8", and ½". These plug cutters are made from high carbon steel, are self-starting, and even eject the plug easily. Plug cutters are also available from the catalog sources listed below.

Set of Three Plug Cutters
W45-1505-412

CUSHIONS. We bought the cushions shown in the photograph at a local store that carries outdoor furniture. They're called "chaise replacement cushions."

We used two separate cushions (about 20" wide x 37" long each), but most one piece cushions that are sold (usually 23" or 24" wide x 72" long) should also fit the Chaise. The size of the cushions varies slightly depending on the fill and tufting. It's okay if some cushion overlaps the side of the chaise.

If you can't find cushions locally, they can be ordered through large retail catalogs such as Sears and J.C. Penney. (Look in the summer sales brochures since they aren't shown in the full-line catalogs.)

GARDEN BENCH

You should be able to find the screws and doweling pins (used to pin the mortise and tenon joints) locally:

- (24 min.) No. 10 x 1¼" Flathead Brass Screws
- (8 min.) No. 10 x 2" Flathead Brass Screws
- (26) Doweling Pins 3/8" x 1½"

Note: If you can't find the pins (sometimes called gluing dowels) locally, they're available from the sources listed below.

MORTISING BIT. There are a number of ways to cut out mortises. One of our favorite methods (and the least expensive since it doesn't require a square mortising chisel or attachment for the drill press) is to use *Sears* Mortising Bits.

Editor's Note Upon Reprinting. Unfortunately the mortising bits mentioned above are no longer in production. We recommend using either a forstner bit or a spiral end mill bit for cutting the mortise.

BRAD POINT BITS

Brad point bits are great for drilling. Unlike twist bits, brad points work off of their centerpoint, which means no wandering or drifting. **Woodsmith Project Supplies** is featuring a 7 Piece Brad Point Bit Set which includes the following sizes: 1/8" 3/16", ¼", 5/16", 3/8", 7/16", and ½".

7 Piece Brad Point Drill Bit Set
W45-1505-410

There are a number of other sources that feature brad point bits mentioned in the article on pages 4-5. (See below.)

PROTRACTOR. The stainless steel protractor we used to measure the relief angle on the bits (shown on page 4) is made by General and is available at most hardware stores. Also refer to sources listed below.

OUTDOOR WOODS

Quality teak, mahogany, redwood, and cedar can be hard to find in many areas of the country (see article on page 13). One source that has all of these woods in a variety of sizes is M.L. Condon Co. They are a large dealer of boat lumber but also carry a variety of more common lumber (including walnut, cherry, oak, maple, and ash) and even some exotics (including ebony, rosewood, padauk, and bubinga).

For more information, prices, and shipping requirement contact M.L. Condon Co., 250 Ferris Ave., White Plains, NY 10603 (914) 946-4111.

OUTDOOR FINISH

You can use any spar varnish and tung oil to make the finish explained on page 15. Again if you can't find them locally, refer to the sources below.

OUTDOOR SCREWS

You can order zinc-plated, galvanized steel, brass, silicon bronze, and stainless steel screws mentioned on page 23 from Jamestown Distributors. They have a wide range of screws (slotted and phillips, flat, round, and ovalheads) from No. 4 to No. 20 and ¼" to 4" long. For a free catalog call number listed below.

OUTDOOR GLUES

If you can't find the glues locally that are mentioned in the article on page 14, you can order them from the sources listed below.

WOODSMITH PROJECT SUPPLIES

ORDER BY PHONE

For fast service, use or Toll Free order line. Phone order can be placed Monday through Friday between 7:00 AM and 7:00PM CST

Before calling, have your VISA, MasterCard, or Discover card ready.

800-444-7002

Merchandise is subject to availability. Please all for current prices.

MAIL ORDER SOURCES

Similar hardware and supplies may be found in the following catalogs. Please call each company for a catalog or information.

Woodcraft
800-225-1153
Plug Cutters, Bits, Protractor, Finishes, Books

Constantine's
800-223-8087
Plug Cutters, Bits, Finishes, Protractor

The Woodworkers' Store
800-279-4441
Screws, Doweling Pins, Bits, Finishes

Jamestown Distributors
800-423-0030
Screws, Glues, Finishes

Trendlines
800-767-9999
Screws, Plug Cutters, Bits

Garrett Wade
800-221-2942
Plug Cutters, Bits, Finishes, Protractor